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

Trennkupplung für Strassenrandelemente

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EP 1 477 611 B1

Description1. Field of the Invention

5 **[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.

2. Description of the Prior Art

10 **[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
15 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.

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

25 **[0004]** 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,
30 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.

35 **[0005]** 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.

40 **[0006]** 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
45 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
50 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.

[0007] 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.

[0008] 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

[0009] 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.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] 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 preselected region of the coupling.

[0016] 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.

[0017] The controlled breaking region is a steel alloy that 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 and has a minimum ultimate tensile strength from about 53.8 kN to about 221.5 kN, and wherein said maximum ultimate restrained shear strength is from about 5.8 kN to about 24.5 kN, and wherein said maximum ultimate restrained shear strength is within the range of about 6% to about 12% of said minimum ultimate tensile strength, and wherein the radius of curvature R1 of one necked down (16, 18) portion is approximately 0.3175 cm (0.125 inches) and the radius of curvature R2 of the other necked down (16, 18) portion is approximately 0.48 cm (0.2 inches), 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] 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

[0019] 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.

[0020] 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.

[0021] 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'.

[0022] 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.

[0023] 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.

[0024] 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,

[0025] 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 levelling 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.

[0026] 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.

[0027] 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 defining a radius of curvature R1, and R2 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 (12 APPROX I3 > I4 APPROX 15), 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.

[0028] 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.

[0029] 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,

[0030] 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 alpha with the base or horizontal plane and the lower conical portion 62 forms an angle beta with its base or a horizontal plane. The angles alpha and beta of the same necked-down portion may be equal. In the presently preferred embodiment, the alpha and beta angle are equal to approximately 45 DEG. However, the angles alpha and beta may be different from each other without causing significant deterioration of performance. Also, it is possible that the angles alpha of the upper and lower necked-down portions may be the same or different. The same applies for the alternate angles beta.

[0031] 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 7.62-10.16 cm (3-4 inches).

[0032] As indicated, the radii of curvature R1 and R2 are different from each other in accordance with the present invention and the radii of curvature are preferably selected from the range of approximately 0.254 to 0.5715 cm (0.1 to 0.225 inches). In the presently preferred embodiment, the radius of curvature R1 of one necked-down portion is approximately 0.3175 cm (0.125 inches) and the radius of curvature R2 of the other necked-down portion is approximately 0.508 cm (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 maybe 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 1.016 to 1.778 cm (0.4 to 0.7 inches).

[0033] 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.

[0034] A breakaway coupling according to the present invention has a low maximum 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 maximum 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.

[0035] A breakaway coupling according to the present invention will 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 in the range of about 45 kN to about 195 kN, and, more, between about 86% and about 87% of the minimum ultimate tensile strength. In addition, the maximum ultimate restrained shear strength of the breakaway coupling will be in the range of about 5 kN to about 25 kN and between about 6% to about 12% of the minimum ultimate tensile strength.

[0036] The following table summarizes the tensile and shear characteristics of four preferred breakaway couplings according to the present invention:

Coupling	Minimum Ultimate Tensile Strength (kN)	Minimum Tensile Yield Strength (kN)	Maximum 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

[0037] A preferred material for manufacturing the breakaway coupling according to the present invention is a steel alloy having a minimum tensile strength of about 1,034,213.55 kN/m² (150,000 psi), a minimum yield strength of about 896,318.41 kN/m² 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.

[0038] 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.

[0039] 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 embodies 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.

[0040] 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.

[0041] 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.

[0042] 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 453.6 kg (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.

[0043] 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 2.54 - 6.35 cm (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 4.57 - 5.08 cm (1.8" and 2.0"), respectively.

[0044] Coupling samples made in accordance with the invention have been tested for fatigue at 10 Hz to failure. With load ranges of -12.01 kN to 33.36 kN (-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.

[0045] Having described the invention, many modifications thereto will become apparent to those skilled in the art to which it pertains without deviation from the invention as defined by the scope of the appended claims.

