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(54) **Fusible mechanism for the bolted joint connecting the horizontal fence railings and the vertical support posts of metallic safety barriers used in the margins and median strips of roads for vehicle contention**

(57) Fusible mechanism for the bolted joint connecting the horizontal fence, beams or railings (1) of a metallic safety barrier to the vertical support poles (2) of same that confers said joining element the capacity to be released or disengaged in a controlled manner when the intensity of the force transmitted to said joining element

by an impacting vehicle reaches a pre-established threshold value. Said joining element is comprised by a bolt (3) in which a straight section or area in the rod located at a particular distance from its head has been mechanically or chemically treated to reduce its mechanical resistance capacity.

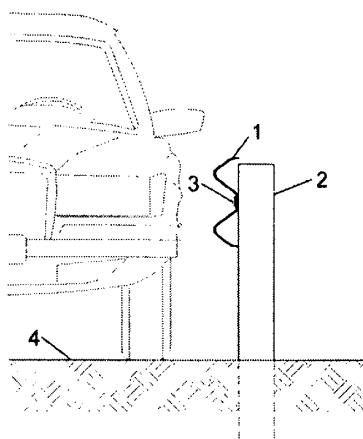


FIG. 2a

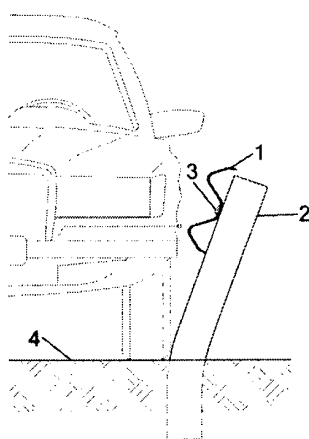


FIG. 2b

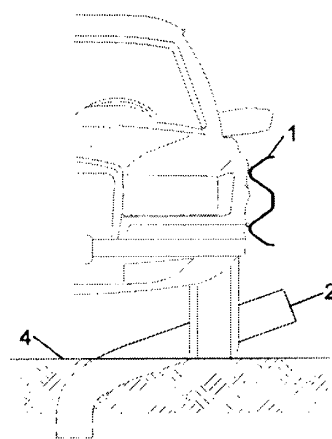


FIG. 2c

FIG. 2

## Description

### OBJECT OF THE INVENTION

**[0001]** The present invention refers to a fusible mechanism applicable to the bolted joints connecting the horizontal fences, beams or railings to the vertical support poles of a metallic vehicle contention system intended to contain lateral vehicle impacts or safety metallic barrier, that confers said joining element the capacity to be released or disengaged in a controlled manner when the force caused by a vehicle impacting the metallic safety barrier that acts on it exceeds a pre-established threshold value, said safety barrier being of the kind generally used in roadside embankments and in median strips of roads and, occasionally at the edges of road bridges decks, contention wall caps or similar structures.

### STATE OF THE ART

**[0002]** A variety of vehicle contention systems are used in the general practice, understanding as such any device installed on a road which is intended to provide means of retention and redirection for vehicles that veer off the road erratically while out of control. These devices reduce the severity of accidents caused in this manner, limiting damages and injuries for both the occupants of the vehicle and the remaining road users as well as for other persons or objects standing or located nearby.

**[0003]** One of the contention systems that is most often implemented commercially is the metallic safety barrier, a device used in the sides and median strips of roads. These systems are intended to resist vehicle impacts while at the same time preventing the vehicle from going through the barrier and thus ensure protection for third parties, allowing for a controlled redirection and deceleration of the colliding vehicle in such a manner that the vehicle can come out of the impact in a stable manner and can continue on its way at a decreased speed next to the contention system and in the original direction of traffic and lane it was traveling, and thus ensure the safety of the occupants of the vehicle and other road users.

**[0004]** In compliance with current legislation, (EN 1317-2 in Europe and NCHRP 350 in the US), metallic safety barriers and parapets are subject, before being used commercially, to standardized full scale crash tests. During these tests a vehicle is crashed in a controlled manner against a contention system and then performance is evaluated qualitatively and quantitatively. The performance of a contention system is considered satisfactory when all the requirements and acceptance criteria established in the legislation for a full scale crash test are met, particularly in what pertains to level of contention, impact severity, deformation and departure angle, and therefore ensures suitable safety conditions, mainly for the occupants of the impacting vehicles and for third parties. It is then stated that a contention system is capable of con-

taining a particular type of vehicle.

**[0005]** According to the aforementioned legislation, a contention system (specifically designed to receive crashing heavy vehicles such as trucks and buses) must pass real full scale crash tests for both passenger cars and heavy vehicles (heavy weight passenger cars, trucks and buses), as well as crash tests for light vehicles (light weight passenger cars). This allows standard and high contention systems to also ensure the safety of lighter vehicles, which are the vehicles most frequently involved in accidents. For instance, according to the European standard EN 1317-2, the standard level of contention N2 requires the barrier to pass the TB32 crash test (impact of a 1500 kg heavy weight passenger car traveling at 110Km/h speed, impacting the contention system at a 20° crash angle) plus the TB11 test (impact of a 900 kg light weight passenger car traveling at 100Km/h speed, impacting the contention system at a 20° crash angle).

**[0006]** In real life situations, commercial contention systems offer several solutions against impacts from both light and heavy vehicles and have the following problems:

**[0007]** On the one hand, all the constituting elements of safety barriers have, generally, the capability to react in a similar manner and as a whole, by deforming when impacted by either a light or a heavy vehicle. Safety barriers designed to withstand impacts from heavy vehicles (known as high contention barriers) have, generally, operating mechanisms capable of responding differently when impacted by a light or heavy vehicle. For said barriers, successful design is obtained when the same barrier can perform satisfactorily when responding appropriately to such different types of impacts.

**[0008]** Safety barriers designed to withstand impacts from heavy passenger cars (standard contention) have, generally, operating mechanisms capable to respond progressively to the impact of passenger cars having different gravity indexes (transversal kinetic energy of the impact) which ensure a reasonably decreased maximum deformation before impacts indexed at the greatest severity level, and, in all cases, at a level of severity (based on measuring the deceleration progression the vehicle goes through during impact) sufficiently low, while also having the capability to suitably redirection the vehicle along its departure path.

**[0009]** The basic configuration of metallic safety barriers is that of two basic metallic elements joined together and two other elements, a third and a fourth that are optional:

1°.- The **fence(s) or guardrail(s)**, are the longitudinal elements arranged horizontally in one or two levels at a given height in a continuous manner, which function is to contain and guide the vehicle colliding against it, thus preventing it from going through the fence or guardrail element, limiting transversal deformation and guiding it so it can be redirected by the system in a suitable manner. The fence may be configured in various manners: one or several lon-

gitudinal profiles having an open or nearly-closed cross-section and shaped as a double or triple wave or "C" or "sigma" shaped, joined to the pole by means of a spacing element; cables or stressed metal rods affixed directly to the pole; longitudinal profiles shaped as double or triple wave which lower side is joined to metal sheets that are capable of moving freely and are calibrated to oppose a given resistance when receiving an impact.

2°.- The **pole**, placed vertically at regular intervals and affixed to the fence(s) or guardrail(s), which function is to support and maintain the fence(s) or guardrail(s) elements of the barrier at a pre-established height during vehicle impact. The poles are generally metal profiles which section may be either "C", "U", "I", "Sigma" or "Z" shaped, closed round or rectangular tubular sections or other types of section that are embedded in a road embankment or median strip so a portion of their length is either inserted in the ground or secured to it by means of a plate anchored to the ground with bolts. When impacted by a vehicle and as a function of the energy generated by said impact, the pole will deform more or less, bending and/or twisting in relation to the embedded or anchored portion.

3°.-The **spacing** element is the intermediate connecting part that is often placed between a fence or guardrail and the pole. The functions of said spacing element are as follows:

- (I) Joining the fence or guardrail to the securing poles at a certain height,
- (II) Acting as spacing element between said fence or guardrail and the pole to prevent the vehicle's wheel to become hooked or otherwise engaged on the pole when it impacts the barrier,
- (III) Maintaining the height of the fence in contact with the vehicle during the impact, compensating the collapsing effect caused by the pole deforming during the impact by doubling backwards and downwards, and
- (IV) Buffering or absorbing part of the impact's energy while contributing to redirect the vehicle during the collision. In this last instance, the spacing element is called energy absorber. The energy-absorbing function of the spacing element is characteristic of high contention barriers, since said barriers have a very robust or rigid basic structure, comprised by the fence or fences and robust poles installed at short intervals that are capable to contain heavy vehicles, which makes this structure too rigid to be suitable as impact-contention device for light vehicles. The spacer-absorber element is specifically designed to reduce the severity of impacts caused by light vehicles against basic rigid struc-

tures, softening the contact against the pole and favoring the function of redirecting veering vehicles. On occasion this element is configured either as a single component or as an assembly of plates and/or metal profiles configured in a more or less complex manner, or in square or rectangularly sectioned tubular profiles that can be open or closed. There are also barriers built without the spacer or absorber element. In these barriers the fence element is attached directly to the pole element. In other situations, particularly in racing circuits roads, it is possible to find other configurations in which the absorber or spacing element is configured by cylinders made of resistant elastic material filled with foam or similar materials and placed between the fences and the pole or external wall; or even by a semi-truss like triangular metal structure that acts simultaneously as absorber element and pole element, allowing the barrier to move during vehicle impact. Some times, the energy-absorption capacity of the safety barrier is achieved through elastic adapters that are inserted as sheaths or covers over the fences or guardrails.

