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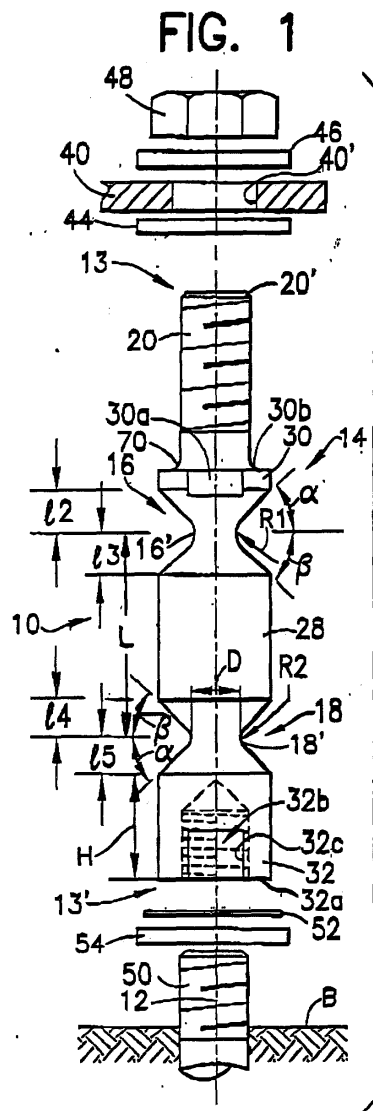
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(54) **Breakaway coupling for roadside appurtenances**

(57) In a breakaway coupling (10) for a highway and roadside appurtenance, a controlled breaking region (14) is provided which has at least two axial spaced necked-down (16,18) portions coaxially arranged between the axial ends (13,13') of the coupling (10) which are configured to be attached both to the appurtenance, at one end, and to the support base (B), at the other end. Each necked-down portion (16,18) essentially consists of two axially aligned conical portions (60,62,64,66) inverted one in relation to the other and generally joined at their apices to form a generally hour-glass configuration having a region of minimal cross section at an inflection point (16',18') having a gradually curved annular concave surface defining a radius of curvature. Each of the two necked-down (16,18) portions has different radii of curvature that at respective inflection points (16',18') to provide preferred failure modes as a function of the position and direction of impact of a force on the appurtenance. The breakaway coupling (10) preferably has a minimum ultimate tensile strength equal to or greater than about 53.8 kN and a minimum ultimate restrained shear strength equal to or greater than about 5.8 kN. The minimum ultimate restrained shear strength of the breakaway coupling (10) is preferably about from about 6% to about 12% of the minimum ultimate tensile strength.



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Description**BACKGROUND OF THE INVENTION**5 1. Field of the Invention

[0001] The present invention generally relates to breakaway couplings and, in particular, to such breakaway couplings for supporting roadside signage, lighting poles, and other similar equipment, materials, or appurtenances.

10 2. Description of the Prior Art

[0002] Many highway and roadside appurtenances, such as lighting poles, signs, etc., are mounted along highways and roads. Typically, these are mounted on and supported by concrete foundations, bases or footings. However, while it is important to securely mount such roadside appurtenances to withstand weight, wind, snow and other types of service loads, they do create a hazard for vehicular traffic. When a vehicle collides with such a light pole or sign post, for example, a substantial amount of energy is normally absorbed by the light pole or post as well as by the impacting vehicle unless the pole or post it is mounted to be readily severed from the base. Unless the post is deflected or severed from the base, therefore, the vehicle may be brought to a sudden stop with potentially fatal or substantial injury to the passengers. For this reason, highway authorities almost universally specify that light poles and the like must be mounted in such a way that they can be severed from the support structure upon impact by a vehicle.

[0003] In designs of such breakaway couplings several facts or considerations come into play. A given coupling must have high tensile strength for supporting an appurtenance and withstanding typical environmental conditions, yet simultaneously have low shear strength for quick and controlled severing upon impact by a vehicle. The optimal combination of very high tensile strength and very low shear strength requires a difficult balance of forces, which has heretofore gone unattained.

[0004] Additionally, the couplings must be easy and inexpensive to install and maintain. They must, of course, be totally reliable.

[0005] Numerous breakaway systems have been proposed for reducing damage to a vehicle and its occupants upon impact. For example, load concentrated breakaway couplings are disclosed in U.S. Patent Nos. 3,637,244, 3,951,556 and 3,967,906 in which load concentrating elements eccentric to the axis of the fasteners, for attaching the couplings to the system oppose the bending of the couplings under normal loads while presenting less resistance to bending of the coupling under impact or other forces applied near the base of the post. In U.S. Patent Nos. 3,570,376 and 3,606,222, structures are disclosed which include a series of frangible areas. In both cases, the frangible areas are provided about substantially cylindrical structures. Accordingly, while the supports may break along the frangible lines, they do not minimize forces for bending of the posts and, therefore, generally require higher bending energies, to the possible detriment of the motor vehicle.

[0006] In U.S. Patent No. 3,755,977, a frangible lighting pole is disclosed which is in a form of a frangible coupler provided with a pair of annular shoulders that are axially spaced from each other. In a sense, the annular shoulders are in the form of internal grooves. A tubular section is provided which is designed to break in response to a lateral impact force of an automobile. The circumferential grooves are provided along a surface of a cylindrical member.

[0007] A coupling for a breakaway pole is described in U.S. Patent No. 3,837,752 which seeks to reduce maximum resistance of a coupler to bending fracture by introducing circumferential grooves on the exterior surface of the coupler. The distance from the groove to the coupler extremity is described as being approximately equal to or slightly less than the inserted length of a bolt or a stud that is introduced into the coupler to secure the coupler, at the upper ends, to a base plate that supports the post and to the foundation base or footing on which the post is mounted. The grooves are provided to serve as a stress concentrators for inducing bending fracture and to permit maximum effective length of moment arm and, therefore, maximum bending movement. The invention design is intended to have the grooves provide better control on the bending strength applied by a vehicle before severance or fracture takes place. The grooves in the patent are generally shallow and of a rectangular cross-section. Because the coupler is provided with a central axial bore for the introduction of a bolt, the coupler is cylindrical in form and is not a solid member. Also, because the coupler described in the patent has a cylindrical bore in the middle, very little of the metal is situated on the neutral axis (along the central axis) about which bending takes place, so that, for a given cross-section of material required to withstand a predetermined amount of tensile and compressive stress, the coupler disclosed in the patent is more resistant to bending than a comparable solid member. Because the patent requires that the bolts or studs penetrate at least as deep as the end of the notch or groove, the design is not practical since such design requires that the bolts or studs to bend simultaneously with the coupler about the notch or groove, at least to some degree, during impact. However, it is a major drawback to have the bolts or studs have any effect on the breaking strength of the part since control over the breaking characteristics of the coupler are lost and the point at which the coupler breaks is a function

of a system consisting of the coupling as well as the bolt or stud. This patent also requires that the geometry of the shape of the base (the inner or bottom surface) of the groove is to be used to produce the required weakness in bending. According to the patent, the diameter of the neck is not the variable to manipulate in order to achieve the desired strength of the part, as the axial (tensile/compressive) strength is also affected.