Claims

1. A multiple necked-down breakaway coupling (10) for a highway and roadside appurtenance to be mounted on a base, the coupling defining an axis and comprising:

- a controlled breaking region (14) 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.
- at least two axially spaced necked down (16, 18) portions coaxially arranged between said opposing axial ends of the controlled breaking region (14);
- two axially aligned conical portions (60, 62, 64, 66), arranged on the necked down (16, 18) 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 (16, 18) portions having different radii of curvature at respective inflection points (16', 18') to provide different failure modes as a function of the position and direction of impact of a force on the appurtenance, wherein the controlled breaking region (14) has a minimum ultimate tensile strength from about 53.8 kN to about 221.5 kN, and wherein said maximum ultimate restrained shear strength is from about 5.8 kN to about 24.5 kN, and wherein said maximum ultimate restrained shear strength is within the range of about 6% to about 12% of said minimum ultimate tensile strength, and wherein the radius of curvature R1 of one necked down (16, 18) portion is approximately 0.3175 cm (0.125 inches) and the radius of curvature R2 of the other necked down (16, 18) portion is approximately 0.48 cm (0.2 inches), **characterized in that**
- the controlled breaking region (14) is a steel alloy that 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 and the microstructure of said steel alloy is substantially acicular ferrite and fine pearlite, and said steel alloy has a fine grain size of about 5 to about 8.

2. A coupling (10) as defined in claim 1, wherein said first and second connecting means each comprising an externally threaded bolt coextensive with said axis.

3. A coupling (10) as defined in claim 2, wherein said first connecting means comprises an externally threaded bolt co-extensive 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 (10) as defined in claim 1, wherein each of said two conical portions (60, 62, 64, 66) forming each of

said at least two necked down (16, 18) portions defines base angles alpha and beta, respectively, in relation to a plane normal to said axis, wherein said angles alpha, beta are equal.

5. A coupling (10) as defined in claim 1, wherein each of said two conical portions (60, 62, 64, 66) forming each of said at least two necked down (16, 18) portions defines base angles alpha and beta, respectively, in relation to a plane normal to said axis, wherein alpha + beta equals 45 DEG,
6. A coupling (10) as defined in claim 1, wherein each of said two conical portions (60, 62, 64, 66) forming each of said at least two necked down (16, 18) portions defines base angles alpha and beta, respectively, in relation to a plane normal to said axis, wherein alpha, beta are different angles,
7. A coupling (10) as defined in claim 1, wherein the axial distance between the inflection points (16', 18') of said two necked down (16, 18) portions is selected within the range of approximately 7.62 -10.16 cm (3-4 inches).
8. A coupling (10) as defined in claim 1, wherein said necked down (16, 18) portions define circular cross sections at said inflection points (16', 18').
9. A coupling (10) as defined in claim 8, wherein the diameter of said necked down (16, 18) portions at said inflection points (16', 18') are selected within the range of approximately 1.016 to 1.778 cm (0.4 to 0.7 inches).
10. A coupling (10) as defined in claim 1, wherein said minimum ultimate tensile strength is about 53.8 kN, and said maximum ultimate restrained shear strength is about 5.8 kN.
11. A coupling (10) as defined in claim 1, wherein said minimum ultimate tensile strength is about 101.9 kN, and said maximum ultimate restrained shear strength is about 8.0 kN.
12. A coupling (10) as defined in claim 1, wherein said minimum ultimate tensile strength is about 131.0 kN, and said maximum ultimate restrained shear strength is about 8.9 kN.
13. A coupling (10) as defined in claim 1, wherein said minimum ultimate tensile strength is about 221,5 kN, and said maximum ultimate restrained shear strength is about 24.5 kN.
14. A coupling (10) as defined in claim 1, wherein the coupling can withstand 2,000,000 cycles without failure under a load range of -12.01 kN to +33.36 kN (-2.7 to +7.5 kips).
15. A coupling (10) as defined in claim 1, wherein the 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.
16. A coupling (10) as defined in claim 1, wherein said maximum ultimate restrained shear strength is about 6.8% of said minimum ultimate tensile strength.
17. A coupling (10) as defined in claim 1, wherein said maximum ultimate restrained shear strength is about 7,85% of said minimum ultimate tensile strength.
18. A coupling (10) as defined in claim 1, wherein said maximum ultimate restrained shear strength is about 10.7% of said minimum ultimate tensile strength.
19. A coupling (10) as defined in claim 1, wherein said maximum ultimate restrained shear strength is about 11,1 % of said minimum ultimate tensile strength.
20. A coupling (10) as defined in claim 1, wherein the coupling (10) comprises a first connecting means for connecting one of said opposing axial ends to the highway or roadside appurtenance; and a controlled breaking region (14) substantially comprises a steel alloy having a minimum tensile strength of about 1,034,213.55 kN/m² (150,000 psi), a minimum yield force of about 896,318.41 kN/m² (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.