4°.- A continuous horizontal **rear brace** connecting the barrier poles longitudinally at the back of the barrier, joining the consecutive poles either through their upper portions or the consecutive spacing elements through their rear part. The functions of said brace are as follows:

- (I) Distributing amongst the various poles the stresses caused by the impact to decrease transversal deformation of the barrier, and
- (II) Compensating and limiting the torsional forces between the pole's heads.

**[0010]** The different components that constitute a metallic safety barrier are assembled together, usually, through bolted type joints, that is, those formed by a bolt or threaded bolt secured by an internally threaded locking nut and one or several washers.

**[0011]** Metallic safety barriers designed for different contention levels and, essentially, to contain passenger cars having different weights and traveling at different speeds, frequently have a rigid distancing element - spacer- in order to attain acceptable barrier deformation levels, as well as to maintain vehicle stability during and after the collision, restrict the severity levels within the lowest class (better class) and endow it with a suitable capacity for redirectioning the departing vehicle.

**[0012]** The typical impact sequence of a passenger car against a metallic safety barrier of the kind configured by a continuous horizontal fence supported by vertical elements and installed at the margin or median strip of the road is as follows:

- The initial impact between the passenger car and the barrier occurs between the lateral frontal part (left or right depending on if the collision has occurred on the left or the right sides) of the passenger car and the metallic fence. As a consequence of this contact, the fence transmits the stresses thus created to the closest pole, that then starts deforming by twisting and folding backwards. Because the impact involves the area located before the vehicle's center of gravity, it causes the vehicle to rotate in a redirectioning direction. During this initial contact, and to a lesser extent, successively thereafter, the spacer (if present) keeps the vehicle's wheels away from the pole's base to prevent broadenings.
- When the pole exhausts its capacity for deformation when it reaches a certain backwards flexing angle, it becomes necessary to release the joint connecting this pole to the fence to prevent the pole from dragging the fence downwards, and to prevent the vehicle from destabilizing because of the grade differential that would appear in such case between the height of the contact fence and the center of gravity of the vehicle, causing then the vehicle to either overturn or to go through the barrier transversally with the fence nearly collapsed. Once the element joining pole to fence has been released, the fence behaves as an element subject to traction or "cable-pulled", transmitting longitudinal and transversal deformation stresses to the poles adjacent to the "disengaged" pole and thus propagating the impact in the direction the vehicle was traveling before veering off. This mechanism that releases the joint between fence or fence-spacer and the pole is known as "fusibility".
- Once the first pole has been disengaged by the effects of fusibility, the impact propagates as the vehicle is redirectioned in the original direction of traffic, always in contact with the fence, and it successively disengages the consecutively placed poles of the fence, that continues to operate as an element subject to traction, until the secondary collision occurs when the rear part of the vehicle collides against the fence. Because this secondary impact involves the part behind the vehicle's center of gravity, it causes it to spin in the direction opposite to that of the redirectioning, arresting the redirectioning process and causing the exit of the vehicle, that then separates from the system. During said departure, due to the vehicle having penetrated transversally at some distance in relation to the longitudinal alignment of the barrier, the last pole of the barrier in contact with the vehicle may also be disengaged. During the secondary impact the vehicle may also be destabilized and go through the contention system if the height of the "disassembled" fence in relation to the vehicle is sufficiently short for this to happen.

**[0013]** The barrier's fusibility mechanism is usually lo-

cated at the point where the spacer and the pole join together. It entails either "tearing out" the head element of one or more bolts by going through the corresponding orifices in the pole or the spacer, or progressively "cutting off" the sheet metal membranes that separate a series of aligned orifices that are part of the bolted joints that connect the spacer to the pole or the pole to ancillary connection parts, or by disengaging some intermediate connection part, etc.

**[0014]** In cases when the metallic barrier is not equipped with a spacing element, the only fusible mechanism that has been used, up until the present invention, entails making the pole go through the head of the joint bolt of the fence, by which action said head of the bolt is "tom out" from the elongated orifice of the fence housing said joint. However, this mechanism is not very controllable and the loads that trigger the fusibility vary and are not very repeatable.

**[0015]** During the impact of a passenger car type of vehicle, the spacer fulfills its functions of distancing fence from vehicle and of maintaining the height of the fence in contact with the colliding vehicle, as well as contributing to keeping the deformation of the barrier (transversal operating width) to a minimum. This notwithstanding, spacers present the following three disadvantages:

(i). Placing a spacer between fence and pole widens the width of the barrier, a fact that creates a serious space problem in those situations where the available berm space for the barrier outside road is small, consequently creating also a traffic safety problem.

(ii). Because the spacer is arranged horizontally between fence and pole, it causes a dynamic "lever" effect on the pole head that distorts the transmission of stresses from fence to pole, due to the loads applied to the barrier when a passenger cars impacts it at speed.

(iii). Installing the spacer increases the total cost for materials and installation of the metallic safety barrier.

**[0016]** Using a narrower, more robust, and cheaper metallic barrier without spacers in the margins or median strips of roads, specifically designed for passenger cars impacts, requires using a special joining element between fence and pole that can provide the system with a highly controlled fusibility system (the connecting element is released when a pre-established load value is reached and it is released at precisely the required instant within the impact sequence). This system allows the barrier to offer the appropriate response when impacted by a passenger car, thus ensuring the following benefits:

a) Preventing the colliding passenger car from becoming entangled in the poles that become disengaged by its passing -as the vehicle moves longitu-

dinally against the barrier deforming it transversally and going over them. To attain this, it is necessary that the pole's torsioning-flexing deformation response before disengagement is such, that once the vehicle collides against the pole, said pole has deformed sufficiently and appropriately so the section of the pole that is oriented towards the passenger car remains in its lowest inertial position and the pole as a whole becomes significantly bent at the point where it is embedded in the terrain.

b) Preventing the fence from being dragged vertically and downwards towards the ground when the pole deforms backwards and downwards to keep the upper part of the barrier in contact with the vehicle, thus ensuring the stability of the passenger car during and after the impact.

c) Ensuring the joining element connecting pole and fence is released at the right instant, nor before or after, in order for the loads and deformation caused by the impact to be distributed to the greatest possible number of consecutive poles, thus limiting the barrier's maximum transversal deformation. Premature fusibility increases transversal deformation and may cause entrapment because transversal motion dominates over the redirectioning rotation motion. If fusibility is tardy, the fence lowers excessively while being dragged down by the pole, the vehicle becomes unstable and may go over the barrier. Maximum transversal deformation is also increased in this instance.

## DESCRIPTION OF THE INVENTION

**[0017]** The present invention provides a fusible mechanism for bolted joints connecting fences, beams or horizontal railings to the vertical support poles of a metallic safety barrier, that enables said joining element to be released or uncoupled in a controlled manner when the force transmitted to it as a result of the actions occurred on the barrier when a vehicle impacts it laterally exceeds a pre-established threshold value, contributing the same technical advantages in terms of the state of the art that the spacing element contributes to the safety barrier performance but avoiding the disadvantages the latter present, while improving its performance, and also configuring a narrower, more robust and cheaper metal barrier.

**[0018]** To that effect, and in order to achieve said advantages when compared to the current state of the art, it has been necessary to configure a new joining system that is directly bolted to the fence and the pole elements of the metallic safety barrier, which main property is its controlled fusible nature, both in time and in the magnitude of the strength, that provides the following technical advantages:

1). Prevents the passenger car from getting caught in the disengaged poles as its passing deforms the

barrier transversally and the vehicle goes over them as it moves longitudinally to the barrier. To do this it is necessary that the torsioning-flexing deformation of the pole before it becomes disengaged is such, that once the vehicle collides against it, the pole has already deformed sufficiently and appropriately, so the pole section oriented towards the passenger car is at its lowest inertial position, while as a whole the pole is significantly bent at the point where it is embedded in the ground.

2). Preventing the fence from being dragged vertically and downwards towards the ground when the pole deforms backwards and downwards to keep the upper part of the barrier in contact with the vehicle, thus ensuring the stability of the passenger car during and after the impact.

3). Ensuring the joining element connecting pole to fence is released ("fusibility" occurs) at the right instant, nor before or after, in order for the loads and deformation caused by the impact to be distributed to the greatest possible number of consecutive poles, thus limiting the barrier's maximum transversal deformation. Premature fusibility increases transversal deformation and may cause entrapment because transversal motion dominates over the redirectioning rotation motion. If fusibility is tardy, the fence lowers excessively while being dragged by the pole, the vehicle becomes unstable and may go over the barrier. Maximum transversal deformation is also increased in this instance.