[0008] U.S. Patent No. 6,056,471 provides for a multiple necked-down breakaway coupling for highway or roadside appurtenances in which a controlled breaking region is provided that has at least two axially spaced necked-down portions co-axially arranged between the axial ends of the coupling that are configured to be attached both to the appurtenance at one end and to the support base at the other end. Each necked-down portion essentially consists of two axially aligned conical portions inverted one in relation to the other and generally joined at their apices to form a generally hour-glass configuration having a region of minimal cross section at an inflection point having a gradually curved annular concave surface defining a radius of curvature. Each of the two necked-down portions has a different radius of curvature at the respective inflection points to provide preferred failure modes as a function of the position and direction of impact of a force on the appurtenance.

[0009] U.S. Patent No. 6,056,471 does not disclose any material from which a safe and effective breakaway coupling could be made, nor does the '471 patent disclose the important or critical physical properties (e.g., tensile and/or shear strength) of any such material. Moreover, the '471 patent fails to disclose any relationship between ultimate tensile strength and ultimate restrained shear strength in a breakaway coupling. Thus, many couplings made in accordance with the disclosure of the '471 patent will lack important or critical physical properties and could create hazardous conditions due to improper failure modes.

SUMMARY OF THE INVENTION

[0010] It is, accordingly, an object of the present invention to provide a breakaway coupling for a highway or roadway appurtenance which does not have the disadvantages inherent in comparable prior art breakaway couplings.

[0011] It is another object of the present invention to provide a breakaway coupling which is simple in construction and economical to manufacture. It is still another object of the present invention to provide a breakaway coupling of the type under discussion which is simple to install and requires minimal effort and time to install in the field.

[0012] It is yet another object of the present invention to provide a breakaway coupling as in the aforementioned objects which is simple in construction and reliable, and whose functionality is highly predictable.

[0013] It is yet another object of the present invention to provide a breakaway coupling as in the previous objects which can be retrofitted to most existing breakaway coupling systems.

[0014] It is still a further object of the present invention to provide a breakaway coupling that has very low shear strength for a quick and controlled fracture upon impact, while maintaining high tensile and compressive strength to hold appurtenances and withstand typical environmental conditions, such as wind load.

[0015] It is yet a further object of the present invention to provide breakaway couplings of the type suggested in the previous objects which essentially consists of one part and, therefore, requires minimal assembly in the field and handling of parts.

[0016] It is an additional object of the present invention to provide a breakaway coupling in which the failure mechanism can be better controlled to insure failure at a pre-selected region of the coupling.

[0017] In order to achieve the above objects, as well as others which will become apparent hereafter, a multiple necked-down breakaway coupling for a highway and roadside appurtenance is provided to be mounted on a base. The coupling defines an axis and comprises a controlled breaking region arranged along said axis and the coupling has opposing axial ends. First connecting means is provided for connecting one of said opposing axial ends to the highway or roadside appurtenance. A second connecting means is provided for connecting another one of said opposing axial ends to the base on which the highway or roadside appurtenance is to be mounted. Said controlled breaking region includes at least two axially spaced necked-down portions co-axially arranged between said first and second connecting means. Each necked-down portion essentially consists of two axially aligned conical portions inverted one in relation to the other and generally joined at their apices to form a generally hour-glass shaped configuration having a region of minimal cross-section at an inflection point having a gradually curved annular concave surface and defining a radius of curvature. Each of the two necked-down portions having different radii of curvature at respective inflection points to provide preferred failure modes as a function of the position and direction of impact of a force on the appurtenance.

[0018] The breakaway coupling preferably has a minimum ultimate tensile strength equal to or greater than about 53.8 kN and a minimum ultimate restrained shear strength equal to or greater than about 5.8 kN. The minimum ultimate restrained shear strength of the breakaway coupling is preferably from about 6% to about 12% of the minimum ultimate tensile strength.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will be thoroughly understood from the following description of a preferred embodiment thereof as read in conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded view, in front elevation, of a multi necked-down breakaway coupling in accordance with the present invention which is provided with one internally threaded axial end for use with a male anchor imbedded in a support base;

FIG. 2 is an exploded, view in front elevation, a multi necked-down breakaway coupling similar to FIG. 1, but provided with two externally threaded axial ends, one of which interfaces with a female anchor imbedded in a support base;

FIG. 3 is a side elevational view of a support system for a roadside appurtenance, such as a lamp pole, supported on four (4) multiple necked-down breakaway couplings in accordance with the present invention, of the type shown in FIG. 1, after assembly and prior to impact by a vehicle;

FIG. 4 is similar to FIG. 3, but showing the initial bending or deformations at the necks of the coupling immediately after impact; and

FIG. 5 is similar to FIG. 4 but showing the support system shown in FIG. 4 after the couplings have been sufficiently bent to sever at the necks to thereby cause separation between the pole supporting platform and the lower portions of the couplings anchored to the base or ground.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Referring now specifically to the Figures, in which identical or similar parts are designated by the same reference numerals throughout and first referring to FIGS. 1 and 2, a multiple necked-down breakaway coupling for a highway and roadside appurtenance to be mounted on the base B, which is illustrated in FIG. 1 as a concrete slab forming a foundation, is generally defined by the reference numeral 10.

[0021] The coupling 10 generally defines an axis 12 and has opposing axial ends, shown in FIG. 1 to include an upper axial end 13 and a lower axial end 13'. A controlled breaking region, generally defined by the reference numeral 14 is arranged along the axis 12 between the opposing axial ends 13, 13'. The controlled breaking region 14 includes two axial spaced necked-down portions 16, 18 to be more fully described below.

[0022] At one axial end 13, a suitable connecting member is provided for connecting the axial end 13 to the highway or roadside appurtenance. In the embodiment illustrated in FIG. 1, such connecting member is in the form of an externally threaded bolt 20, arranged along the axis 12 and advantageously provided with a chamfer 20'.

[0023] The two necked-down portions 16, 18 are separated by a central cylindrical portion 28 which is generally of uniform circular cross-section along the axis 12 and dimensioned to remain rigid and unbending relative to the necked-down portions 16, 18.

[0024] Provided between the threaded bolt 20 and the necked-down portion 16, there is provided an upper cylindrical portion 30 which includes at least one circumferential flat surface 30a, and preferably two such diametrically opposing flat surfaces, which may be readily engaged by a wrench or the like for transmitting torque from the wrench to the upper portion 30. The upper portion 30 is also advantageously provided with a generally flat surface 30b normal to the axis 12 from which the threaded bolt 20 projects and which is suitable for abutment against the roadside appurtenance or related components for securing the appurtenance to the threaded bolt 20.