Patentansprüche

1. Eine mehrfach verengte Abreißkupplung (10) für Autobahn- und Straßenrand-Zubehörteile, die auf einem Sockel montiert werden müssen, die Kupplung definiert dabei eine Achse und weist Folgendes auf:

- einen Sollbruchbereich (14), der entlang der besagten Achse angeordnet ist und gegenüberliegende axiale Enden hat;
- eine erste Verbindungseinrichtung für den Anschluss eines der gegenüberliegenden axialen Enden an das Autobahn- oder Straßenrand-Zubehörteil;
- eine zweite Verbindungseinrichtung für den Anschluss des anderen der gegenüberliegenden axialen Enden an den Sockel, an dem das Autobahn- oder Straßenrand-Zubehörteil montiert werden soll.
- mindestens zwei axial voneinander getrennte verengte (16, 18) Teile, die coaxial zwischen den gegenüberliegenden Enden des Sollbruchbereichs (14) angeordnet sind;
- zwei axial ausgerichtete konische Teile (60, 62, 64, 66), die an den verengten (16, 18) Teilen angeordnet und wobei der eine im Verhältnis zum anderen umgekehrt ist, und die im Allgemeinen an ihren Scheitelpunkten verbunden sind, um eine im Allgemeinen uhrglasförmige Konfiguration zu bilden, mit einem Bereich minimalen Querschnitts an einem Knickpunkt, der eine graduell gewölbte ringförmige konkave Oberfläche hat, die einen Wölbungsradius definiert, jeder dieser zwei verengten (16, 18) Teile, hat dabei einen unterschiedlichen Wölbungsradius an den entsprechenden Knickpunkten (16', 18'), um unterschiedliche Ausfallarten als Funktion der Position und Richtung der Auftreffkraft auf das Zubehörteil bereitzustellen, wobei der Sollbruchbereich (14) eine Mindestbruchfestigkeit von ungefähr 53,8 kN bis ungefähr 221,5 kN hat, und wobei die Höchstbruchscherfestigkeit bei ungefähr 5,8 kN bis ungefähr 24,5 kN liegt, und wobei die Höchstbruchscherfestigkeit im Bereich von ungefähr 6% bis ungefähr 12% der besagten Mindestbruchfestigkeit liegt, und wobei der Wölbungsradius R1 eines der verengten (16, 18) Teile ungefähr bei 0,3175 cm (0,125 Zoll) und der Wölbungsradius R2 des anderen verengten (16, 18) Teils bei ungefähr 0,48 cm (0,2 Zoll) liegt,

dadurch gekennzeichnet, dass

- der Sollbruchbereich (14) eine Stahllegierung hat, die mindestens ungefähr 0,4% Kohlenstoff, ungefähr 0,7% bis ungefähr 1,10% Mangan, ungefähr 0,15% bis ungefähr 0,35% Silikon, ungefähr 0,8% bis ungefähr 1,20% Chrom und ungefähr 0,15% bis ungefähr 0,25% Molybdän aufweist und die Mikrostruktur der besagten Stahllegierung im Wesentlichen nadeliges Ferrit und feines Pearlit ist, und die besagte Stahllegierung eine feine Korngröße von ungefähr 5 bis ungefähr 8 hat.

2. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die erste und zweite Verbindungseinrichtung jeweils einen Bolzen mit Außengewinde aufweist, der flächengleich mit der besagten Achse ist.