**[0019]** The fusible bolted joint (3) object of the invention described below is integrated in a metallic safety barrier constituted by a continuous horizontal impact element formed by one or several continuous horizontal fences or guardrails (1), supported through said fusible joint (3) by vertical holding elements or vertical poles (2) inserted in the terrain (4) at regular intervals, as shown in Fig. 1 and Fig. 3.

**[0020]** The fusible bolted joint (3) is configured (see Fig. 4) from a metal bolt (5) having along its threaded rod (10) and at a given distance from the bolt head (9), a straight section (11) or specific area, preferably cylindrical, that has been subject to an specific mechanical, thermal or chemical treatment, so that the mechanical resistance to breakage of said section (11) or area of the bolt is considerable lower than all the remaining sections of the bolt's rod (10). This section (11) or area of lower mechanical resistance of the rod (10), located below the head (9) of the metal bolt (5) connecting the fence (1) to the pole (2) of a metallic safety barrier, is known as "fusible section" and characterizes the bolt (5) as "fusible bolt" and the joint (3) between fence (1) and pole (2) as a "fusible bolted joint".

**[0021]** This property (sic) of the fusible bolt (5) having a "fusible section (11) characterized by having lower me-

chanical resistance is placed along the bolt's rod (10) in such a manner that once the joint (3) between fence (1) and pole (2) is assembled, as shown in Fig. 9, the fusible section (11) is placed, approximately, in the middle of the joint area connecting both elements, so that when a passenger car collides laterally against the barrier (see Fig. 5) the shearing stress forces originated by the collision and affecting the bolt's rod (10) of joint (3) connecting fence (1) and pole (2) concentrate, almost completely, in the fusible section or area (11).

**[0022]** In fact, when a passenger car collides laterally against the barrier exerting over it a given lateral force F (see Fig.5) this causes the onset of a pair of opposing forces (T) in the barrier that arise, on the one hand because the pole (2) starts deforming backwards and downwards while firmly embedded in the terrain (4) and, on the other, the fence (1) is pushed upwards by the passenger car, originating the upwards force (T) that acts on the fence (1) and another downward force (T) that acts on the pole (2). The combination of both forces (T), subjects the bolt's rod (10) of the joint (3) connecting the fence (1) to the pole (2) to a shearing type stress.

**[0023]** The concentration of the shearing stress forces originated by the passenger car colliding against the barrier at a specific section (11) of the bolted joint's rod (10) connecting the fence (1) and the pole (2) causes the joint's bolt (5), to break just through said section (11) due to said section (11) having a lower mechanical resistance.

**[0024]** It follows then that the performance of metallic barrier when impacted by a passenger car is based on a fusible mechanism that allows the release or disengagement of the joint (3) between the fence (1) and the pole (2), as shown in Figure 2. The passenger car penetrates the barrier laterally at a certain distance, while the vehicle is redirected and exits the system. The precise instant at which the temporal sequence of the impact and the magnitude of the force, caused as a consequence of it, at which the fusibility or component disengagement occurs, will be essential factors in the response of the barrier to impacts, and therefore in the consequences of said impact. In order to obtain the appropriate response is therefore necessary that fusibility is highly controlled, foreseeable and repeatable.

**[0025]** One of the technical advantages presented by the fusibility mechanism object of the invention is that the intensity of the mechanical or chemical treatment applied to the bolt's fusible section or area (11), determines the final mechanical resistance value to breakage of this section or area (11) and, therefore, the value of the difference between it and the nominal mechanical resistance of the bolt (5). Therefore, by varying the intensity of said treatment over said section or area it is possible to modulate the instance and magnitude of the fusibility or disengagement force of the joint (3), previously described.

**[0026]** The treatment applied to said section or area (11) of the rod (10) of the joint (3) bolt (5) connecting the fence (1) to the pole (2) of the metallic safety barrier, in

order to decrease its mechanical resistance and turn it into a fusible area is, preferably, a mechanical or tooling treatment that entails making a cylindrical furrow (12) which diameter is lower than that of the bolt's rod (10), and located at a particular distance from the bolt's head (9), as shown in Figure 6. In this case, the relationship between the diameter of the furrow (12) and the diameter of the rest of the bolt's rod (10), for a pre-established constituent material, determines the value of the fusibility force and the difference in mechanical resistance between the fusible section or area and the bolt's nominal mechanical resistance value.

**[0027]** A constructive variation in the mechanical treatment to achieve fusibility (see Figure 7) entails making one, two or more notches (12') in the bolt's rod (10), at a particular distance from the bolt's head (9), perpendicular to the rod's (10) shaft or slightly tilted from said perpendicular line. Said notches (12') may be all located in the same straight section of the bolt, as shown in sub-Figure 7a or may be located in different straight sections and placed close together, as shown in sub-Figure 7c. In this case, the relation between the number and depth of the notches (12') and the diameter of the remaining length of the bolt's rod (10) for a given constitutive material, determines the value of the fusibility force and the difference in mechanical resistance between the fusible section or area and the bolt's nominal mechanical resistance.

**[0028]** Another constructive variation of the mechanical treatment used to achieve fusibility (see Figure 8) is to carve one, two or more grooves (12'') in the bolt's rod (10), at a particular distance from the bolt's head (9), with the groove's axis perpendicular to the rod's (10) shaft or slightly tilted from said perpendicular line. Said grooves (12'') may all be located along the same straight section of the bolt, as shown in sub-Figure 8a or may be located in different straight sections placed closed together, as shown in sub-Figure 8c. In this case, the relationship between the number and depth of the grooves (12'') and the diameter of the remaining length of the bolt's rod (10), for a particular constitutive material, determines the value of the fusibility force and the difference in mechanical resistance between the fusible section or area and the bolt's nominal mechanical resistance.

**[0029]** The fusible joint (3) connecting fence (1) to pole (2) is achieved by a fusible bolt (5) having a fusible section or area (11) located in the rod (10) at a particular distance from the bolt's head (9), so the rod (10) goes successively through the fence (1), through the orifice (13) provided to that effect, and through the pole (2) by going through orifice (14) provided to that effect, and is then located between the fence (1) and the pole (2) after the connecting joint (3) element between fence and pole has been installed as shown in Figure 9. The joint (3) may incorporate a flat washer (6), preferably rectangularly shaped, as shown in Figure 13, located in the bolted joint (3) below the bolt's head (9) and above the fence (1), and said flat washer being pierced by the bolt's rod (10) going through

the central orifice (16) of the flat washer (6). This fusible bolted joint (3) may also be equipped with a second flat washer (7) having also a central orifice (17), preferably round, as shown in Figure 14, located between the pole (2) and the locking nut (8).

**[0030]** The technical advantage of using such flat washers (6) and (7) in combination with a fusible bolt (5) resides in that they contribute to reinforce the fence (1) and the pole (2) locally around the area of the fusible joint (3) to avoid these elements, fence and pole, from being locally deformed as a result of vehicle impact around orifices (13) and (14), respectively, in their capacity as parts of the joint (3) equipped with fusible bolt (5). The local deformation of the fence (1) or the pole (2) around orifices (13) and (14), would consume a part of the stresses transmitted to the fusible joint (3) that are not very controllable, damaging thus the phenomenon of concentration of the deforming forces at play at the fusible section or area (11) of the bolt, as well as the eminently shearing natures of said forces. All these interferences (dispersion of the transmitted forces and loss of the shearing aspect of the forces) would disturb the control that can be exerted on the force level and on the instant of fusibility of the bolted joints (3).

**[0031]** The fusible bolted joint (3) between fence (1) and pole (2), object of the present invention, as described previously, presents significant technical advantages when used on a metallic safety barrier configured exclusively by a continuous horizontal fence (1) and vertical support poles (2) arranged at regular intervals, such as that shown in Figure 3. Without prejudice of the aforementioned, the fusible type joint (3) offers also the same technical advantages when the metallic safety barrier comprised by the fence (1) and poles (2) also incorporates a rear brace (25) connected to the pole (2) by a bolted joint (26), preferably a non-fusible joint, as shown in Figure 11.

**[0032]** The same technical advantages can be obtained when the type of bolted fusible joint (3) object of the present invention, is applied to a metallic safety barrier having two fences (1) symmetrically arranged on each side of the pole (2), as shown in Figure 12.

**[0033]** Finally, if the safety fence to be designed needs to have a contention level slightly higher than that required to contain passenger car type vehicles, such as that required to contain light trucks or buses, which center of gravity is located at a greater height than that of passenger cars, it may be necessary to install an intermediate part (15) between the fence (1) and the pole (2), as shown in Figure 10. This intermediate part (15) would be of a size insufficient to qualify it as a true spacer element, since its only function would be allowing the fence (1) a slight vertical displacement in relation to the pole (2), in a measure sufficient to compensate for the imbalance between the different heights of the centers of gravity of vehicle and barrier so the vehicle stability would be maintained and the vehicle would then be prevented from going over the barrier. In this case, both the bolted joints

(3') between the fence (1) and the intermediate part (15), as the bolted joints (3'') between the part (15) and the pole, alternatively, or both joints (3') and (3'') simultaneously may be fusible type joints. This would then allow for some upwards displacement of the fence before fusible joints (3') or (3'') became disengaged.