[0025] At the lower axial end 13', a lower cylindrical portion 32, generally of similar diametrical dimensions as the upper portion 30, includes a generally flat surface 32a suitable for engagement or abutment against the base or related components for mounting the appurtenance on the base B. The lower portion 32, in the embodiment shown, includes an internal axial bore 32b which is provided with internal threads 32c,

[0026] By way of example only, according to one method of securing the coupling 10 to a highway or roadside appurtenance, there is illustrated a Pole base plate 40 which has an internal hole 40' dimensioned to receive the threaded bolt 20 with some clearance. A steel shim 52 may be used for adjusting the elevation of the pole base plate 40 in relation to the support surface 32a, 56a. One or more shims may be used, and these may be of the same or different thicknesses, as required. The number of shims used will depend on the amount of leveling adjustment and the thickness(es) of the shim(s). Washers 44, 46, provided on both sides of the Pole base plate 40 may be in the form of flat washers or lock washers for preventing the parts from moving relative to each other once the appurtenance is secured on the coupling 10 by means of a threaded nut 48.

[0027] At the lower axial end 13', an externally threaded bolt 50 is shown imbedded within the base B to form a low stub projection male anchor which is threadedly receivable within the threaded bore 32b in the lower portion 32 of the coupling. Similarly, as discussed above, an optional shim 52 may be used to level or vertically position the coupling 10 in a desired elevation.

[0028] In accordance with an important feature of the present invention, each necked-down portion 16, 18 essentially consists of two axially aligned conical portions 60, 62 and 64, 66 (FIG. 1) inverted one in relation to the other and generally joined at their apices to form a generally hour-glass shaped configuration having regions of minimal cross-section at inflection points 16', 18', respectively, as shown. Each of the inflection points 16', 18' has a gradually curved annular concave surface refining a radius of curvature R_1 , and R_2 at the upper and lower necked-down portions respectively. Each of the two necked-down portions 16, 18 have different radii of curvature at respective inflection points, resulting in different axial lengths ($l_2 \approx l_3 > l_4 \approx l_5$), to provide different failure modes to insure that maximum bending and severance first occur at the lower necked-down portion 18 to minimize engagement with the under carriage of an advancing vehicle.

[0029] The two necked-down portions 16, 18 are spaced from each other and proximate to another one of the associated connecting members 20, 32b to provide an enlarged or central portion 28 between the two necked-down portions that serves as a pivoting arm about which bending of the necked-down portions can take place.

[0030] In FIG. 2, a similar coupling 10' is shown which is very similar to the coupling 10 shown in FIG. 1 with the exception that the lower axial end 13' includes a lower portion 56 is provided with a downwardly projecting externally threaded bolt 22 which extends from a downwardly facing abutment surface 56a. One, and preferably two opposing, flat wrench engagement surfaces 56b are provided about the circumferential region of the lower portion 56. The embodiment illustrated in FIG. 2 is intended to be used with a female anchor 58 imbedded within the concrete slab or base B which is provided with an internally threaded opening dimensioned and configured to receive the externally threaded bolt 22. Aside from the axial terminations on connector constructions of the couplings, the couplings 10 and 10' may be identical and the description that follows will apply to both couplings,

[0031] As best shown in FIG. 2, each of the two conical portions 60 and 62 of the upper breakaway portion and conical portions 64, 66 of the upper and lower breakaways 16, 18 define a base angle in relation to a plane normal to the axis 12. Referring to the upper breakaway portion 16, the upper conical surface 60 forms an angle α with the base or horizontal plane and the lower conical portion 62 forms an angle β with its base or a horizontal plane. The angles α and β of the same necked-down portion may be equal. In the presently preferred embodiment, the α and β angle are equal to approximately 45° . However, the angles α and β may be different from each other without causing significant deterioration of performance. Also, it is possible that the angles α of the upper and lower necked-down portions may be the same or different. The same applies for the alternate angles β ,

[0032] It has been determined that, for most applications, the axial distance L between the two inflection points 16', 18' or the points of minimal diameter is preferably selected within the range of approximately 3-4 inches.

[0033] As indicated, the radii of curvature R_1 and R_2 are different from each other in accordance with the present invention and the radii of curvature are preferably selected from the range of approximately 0.1 to 0.225 inches. In the presently preferred embodiment, the radius of curvature R_1 of one necked-down portion is approximately 0.125 inches and the radius of curvature R_2 of the other necked-down portion is approximately 0.2 inches. It has also been found that the radii of curvature may be selected to have first and second predetermined values substantially independently of the parameters or dimensions of the necked-down portions. Therefore, while the radii of curvature may be substantially fixed, the circular cross-sections of the inflection points can vary for differently sized couplings. The diameter D of the necked-down portions 16, 18 at the inflection points are preferably selected within a range of approximately 0.4 to 0.7 inches.

[0034] Referring to FIGS. 1 and 2, it is advantageous to provide a round or fillet 70 at the junction(s) where the threaded bolts 20, 22 and the upper portion 30 and/or lower portion 56 (FIG. 2) meet to provide a gradual transition from the diameters of the bolts to the diameters of the associated coupler portions. Without the fillets (70), it has been found that sharp discontinuities at the interfaces mentioned, upon impact very high velocity vehicle on the coupling, can cause the bolts to shear at their bases where they join the surfaces 30b and/or 56a. By providing the fillets 70, this assures that the abrupt changes in stress at the connected portions of the threaded bolts do not exhibit a weak link that can fail before failure at the desired necked-down portions. Clearly, failure at the upper surface 30b would be undesirable since this would result in the remaining part of the coupling below surface 30b to remain intact and project above the ground a considerable distance which would likely engage the undercarriage of a motor vehicle. The purpose of the fillets 70, therefore, are to assure that the mechanism failure can be focused or centralized at a desired failure point and prevent, to the maximum possible, failure at other longitudinal or axial points of the coupling.

[0035] A breakaway coupling according to the present invention has a low minimum ultimate restrained shear strength in relation to its minimum ultimate tensile strength. A breakaway coupling with a relatively high minimum ultimate tensile strength and a relatively low minimum ultimate restrained shear strength will hold an appurtenance under a wide range of environmental conditions, yet breakaway when impacted by a moving vehicle, so as to minimize the loss of velocity of that vehicle due to the impact.

[0036] A breakaway coupling according to the present invention will preferably have a minimum ultimate tensile strength in the range of about 50 kN to about 225 kN depending upon the weight of the intended appurtenance. For example, a breakaway coupling according to the present invention having a minimum ultimate tensile strength of about

221.5 kN is capable of holding an appurtenance with a mass of about 450 kg. The minimum tensile yield strength of a breakaway coupling will be preferably in the range of about 45 kN to about 195 kN, and, more preferably, between about 86% and about 87% of the minimum ultimate tensile strength. In addition, the minimum ultimate restrained shear strength of the breakaway coupling will be preferably in the range of about 5 kN to about 25 kN and, more preferably, between about 6% to about 12% of the minimum ultimate tensile strength.