3. Eine Kupplung (10), wie in Anspruch 2 definiert, wobei die erste Verbindungseinrichtung einen Bolzen mit Außengewinde aufweist, der flächengleich mit der besagten Achse ist und die besagte zweite Verbindungseinrichtung eine Bohrung mit Innengewinde aufweist, die flächengleich mit der besagten Achse ist, um einen Bolzen mit Außengewinde aufzunehmen, der am Sockel montiert ist, an dem das Autobahn- oder Straßenrand-Zubehörteil angebracht werden soll.

4. Eine Kupplung (10), wie in Anspruch 1 definiert, wobei die beiden konischen Teile (60, 62, 64, 66), die die mindestens zwei verengten (16, 18) Teile bilden, die Basiswinkel Alpha bzw. Beta, im Verhältnis zu einer zu der Achse normalen Ebene, definieren, wobei diese Winkel Alpha, Beta gleich sind.

5. Eine Kupplung (10), wie in Anspruch 1 definiert, wobei die beiden konischen Teile (60, 62, 64, 66), die die mindestens zwei verengten (16, 18) Teile bilden, die Basiswinkel Alpha bzw. Beta, im Verhältnis zu einer zu der Achse normalen Ebene, definieren, wobei diese Winkel Alpha + Beta gleich 45 Grad sind.

6. Eine Kupplung (10), wie in Anspruch 1 definiert, wobei die beiden konischen Teile (60, 62, 64, 66), die die mindestens zwei verengten (16, 18) Teile bilden, die Basiswinkel Alpha bzw. Beta, im Verhältnis zu einer zu der Achse normalen Ebene, definieren, wobei Alpha, Beta unterschiedliche Winkel sind.

EP 1 477 611 B1

7. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei der axiale Abstand zwischen den Knickpunkten (16', 18') der beiden verengten (16, 18) Teile ausgewählt ist aus einem Bereich von ungefähr 7,62 -10,16 cm (3-4 Zoll).
- 5 8. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die verengten (16, 18) Teile kreisförmige Querschnitte an den besagten Knickpunkten (16', 18') definieren.
9. Eine Kupplung (10) wie in Anspruch 8 definiert, wobei der Durchmesser der verengten (16, 18) Teile an den Knickpunkten (16', 18') ausgewählt sind aus dem Bereich von ungefähr 1,016 bis 1,778 cm (0,4 bis 0,7 Zoll).
- 10 10. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Mindestbruchfestigkeit ungefähr 53,8 kN und die Höchstbruchscherfestigkeit ungefähr 5,8 kN beträgt.
11. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Mindestbruchfestigkeit ungefähr 101,9 kN und die Höchstbruchscherfestigkeit ungefähr 8,0 kN beträgt.
- 15 12. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Mindestbruchfestigkeit ungefähr 131,0 kN und die Höchstbruchscherfestigkeit ungefähr 8,9 kN beträgt.
13. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Mindestbruchfestigkeit ungefähr 221,5 kN und die Höchstbruchscherfestigkeit ungefähr 24,5 kN beträgt.
- 20 14. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Kupplung 2.000.000 Zyklen ohne Störung unter einem Lastbereich von -12,01 kN bis +33,36 kN (-2,7 bis +7,5 kips) übersteht.
- 25 15. Eine Kupplung (10), wie in Anspruch 1 definiert, wobei die erste Verbindungseinrichtung einen Bolzen mit Außengewinde aufweist, der flächengleich mit der besagten Achse ist und die besagte zweite Verbindungseinrichtung eine Bohrung mit Innengewinde aufweist, die flächengleich mit der besagten Achse ist, um einen Bolzen mit Außengewinde aufzunehmen, der am Sockel montiert ist, an dem das Autobahn- oder Straßenrand-Zubehörteil angebracht werden soll, jeder der Bolzen mit Außengewinde hat dabei einen geringeren Durchmesser als der Durchmesser des Teils der Kupplung, aus dem es herausragt.
- 30 16. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Höchstbruchscherfestigkeit ungefähr 6,8% der Mindestbruchfestigkeit beträgt.
- 35 17. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Höchstbruchscherfestigkeit ungefähr 7,85% der Mindestbruchfestigkeit beträgt.
18. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Höchstbruchscherfestigkeit ungefähr 10,7% der Mindestbruchfestigkeit beträgt.
- 40 19. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Höchstbruchscherfestigkeit ungefähr 11,1 % der Mindestbruchfestigkeit beträgt.
- 45 20. Eine Kupplung (10) wie in Anspruch 1 definiert, wobei die Kupplung (10) eine erste Verbindungseinrichtung für den Anschluss eines der gegenüberliegenden axialen Enden an das Autobahn- oder Straßenrand-Zubehörteil aufweist; und
einen Sollbruchbereich (14), der im Wesentlichen eine Stahlliegierung aufweist, mit einer Mindestbruchfestigkeit von ungefähr 1.034.213,55 kN/m² (150.000 psi), einer Mindeststreckgrenze von ungefähr 896.318,41 kN/m² (130.000 psi) bei 0,2% Versatz, eine durchschnittliche Verlängerung von ungefähr 10%, einer durchschnittlichen Querschnittminderung von ungefähr 37%, einer Bearbeitbarkeit von ungefähr 75% im Vergleich zu 1212 Stahl, eine Rockwell C-Mindesthärte von ungefähr 32 HRC und eine Brinell-Mindesthärte von ungefähr 302 HB.
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Revendications