**[0034]** Another constructive alternative to achieve controlled fusibility of the joint (3) located between fence (1) and pole (2), is to use a fusible washer (18) instead of a bolt (5) which rod (10) has a fusible section or area (11), as shown in Figure 15. The fusible washer (18) is installed below the head of the bolt (5) and above the fence (1) and allows clearance for the bolt's (5) head through its central orifice (19), after a given force is applied over the joint subsequent to a vehicle colliding against the barrier.

**[0035]** Figure 15 shows how the "non-fusible" rod (20) of said bolt (5) goes, successively, through the fusible washer (18) through its central orifice (19), the fence (1) through its central orifice (13), the pole (2) through its orifice (14), the flat washer (7) through its central orifice (17) and the locking nut (8).

#### **DESCRIPTION OF THE DRAWINGS**

**[0036]** The following set of drawings are attached to complement the description and to provide better understanding of the characteristics of the invention using as reference the preferred embodiment of the practical application. Said drawings are an integrated part of said description and are to be understood as having an illustrative but not limiting character:

**Figure 1.-** shows the straight cross-section of a metallic safety barrier, comprising a continuous horizontal fence (1) supported, by means of the fusible bolted joint (3), by a vertical post (2) inserted in the ground (4).

**Figure 2.-** Shows, by means of sub-figures 2a, 2b and 2c, the typical sequence of events that occur when a passenger car collides laterally against a metallic safety barrier showing the performance of the fusible joint (3) located between the fence (1) and the pole (2).

**Figure 3.-** Is a lateral perspective view of a section of a metallic safety barrier comprising a continuous horizontal fence (1) connected by means of fusible bolted joints (3) to the corresponding vertical poles (2) that are inserted in the terrain (4), said joints comprising a fusible bolt (5), a rectangular flat washer (6) located below the bolt's head, and a flat square washer (7) located below the locking and tightening nut (8).

**Figure 4.-** Corresponds to a longitudinal meridian section view of a fusible metal bolt (5), representing the bolt's head (9), rod (10) and fusible section (11).

**Figure 5.-** Is a graphic representation in two images, 5a and 5b, of force (F) transmitted to the bolt (5) of the fusible joint (3) from the passenger car that collides laterally against the barrier and the stresses (T) subsequently caused that affect the fence (1) upwards and the pole (2) downwards, subjecting to shearing stress forces the fusible section (11) of the bolt's rod (10) belonging to the bolted joint (3) connecting fence (1) and pole (2).

**Figure 6.-** Shows two images, sub-Figure 6a and sub-Figure 6b, of a fusible metal bolt (5) having a fusible section embodied by a cylindrical furrow (12) placed at a given section of the rod (10) below the bolt's head (9). Sub-Figure 6a shows the meridian section of the fusible bolt (5) and Sub-Figure 6b shows a three-dimensional view of same.

**Figure 7.-** Shows three images, sub-Figure 7a, sub-Figure 7b and sub-Figure 7c, of a fusible metal bolt (5) having a fusible section embodied by a pair of notches (12') made at a certain section of the rod (10) and perpendicular to it, below the bolt's head (9). Sub-Figure 7a corresponds to the meridian section of the fusible bolt (5) with the two notches (12') made in the same section, sub-Figure 7b is a three-dimensional view of same and sub-Figure 7c shows the meridian section of the fusible bolt (5) with both notches (12') located in two different sections but located close together in the rod (10).

**Figure 8.-** shows three images, sub-Figure 8a, sub-Figure 8b and sub-Figure 8c, of a fusible metal bolt (5) having a fusible section embodied by a pair of grooves (12'') made at a certain section of the rod (10) and perpendicular to it, below the bolt's head (9). Sub-Figure 8a shows the meridian section of the fusible bolt (5) with both grooves (12'') made in the same section, Sub-Figure 8b is a three-dimensional view of same and Sub-Figure 8c shows the meridian section of the fusible bolt (5) with the two grooves (12'') located in two, closely set together, different sections of the rod (10).

**Figure 9.-** Shows two images. Sub-Figure 9a shows an exploded view, and Sub-Figure 9b shows and assembled view of the fusible bolted joint between a fence (1) and a pole (2) of a metallic safety barrier, comprised by a fusible bolt (5), characterized by having a fusible section (11), that goes successively through the central orifice (16) of a flat washer (6) placed below the bolt's head, the central orifice (13), the fence (1), the pole's (2) orifice (14) and the central orifice (17) of a flat washer (7) placed below the joint's locking and tightening nut (8).

**Figure 10.-** Shows the straight cross-section of a metallic safety barrier, comprised by a continuous

horizontal fence (1) supported, by means of an intermediate part (15), on a vertical post (2) inserted in the ground (4), and where the joint (3') located between the fence and the intermediate part and/or the joint (3'') located between the intermediate part and the pole is a fusible-type joint.

**Figure 11.-** Shows the straight cross-section of a metallic safety barrier, comprised by a continuous horizontal fence (1) supported, by means of the fusible bolted joint (3) connecting it to a vertical post (2) inserted in the ground (4) and a continuous rear brace (25) connected to the pole by a joint (26).

**Figure 12.-** Shows the straight cross-section of a double metallic safety barrier, comprised by two continuous horizontal fences (1) and a vertical post (2), said fences being symmetrically arranged on each side of the pole, and both fences supported by said pole to which they are attached by means of the fusible bolted joints (3), while the vertical post (2) is inserted in the ground (4).

**Figure 13.-** Shows the three-dimensional image of a flat rectangular washer (6), placed below the head of the fusible bolt, having an elongated central orifice (16).

**Figure 14.-** Shows the three-dimensional image of a flat square washer (7), placed below the head of the fusible bolt, having a round central orifice (17).

**Figure 15.-** Shows two images. Sub-Figure 15a depicts the exploded view and Sub-Figure 15b depicts the assembled view, of the fusible bolted joint located between a fence (1) and a pole (2) of a metallic safety barrier, comprised by the combination of a non-fusible bolt (5) and a fusible washer (18), going, successively, through the bolt's rod (20), the central orifice (19) of the fusible washer (18) placed below the bolt's head, the central orifice (13) of the fence (1), the pole's (2) orifice (14), and the central orifice (17) of a flat washer (7) placed below the joint's locking and tightening nut (8).

#### **EXAMPLE OF AN EMBODIMENT OF THE INVENTION**

**[0037]** Figures 1, 3, 6, 9, 11, 12, 13 and 14 show a particular embodiment of the present invention, comprising a metal bolted joint (3) between the fence (1) and the pole (2) of a metallic safety barrier, comprising a metal bolt (5) having preferably a round head, a metal flat washer (6), preferably rectangularly shaped, located below the bolt's head (9), another metal flat washer (7), preferably square located underneath the nut and a metal locking nut (8), which bolt (5) has in its rod (10), at a particular distance from the bolt's head (9), a section or area (12), preferably cylindrical, which diameter is smaller than the



rod's (10) diameter, and is furrow-shaped. This area is called the fusible section or area, since it is the area in the rod (10) and the bolt (5) having the lowest mechanical resistance. The name is then extended to the bolt that is then known as fusible bolt.

[0038] The rod of the fusible bolt (5) goes, successively, through the flat washer (6) placed underneath the bolt head (9), the fence (1), the pole (2), the flat washer (7) and the nut (8) which is the component that locks and tightens the bolted joint (3), as shown in Figure 3. More specifically, said rod (10) goes, successively, through the central orifice (16) of the rectangular flat washer (6), the central orifice (13) of the fence (1), the pole's (2) orifice (14), the central orifice (17) of the flat square washer (7), and the central orifice of the locking and tightening nut (8), as shown in Figure 9.

[0039] The position of the fusible section or area (12) along the rod (10) of the fusible bolt (5) is such that, once it has been definitely implemented, the joint (3) between the fence (1) and the pole (2), as shown in Figure 9, the fusible section or area (12) tooled in the rod (10) as a furrow-like indentation, is confined, approximately, to the area inside the orifices (13) of the fence (1) and (14) of the pole (2) and therefore it may be considered that the theoretical surface that separates the fence (1) and the pole (2) would "cut" the bolt's (5) rod (10) that connects them together at the fusible area (12).

[0040] The controlled fusibility-type bolted joints (3), between fence (1) and pole (2), is applied both to a metallic safety barrier comprising exclusively a continuous horizontal fence (1) supported by vertical poles (2), arranged at regular intervals and inserted in the terrain (4), as shown in Figure 1, as to a metallic barrier having, aside the aforementioned components, one or two rear continuous horizontal braces (25), affixed to the rear side of the poles (2), as shown in Figure 11, or to double metallic barriers, that is, barriers comprised by two fences (1) symmetrically arranged on each side of the poles (2), as shown in Figure 12.