[0037] The following table summarizes the tensile and shear characteristics of four preferred breakaway couplings according to the present invention:

Table 1

Coupling	Minimum Ultimate Tensile Strength (kN)	Minimum Tensile Yield Strength (kN)	Minimum Ultimate Restrained Shear Strength (kN)
1	53.8	46.5	5.8
2	101.9	88.3	8.0
3	131.0	113.6	8.9
4	221.5	192.0	24.5

[0038] A preferred material for manufacturing the breakaway coupling according to the present invention is a steel alloy having a minimum tensile strength of about 150,000 psi, a minimum yield strength of about 130,000 psi (0.2% offset), a mean elongation of about 10%, a mean reduction of area of about 37%, a machinability of about 75% compared to 1212 steel, a minimum Rockwell C Hardness of about 32 HRC, and a minimum Brinell Hardness of about 302 HB.

[0039] An example of a preferred material for manufacturing the breakaway coupling according to the present invention is a steel alloy containing about 0.4% carbon at the minimum, about 0.7% to about 1.10% manganese, about 0.15% to about 0.35% silicon, about 0.8% to about 1.20% chromium, and about 0.15% to about 0.25% molybdenum. The microstructure is chiefly acicular ferrite and fine pearlite. Fine grain size is about 5 to about 8.

[0040] Referring now to FIGS. 3-5, the operation of the couplings in accordance with the present invention will be described. In FIG. 3, a support system for a lighting Pole is shown which may be relatively conventional with the exception of the specific couplings 10 which embody the present invention. Most of the components or elements shown in FIG. 3 have already been described in connection with FIGS. 1 and 2. In FIG. 3, all of the components are assembled in a conventional manner, which would be well known to those skilled in the art. Prior to impact, typically four couplings 10 are provided at four corners of a generally rectangular base or support plate 40 upon which a Pole P is fixedly mounted. In FIG. 4, a Force F is shown which acts on the Pole and represents the force of a vehicle which impacts upon the Pole. The Force F will urge the base plate 40 to move or be shifted to the right, as viewed in FIG. 4. However, since the lower portions 32 of the coupling are rigidly affixed to the base or ground B, there will generally be a clockwise rotation of that portion of the coupling above the neck 18 as suggested by Arrow D₁. Such relative rotation would cause stretching at 18a on the side of impact, while compression would take place at the opposite side at point 18b. The opposite bending would normally take place at the upper necked-down portion 16 where bending of the upper portion 30 is in a counter-clockwise direction in relation to the coupling below the neck 16. By selecting the radii of curvature R₁ and R₂ as described, the degrees of rotations D₁ and D₂ relative to each other can be better controlled.

[0041] The rotation D₂ is in a counter-clockwise direction because, while the base plate 40 shifts towards the right, as viewed in FIG. 4, there is initially little rotation of the Pole P because of the inertia of the Pole and its tendency to remain generally upright for a considerable period of time. Therefore, since the base plate 40 remains substantially horizontal while it is shifting towards the right, this causes the upper portions 30 to remain generally in their orientations while the central portion undergoes most of the movement or shifting. Referring to FIG. 5, it will be clear that continued bending at the necks 16, 18, will ultimately cause the necks to rupture, as suggested in FIG. 5. When this occurs, even while the base plate 40 and the Pole are still generally in orientation similar to that originally assumed in Fig. 3, though shifted somewhat to the right, a considerable amount of deformation of both necks 16, 18, as shown in Fig. 4, will result in failure of at least one neck or, more preferably, both necks, as shown in Fig. 5.

[0042] The coupling of the present invention can be used to support light poles, sign supports, or any other structural supports which have the surface loads applied higher up from the ground and are expected to breakaway easily when impacted by a vehicle. The couplings have the ability to breakaway, upon impact, from any direction and, unlike slip-based systems, do not depend on application or maintenance of critical torques. Simplicity of the product makes installation easy and without any special training, jigs, or tools.

[0043] Under impact in loading, the precisely machined double neck geometry of the present coupling allows its two ends to bend in opposite directions. This causes the device to fracture safely at relatively low force and energy levels. Crash tests have indicated that the double neck couplings of the present invention perform better than the requirements

for impact velocity change specified by the American Association of State Highway and Transportation Officials (AASHTO), a nonprofit association representing State highway and transportation departments in the United States. In addition, the present couplings are capable of holding appurtenances weighing as much as 1000 lbs, Moreover, the couplings of the present invention meet the requirements of the National Cooperative Highway Research Program (NCHRP), as specified in NCHRP Report 350.

[0044] In terms of cost, the coupling of the present invention is structurally the most economical breakaway device, it is easy to install and requires no special tools or training. The couplings and the system within which they are used can be quickly deployed, they eliminate or greatly reduce pole, anchor bolt and foundation damage. In terms of performance, the couplings of the present invention exhibit consistent breakaway characteristics, breaking away safely and consistently on impact from any direction, at bumper height. They exhibit exceptional structural strength and twice the service load carrying capacity of most other breakaway couplings. Of significant importance, as suggested above, is the low stub projection, particularly 1"-2,5" reveal, after impact provides optimum predictable safety to occupants of the motor vehicle as the coupling is designed to breakaway at least at the lower neck of the coupling before failure takes place in any other region of the coupling. The lower end of the aforementioned ranges applies to the structure of the type in FIG. 2, whereas the upper end applied to those of FIG. 1. In the above tests, the approximate stub heights were 1.8" and 2.0", respectively.

[0045] Coupling samples made in accordance with the invention have been tested for fatigue at 10 Hz ????? to failure. With load ranges of -2.7 to 7.5 kips, the samples withstood 2,000,000 cycles without fracture. The couplings are, therefore, extremely reliable and practical for use in the field under adverse load conditions.

[0046] Having described the invention, many modifications thereto will become apparent to those skilled in the art to which it pertains without deviation from the spirit of the invention as defined by the scope of the appended claims.

Claims

1. A multiple necked-down breakaway coupling for a highway and roadside appurtenance to be mounted on a base, the coupling defining an axis and comprising a controlled breaking region arranged along said axis and having opposing axial ends, said controlled breaking region having at least two axially spaced necked-down portions coaxially arranged between said opposing axial ends, each of said at least two necked-down portions having two axially aligned conical portions inverted one in relation to the other and generally joined at their apices to form a generally hour-glass shaped configuration having a region of minimal cross-section at an inflection point having a gradually curved annular concave surface defining a radius of curvature, each of said two necked-down portions having different radii of curvature at respective inflection points to provide different failure modes as a function of the position and direction of impact of a force on the appurtenance, wherein said controlled breaking region has a minimum ultimate tensile strength equal to or greater than about 53.8 kN and a minimum ultimate restrained shear strength equal to or greater than about 5.8 kN, and wherein said minimum ultimate restrained shear strength is from about 6% to about 12% of said minimum ultimate tensile strength.
2. A coupling as defined in claim 1, further comprising:
 - first connecting means for connecting one of said opposing axial ends to the highway or roadside appurtenance; and
 - second connecting means for connecting another one of said opposing axial ends to the base on which the highway or roadside appurtenance is to be mounted,
 - said first and second connecting means each comprising an externally threaded bolt coextensive with said axis.
3. A coupling as defined in claim 2, wherein said first connecting means comprises an externally threaded bolt coextensive with said axis and said second connecting means comprises an internally threaded hole coextensive with said axis for receiving an externally threaded bolt mounted on the base on which the highway or roadside appurtenance is to be mounted.
4. A coupling as defined in claim 1, wherein each of said two conical portions forming each of said at least two necked-down portions defines base angles α and β , respectively, in relation to a plane normal to said axis, wherein said angles α , β are equal.
5. A coupling as defined in claim 1, wherein each of said two conical portions forming each of said at least two necked-down portions defines base angles α and β , respectively, in relation to a plane normal to said axis, wherein $\alpha + \beta$ equals 45° ,

6. A coupling as defined in claim 1, wherein each of said two conical portions forming each of said at least two necked-down portions defines base angles α and β , respectively, in relation to a plane normal to said axis, wherein α, β are different angles,

7. A coupling as defined in claim 1, wherein the axial distance between the inflection points of said two necked-down portions is selected within the range of approximately 3-4 inches.

8. A coupling as defined in claim 1, wherein said radii of curvature are selected from the range of approximately 0.1 to 0.225 inches.

9. A coupling as defined in claim 8, wherein the radius of curvature of one necked-down portion is approximately 0.125 inches and the radius of curvature of the other necked-down portion is approximately 0.2 inches.

10. , A coupling as defined in claim 1, wherein said necked-down portions define circular cross sections at said inflection points.

11. A coupling as defined in claim 10, wherein the diameter of said necked-down portions at said inflection points are selected within the range of approximately 0.4 to 0.7 inches.

12. A coupling as defined in claim 1, wherein said minimum ultimate tensile strength is about 53.8 kN, and said minimum ultimate restrained shear strength is about 5.8 kN.

13. A coupling as defined in claim 1, wherein said minimum ultimate tensile strength is about 101.9 kN, and said minimum ultimate restrained shear strength is about 8.0 kN.

14. A coupling as defined in claim 1, wherein said minimum ultimate tensile strength is about 131.0 kN, and said minimum ultimate restrained shear strength is about 8.9 kN.

15. A coupling as defined in claim 1, wherein said minimum ultimate tensile strength is about 221,5 kN, and said minimum ultimate restrained shear strength is about 24.5 kN.

16. A multiple necked-down breakaway coupling for a highway and roadside appurtenance to be mounted on a base, the coupling defining an axis and comprising:

a controlled breaking region arranged along said axis and having opposing axial ends;
 first connecting means for connecting one of said opposing axial ends to the highway or roadside appurtenance;
 second connecting means for connecting another one of said opposing axial ends to the base on which the highway or roadway appurtenance is to be mounted,
 said controlled breaking region including at least two axially spaced necked-down portions coaxially arranged between said first and second connecting means, each necked-down portion essentially consisting of two axially aligned conical portions inverted one in relation to the other and generally joined at their apices to form a generally hourglass shaped configuration having a region of minimal cross section at an inflection point having a gradually curved annular concave surface defining a radius of curvature, each of said two necked-down portions having different radii of curvature at respective inflection points to provide different failure modes as a function of the position and direction of impact of a force on the appurtenance,
 said first and second connecting means each comprising an externally threaded bolt coextensive with said axis, each of said externally threaded bolts having a diameter less than a diameter of the portion of the coupling from which the coupling projects,
 and further comprising fillet means at the transition points where the diameters change to provide a gradual transition between the diameters,

wherein said controlled breaking region has a minimum ultimate tensile strength equal to or greater than about 53.8 kN and a minimum ultimate restrained shear strength equal to or greater than about 5.8 kN,

and wherein said minimum ultimate restrained shear strength is from about 6% to about 12% of said minimum ultimate tensile strength.

17. A coupling as defined in claim 1, wherein the coupling can withstand 2,000,000 cycles without failure under a load

range of -2.7 to +7.5 kips.

18. A multiple necked-down breakaway coupling for a highway and roadside appurtenance to be mounted on a base, the coupling defining an axis and comprising:

a controlled breaking region arranged along said axis and having opposing axial ends;
 first connecting means for connecting one of said opposing axial ends to the highway or roadside appurtenance;
 second connecting means for connecting another one of said opposing axial ends to the base on which the highway or roadside appurtenance is to be mounted,
 said controlled breaking region including at least two axially spaced necked-down portions coaxially arranged between said first and second connecting means, each necked-down portion essentially consisting of two axially aligned conical portions inverted one in relation to the other and generally joined at their apices to form a generally hourglass shaped configuration having a region of minimal cross section at an inflection point having a gradually curved annularconcave surface defining a radius of curvature, each of said two necked-down portions having different radii of curvature at respective inflection points to provide different failure modes as a function of the position and direction of impact of a force on the appurtenance,
 said first connecting means comprising an externally threaded bolt coextensive with said axis and said second connecting means comprising an internally threaded hole coextensive with said axis for receiving an externally threaded bolt mounted on the base on which the highway or roadside appurtenance is to be mounted, each externally threaded bolt having a diameter less than the diameter the portion of the coupling from which it projects,
 and further comprising fillet means at the transition point where the diameter changes to provide a gradual transition between the diameters,

wherein said controlled breaking region has a minimum ultimate tensile strength that is at least about 53.8 kN and a minimum ultimate restrained shear strength that is at least about 5.8 kN,

and wherein said minimum ultimate restrained shear strength is from about 6% to about 12% of said minimum ultimate tensile strength,

19. , A coupling as defined in claim 18, wherein said minimum ultimate tensile strength is from about 53.8 kN to about 221.5 kN, and wherein said minimum ultimate restrained shear strength is from about 5.8 kN to about 24.5 kN.

20. A coupling as defined in claim 18, wherein said minimum ultimate tensile strength is about 53.8 kN, and wherein said minimum ultimate restrained shear strength is about 5.8 kN.

21. A coupling as defined in claim 18, wherein said minimum ultimate tensile strength is about 101.9 kN, and wherein said minimum ultimate restrained shear strength is about 8.0 kN.

22. A coupling as defined in claim 18, wherein said minimum ultimate tensile strength is about 131.0 kN, and wherein said minimum ultimate restrained shear strength is about 8.9 kN.