## Claims

1. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, **characterized in that** some of the components comprising the bolted joints (3) connecting the fence (1) to the pole (2) has, at least, one characteristic that confers said joint (3) a controlled fusible behavior when impacted by a colliding vehicle, which enables it to be uncoupled or released when the level of the force transmitted to said joint (3) by the vehicle impacting the barrier reaches a pre-established value.
2. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safe-

ty barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claim 1, **characterized in that** the bolt (5), the bolted joints (3) between the fence (1), and the pole (2) present, in the rod (10) and at a given distance from the bolt's head (9), a section or area (11) having lower mechanical resistance than the remaining bolt's rod (10).

3. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claim 2, **characterized in that** the section or area (11) having lower mechanical resistance has been obtained by applying a mechanical, thermal or chemical treatment to that particular section or area (11) of a bolt (5) that before said mechanical, thermal or chemical treatment presented the same mechanical resistance along its entire rod.
4. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claims 1, 2 and 3, **characterized in that** the rod (10) of the bolt (5) comprising and the bolted joints (3) between the fence (1) and the pole (2) has, at a given distance from the bolt's head (9), a furrow-like section or area (12), preferably cylindrical, which diameter is smaller than the diameter of the rod (10).
5. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claims 1, 2 and 3, **characterized in that** the rod (10) of the bolt (5) comprising the bolted joint (3) between the fence (1) and the pole (2) have at a given distance from the bolt's head (9), one or several notches (12') that are perpendicular to the rod's (10) shaft, or slightly tilted from the perpendicular axis of the rod (10), all of said notches (12') preferably located in the same straight section of said rod (10).
6. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claim 5, **characterized in that** the notches (12') made in the rod (10), that are perpendicular to the rod's (10) shaft, or slightly tilted from the perpendicular axis of the rod (10), are all located in two or more different straight sections of the rod that are preferably closely set together.
7. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safe-

ty barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claims 1, 2 and 3, **characterized in that** the rod (10) of the bolt (5) comprising the bolted joints (3) between the fence (1) and the pole (2) has, at a given distance from the bolt's head (9), one or several grooves (12") which axis are perpendicular to the rod's (10) shaft or slightly tilted from it, and all said notches (12") preferably located in the same straight section of said rod (10).

8. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claim 7, **characterized in that** the grooves (12") made in the rod (10), are perpendicular to the rod's (10) shaft or slightly tilted from it, and are located in two or more different straight sections that are, preferably, set close together.
9. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to the previous claims, **characterized in that** the sections or areas (11) (12) (12') (12") of the bolt's rod (10), of the bolt (5) comprising the bolted joint (3) between the fence (1) and the pole (2) having lower mechanical resistance are located along the bolt's rod (10) and at a given distance from the bolt's head (9), in a position such that, once the bolted joint (3) is implemented, the sections or areas having lower mechanical resistance (11) (12) (12') (12") are then located, simultaneously, inside both the orifice (13) of the fence (1) and the orifice (14) of the pole (2), both orifices (13) and (14) being part of said joint (3), so that the mechanical rupture of the rod (10), caused by the forces transmitted to the bolted joints (3) between fence (1) and pole (2) after a vehicle collides against the metallic barrier tends to occur in the sections or areas (11) (12) (12') (12") of the rod having lower mechanical resistance.
10. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to the previous claims, **characterized in that** the bolted joint (3) between fence (1) and pole (2) incorporates a flat washer (6), preferably rectangularly shaped, located just underneath the bolt's head (9) and above the fence (1).
11. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according

to the previous claims, **characterized in that** the bolted joint (3) between fence (1) and pole (2) incorporates a flat washer (7), preferably square, rectangular or round, located just underneath the locking nut (8) and above the pole (2).

12. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to the previous claims, **characterized in that** said joint (3) is used in a metallic safety barrier solely comprising a continuous horizontal fence (1) supported by a series of vertical poles (2), aligned at regular intervals and inserted in the terrain (4).
13. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to the previous claims, **characterized in that** said joint (3) is used in a metallic safety barrier comprised by a continuous horizontal fence (1) supported by a series of vertical poles (2), aligned at regular intervals and inserted in the terrain (4) and one or several rear braces (25) attached (26) (sic) to the poles (2).
14. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to the previous claims, **characterized in that** said joint (3) is used in a metallic safety barrier comprised by two continuous and symmetrical horizontal fences (1) supported by a series of vertical poles (2), aligned at regular intervals and inserted in the terrain (4), both fences (1) installed symmetrically on each side of the pole (2).
15. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to the previous claims, **characterized in that** the barrier incorporates a small-sized intermediate part (15) installed between the fence (1) and the pole (2), wherein the fusible bolted joint (3') may be installed either between the fence (1) and the intermediate part (15), or the fusible bolted joint (3") maybe installed between the intermediate part (15) and the pole (2) or at both joints (3') and (3").
16. Bolted joint mechanism placed between the horizontal fence and vertical support poles of a metallic safety barrier intended to contain vehicle lateral impacts at the margins and median strips of roads, according to claim 1, **characterized in that** the bolted joint located between the fence (1) and the pole (2) incor-

porates a fusible washer (18), having, preferably, a "U" shaped section, located underneath the head of bolt (5) of the joint, and above the fence (1), that can be fully pierced by the head of the bolt (5) when the force applied to the joint caused by the impacting vehicle exceeds a given value, triggering the mechanism that uncouples or disengages the joint connecting fence (1) to pole (2).

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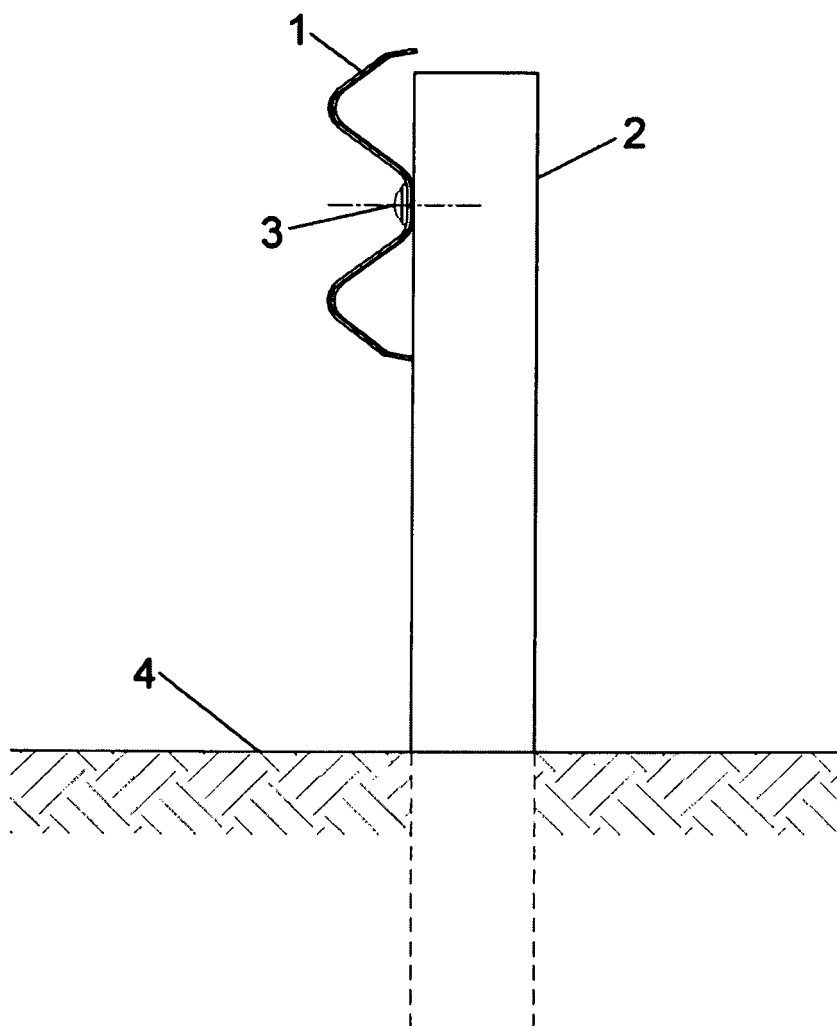