23. A coupling as defined in claim 18, wherein said minimum ultimate tensile strength is about 221,5 kN, and wherein said minimum ultimate restrained shear strength is about 24.5 kN.

24. A coupling as defined in claim 18, wherein said minimum ultimate restrained shear strength is about 6.8% of said minimum ultimate tensile strength.

25. A coupling as defined in claim 18, wherein said minimum ultimate restrained shear strength is about 7,85% of said minimum ultimate tensile strength,

26. A coupling as defined in claim 18, wherein said minimum ultimate restrained shear strength is about 10.7% of said minimum ultimate tensile strength.

27. A coupling as defined in claim 18, wherein said minimum ultimate restrained shear strength is about 11,1 % of said minimum ultimate tensile strength.

28. A coupling as defined in claim 18, wherein the coupling can withstand 2,000,000 cycles without failure under a

load range of -2,7 to +7.5 kips.

29. A multiple necked-down breakaway coupling for a highway and roadside appurtenance to be mounted on a base, the coupling defining an axis and comprising:

a controlled breaking region arranged along said axis and having opposing axial ends;
 first connecting means for connecting one of said opposing axial ends to the highway or roadside appurtenance;
 second connecting means for connecting another one of said opposing axial ends to the base on which the highway or roadside appurtenance is to be mounted,
 said controlled breaking region including at least two axially spaced necked-down portions coaxially arranged between said first and second connecting means, each necked-down portion essentially consisting of two axially aligned conical portions inverted one in relation to the other and generally joined at their apices to form a generally hourglass shaped configuration having a region of minimal cross section at an inflection point having a gradually curved annular concave surface defining a radius of curvature, each of said two necked-down portions having different radii of curvature at respective inflection points to provide different failure modes as a function of the position and direction of impact of a force on the appurtenance,
 said first connecting means comprising an externally threaded bolt coextensive with said axis and said second connecting means comprising an internally threaded hole coextensive with said axis for receiving an externally threaded bolt mounted on the base on which the highway or roadside appurtenance is to be mounted, each externally threaded bolt having a diameter less than the diameter the portion of the coupling from which it projects,
 and further comprising fillet means at the transition point where the diameter changes to provide a gradual transition between the diameters,

wherein said controlled breaking region has a minimum ultimate tensile strength equal to or greater than about 53.8 kN and a minimum ultimate restrained shear strength equal to or greater than about 5.8 kN,

wherein said minimum ultimate restrained shear strength is from about 6% to about 12% of said minimum ultimate tensile strength,

and wherein said controlled breaking region substantially comprises a steel alloy having a minimum tensile strength of about 150,000 psi, a minimum yield strength of about 130,000 psi at 0.2% offset, a mean elongation of about 10%, a mean reduction of area of about 37%, a machinability of about 75% compared to 1212 steel, a minimum Rockwell C Hardness of about 32 HRC, and a minimum Brinell Hardness of about 302 HB.

30. A coupling as defined in claim 29, wherein said steel alloy comprises about 0.4% carbon at the minimum, about 0.7% to about 1.10% manganese, about 0.15% to about 0.35% silicon, about 0.8% to about 1.20% chromium, and about 0.15% to about 0.25% molybdenum, wherein the microstructure of said steel alloy is substantially acicular ferrite and fine pearlite, and wherein said steel alloy has a fine grain size of about 5 to about 8.

31. A coupling as defined in claim 29, wherein the coupling can withstand 2,000,000 cycles without failure under a load range of -2.7 to +7.5 kips.

FIG. 1

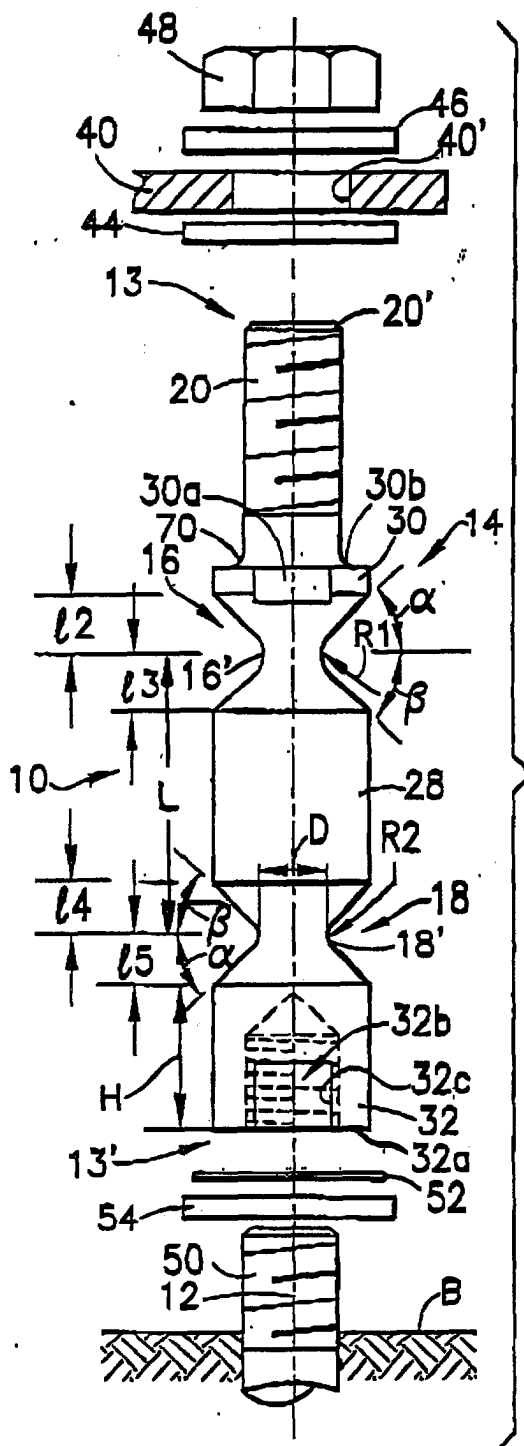
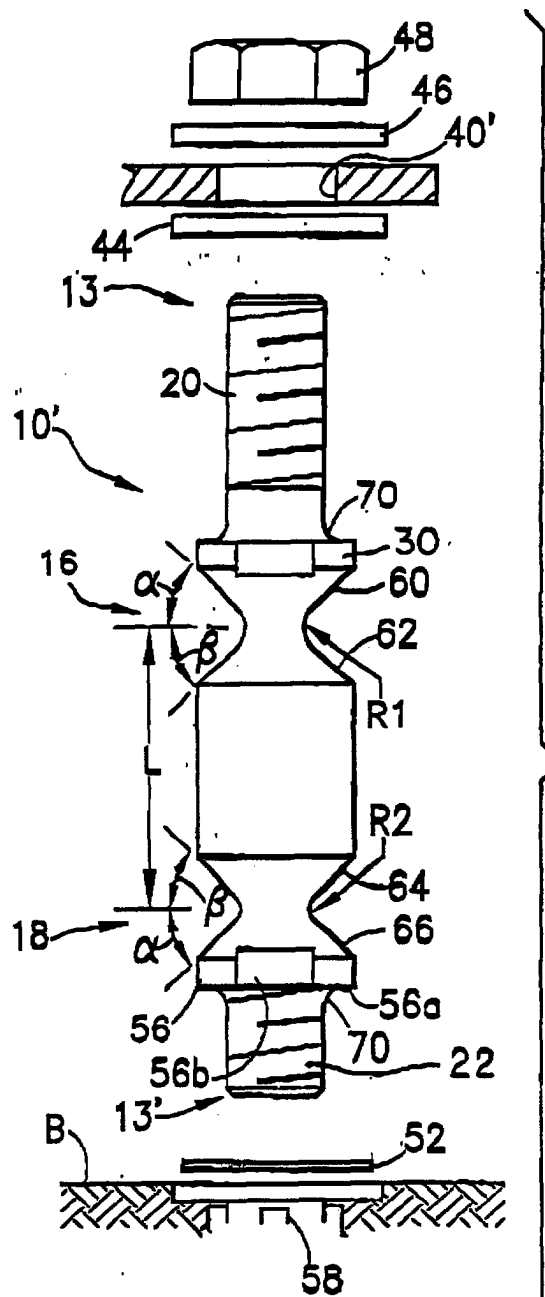