FIG. 1

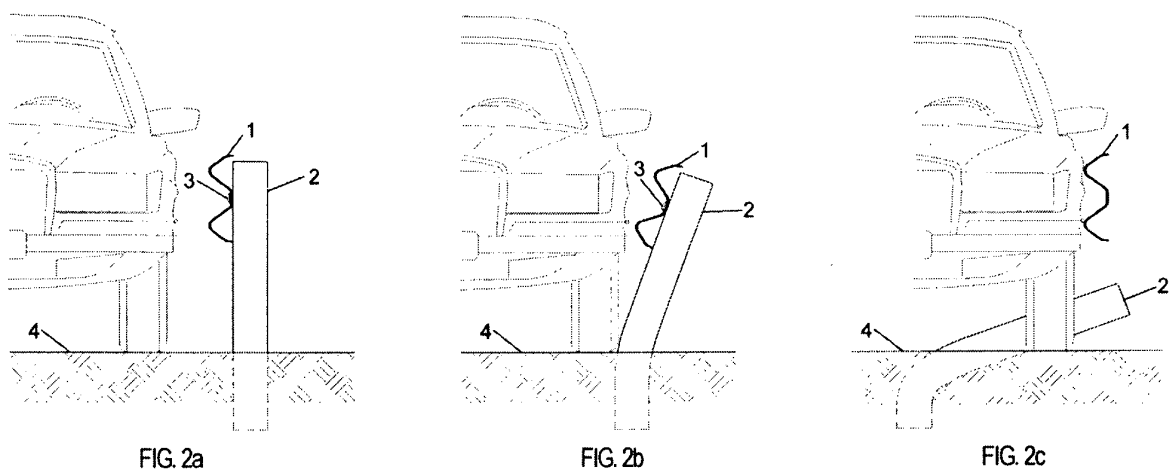
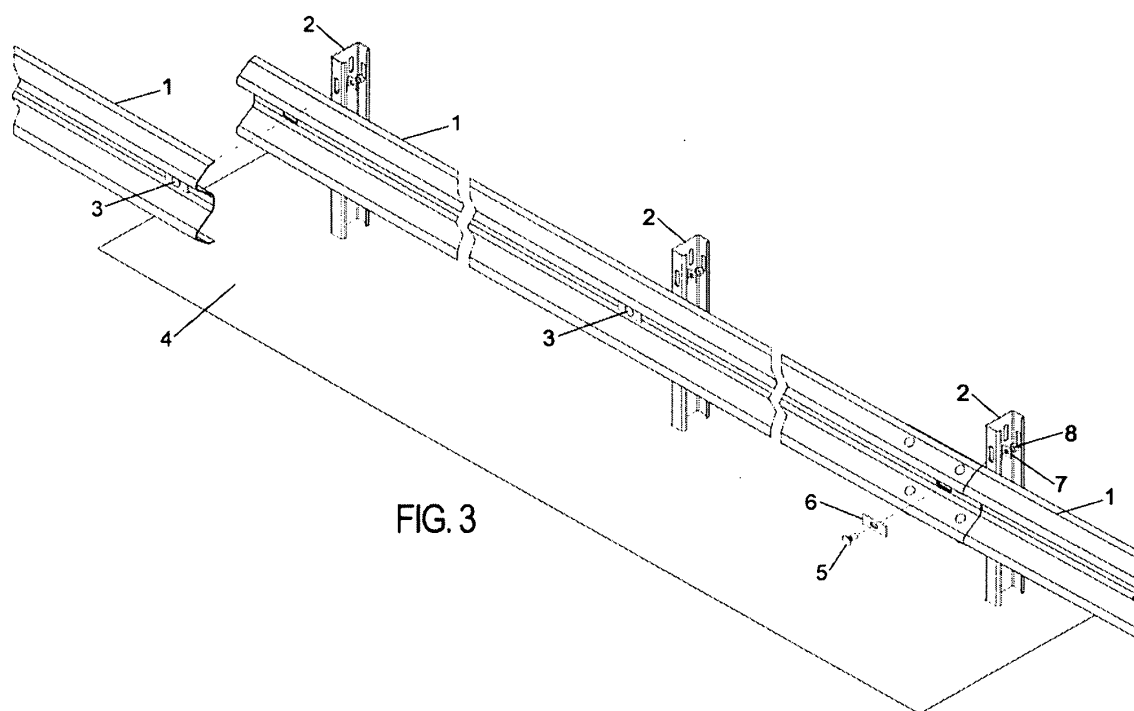


FIG. 2



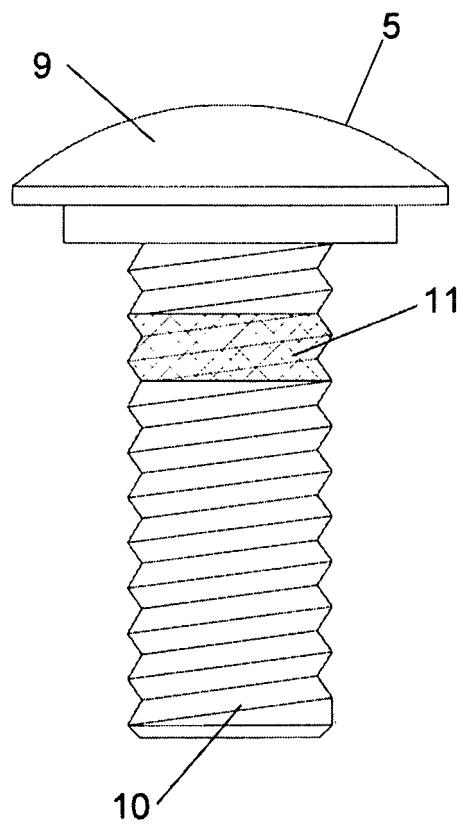


FIG. 4

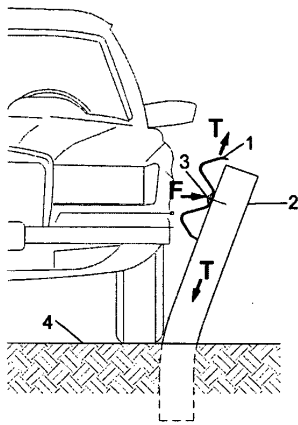


FIG. 5a

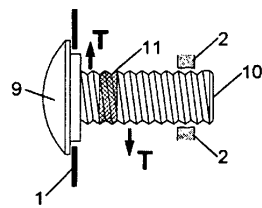


FIG. 5b

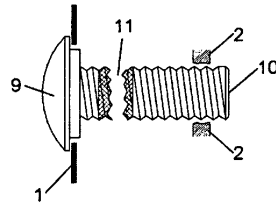


FIG. 5c

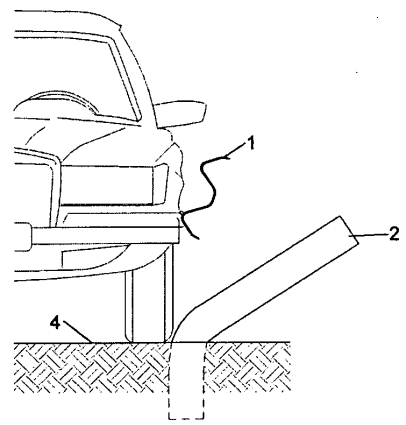


FIG. 5d

FIG. 5



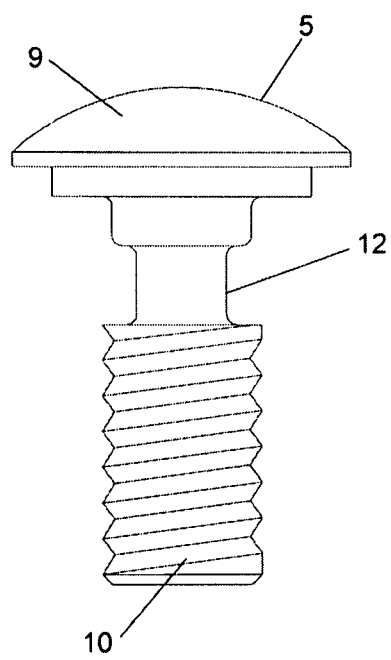


FIG. 6a

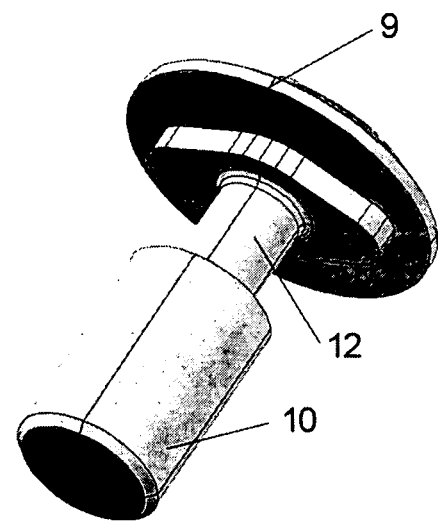


FIG. 6b

FIG. 6

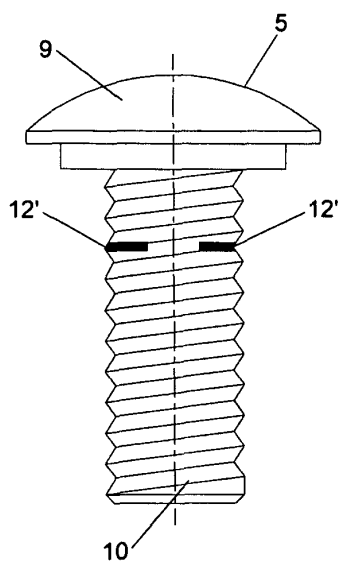


FIG. 7a

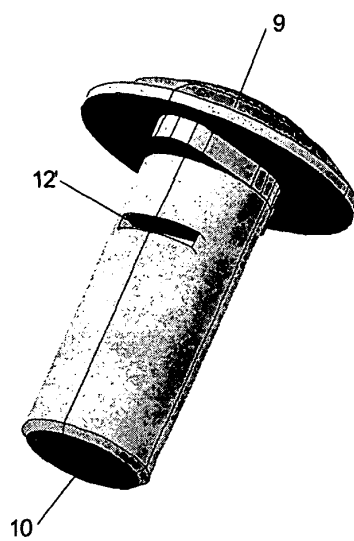


FIG. 7b

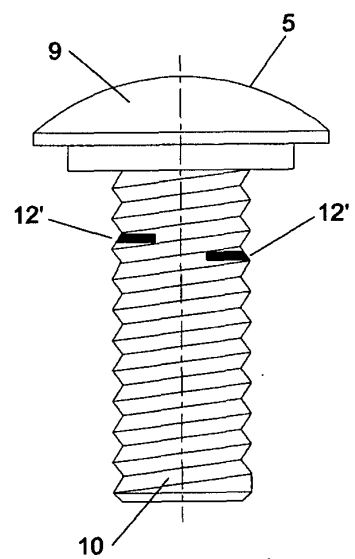


FIG. 7c