FIG. 2



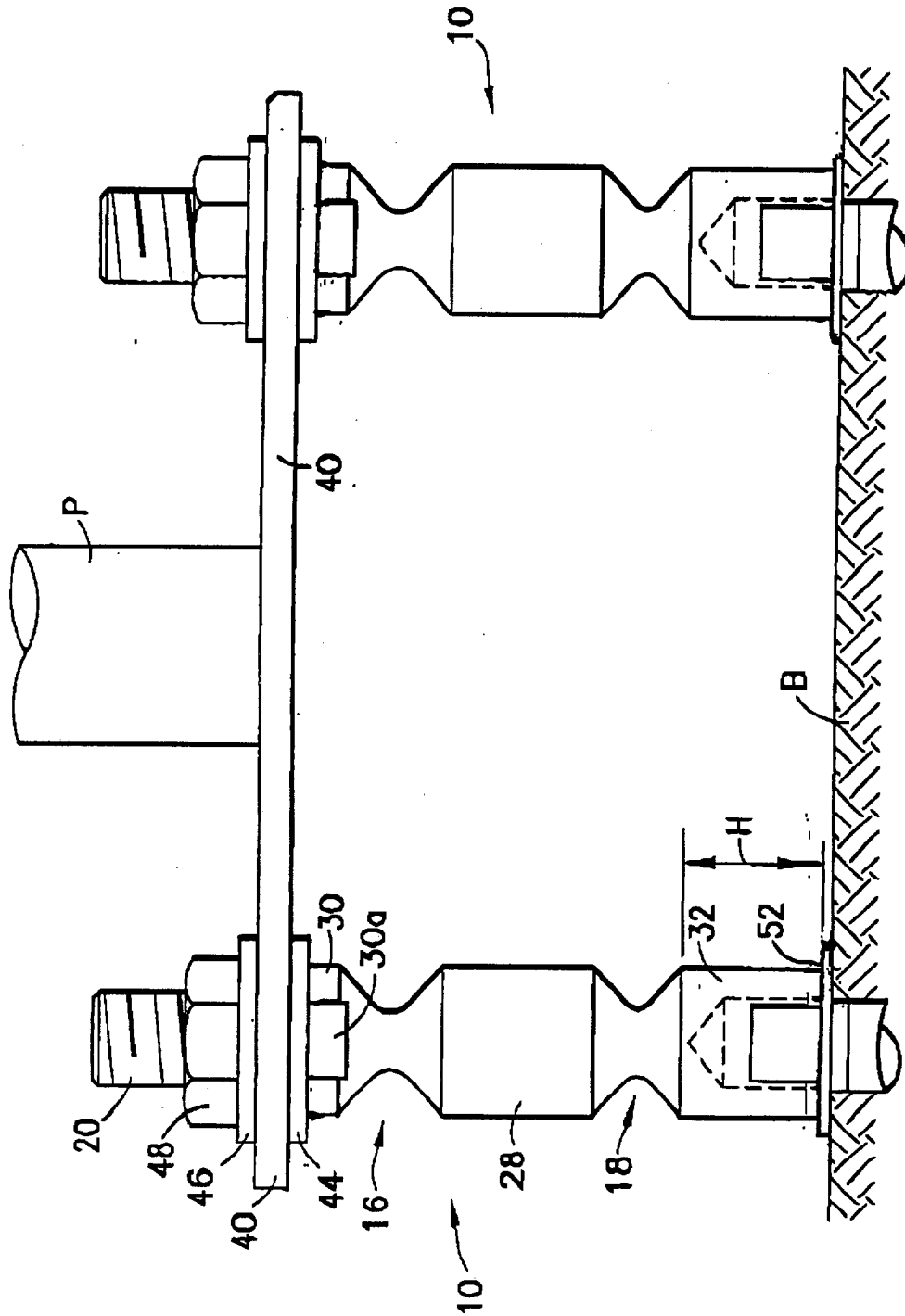


FIG. 3

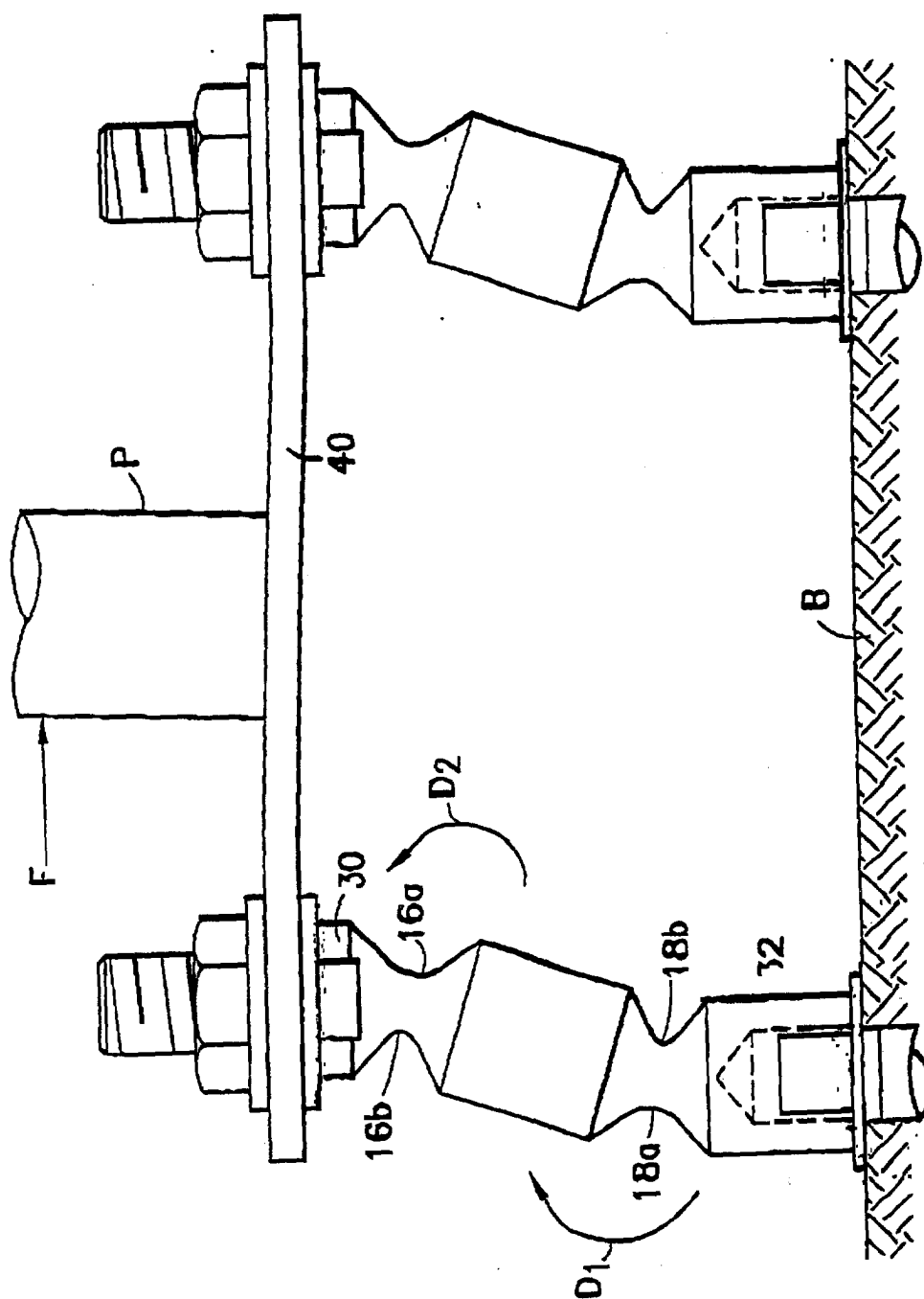


FIG. 4

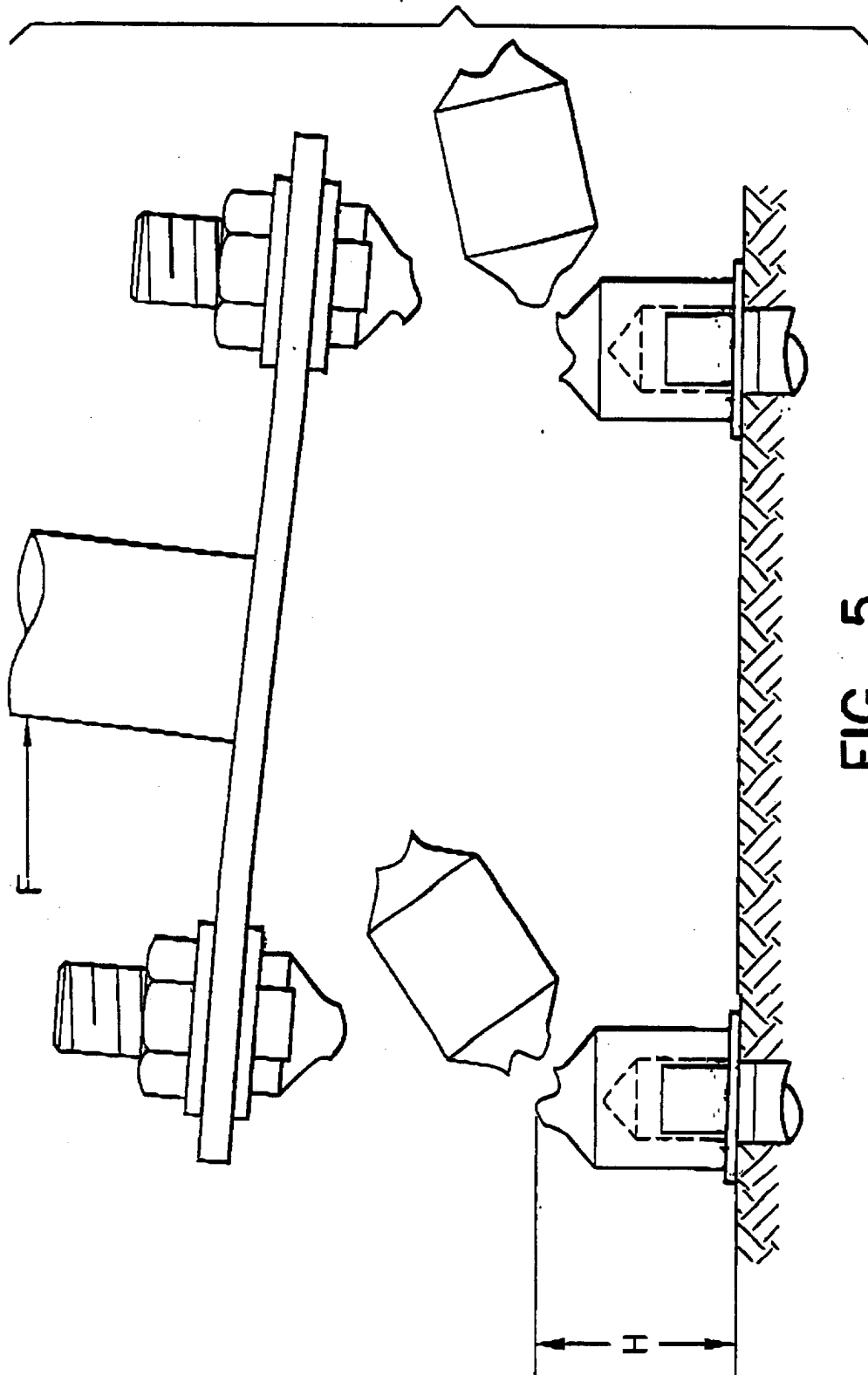


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 03 01 1207

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,X	US 6 056 471 A (DINITZ ARTHUR) 2 May 2000 (2000-05-02) * the whole document *	1-31	E01F9/018 E01F9/011
A	TRANSP0: "Pole-Safe Model 4125" 'Online! XP002256456 Retrieved from the Internet: <URL: http://www.transpo.com/4125.htm> 'retrieved on 2003-09-09! * the whole document *	1-31	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			E01F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 2 October 2003	Examiner Geivaerts, D
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			

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02-10-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6056471	A	02-05-2000	NONE

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