FIG. 7

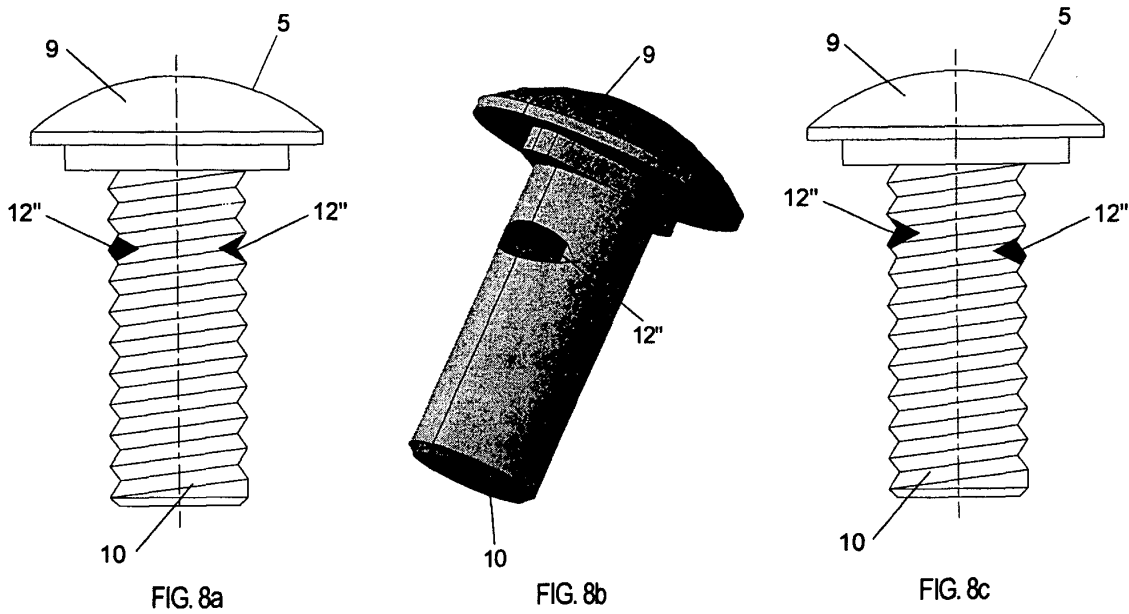


FIG. 8

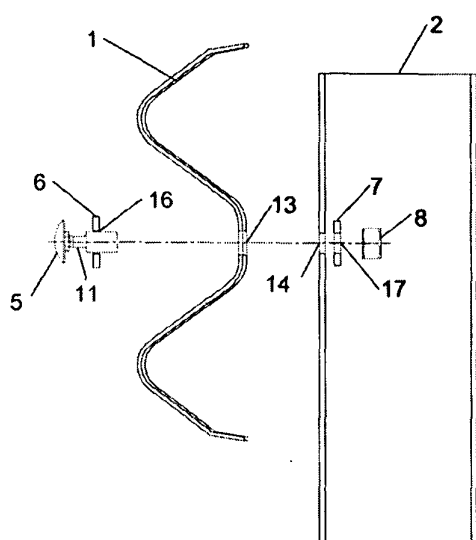


FIG. 9a

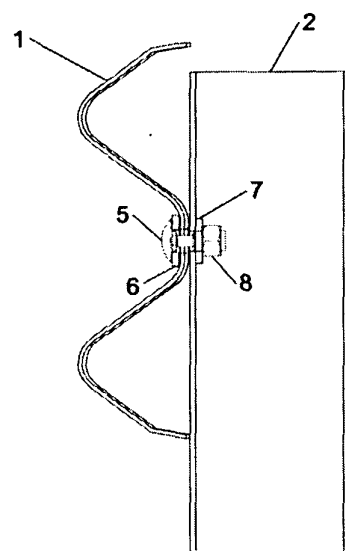


FIG. 9b

FIG. 9

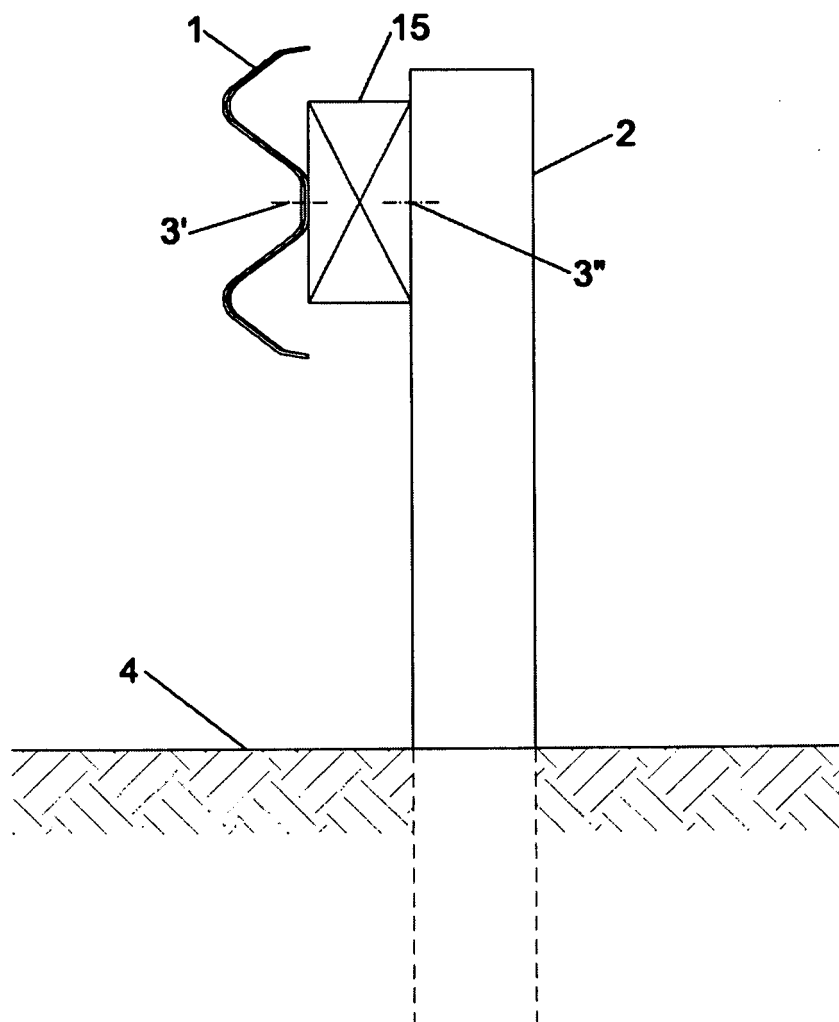


FIG. 10

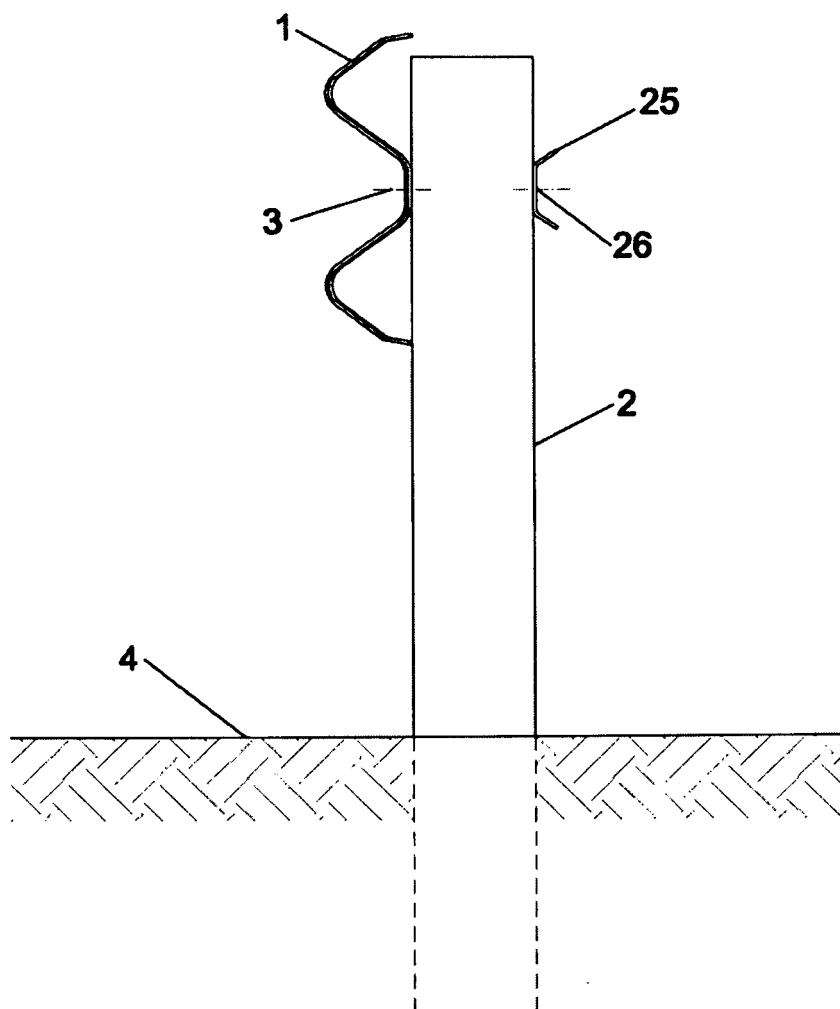


FIG. 11

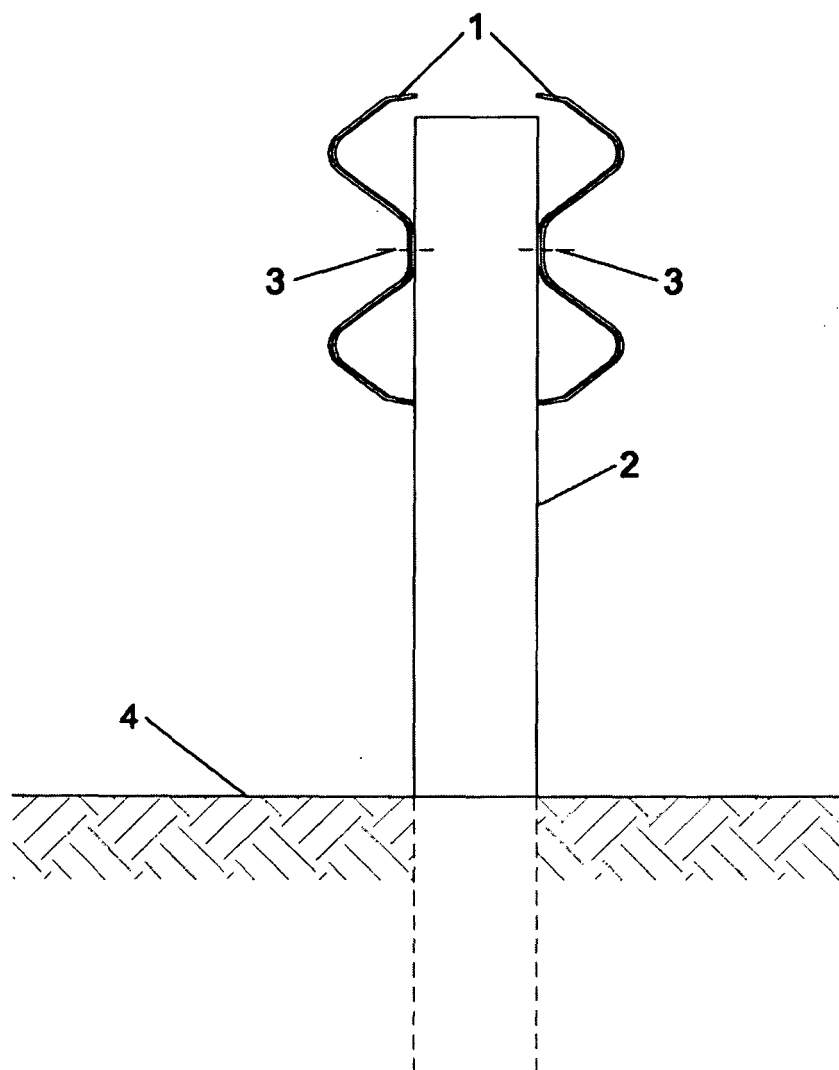


FIG. 12

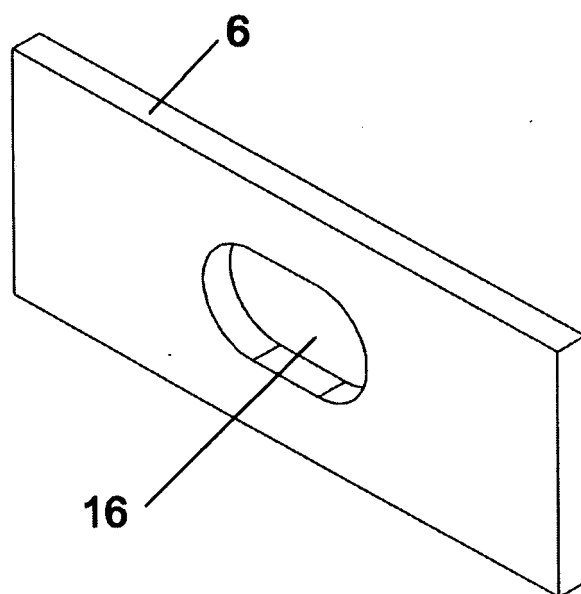


FIG. 13



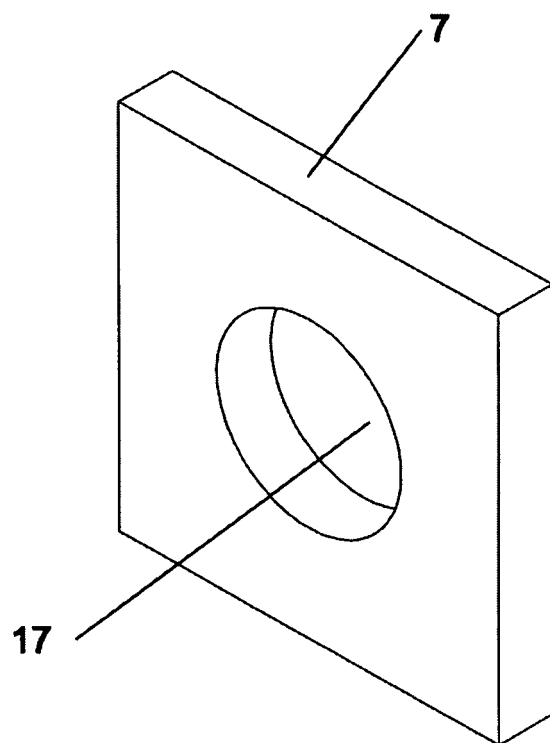


FIG. 14

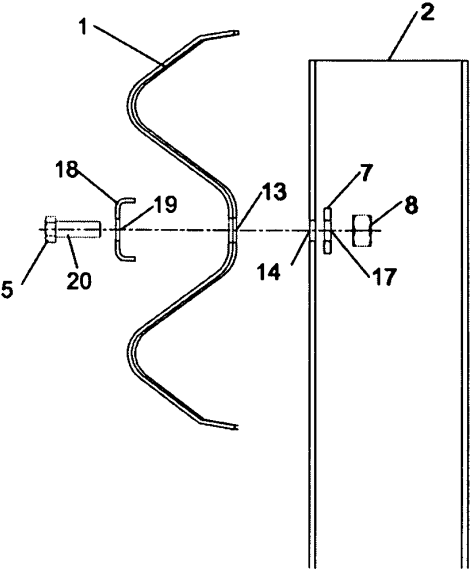


FIG. 15a

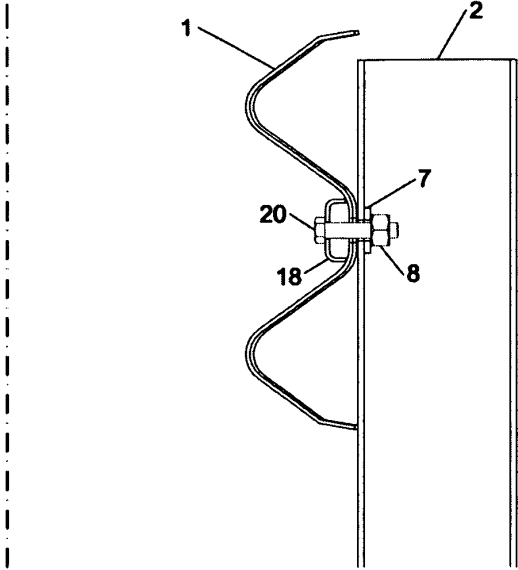


FIG. 15b

FIG. 15