- 55 1. Un raccord séparable à étranglements multiples (10) pour un équipement routier et de bord de route destiné à être monté sur une base, le raccord définissant un axe et comprenant :

- une zone de rupture commandée (14) agencée le long dudit axe et possédant des extrémités axiales opposées,
 - un premier moyen de raccordement destiné au raccordement d'une desdites extrémités axiales opposées à l'équipement routier ou de bord de route,
 - un deuxième moyen de raccordement destiné au raccordement d'une autre desdites extrémités axiales opposées à la base sur laquelle l'équipement routier ou de bord de route est destiné à être monté.
 - au moins deux parties à étranglement axialement espacées (16, 18) coaxialement agencées entre lesdites extrémités axiales opposées de la zone de rupture commandée (14),
 - deux parties coniques axialement alignées (60, 62, 64, 66), agencées sur les parties à étranglement (16, 18), inversées l'une par rapport à l'autre et généralement jointes au niveau de leurs sommets de façon à former une configuration généralement en forme de sablier possédant une zone de section transversale minimale au niveau d'un point d'inflexion possédant une surface concave annulaire graduellement incurvée définissant un rayon de courbure, chacune desdites deux parties à étranglement (16, 18) possédant des rayons de courbure différents au niveau de points d'inflexion respectifs (16', 18') de façon à fournir des modes de défaillance différents sous la forme d'une fonction de la position et de la direction d'impact d'une force sur l'équipement, où la zone de rupture commandée (14) possède une résistance à la traction ultime minimale d'environ 53,8 kN à environ 221,5 kN, et où ladite résistance au cisaillement limitée ultime maximale est d'environ 5,8 kN à environ 24,5 kN, et où ladite résistance au cisaillement limitée ultime maximale se situe à l'intérieur de la plage d'environ 6% à environ 12% de ladite résistance à la traction ultime minimale, et où le rayon de courbure R1 d'une partie à étranglement (16, 18) est approximativement de 0,3175 cm (0,125 pouce) et le rayon de courbure R2 de l'autre partie à étranglement (16, 18) est approximativement de 0,48 cm (0,2 pouce),

caractérisé en ce que

- la zone de rupture commandée (14) est un alliage d'acier qui contient environ 0,4% de carbone au minimum, environ 0,7% à environ 1,10% de manganèse, environ 0,15% à environ 0,35% de silice, environ 0,8% à environ 1,20% de chrome et environ 0,15% à environ 0,25% de molybdène, et la microstructure dudit alliage d'acier est sensiblement de la ferrite aciculaire et de la perlite fine et ledit alliage d'acier possède une taille de grain fin

2. Un raccord (10) selon la Revendication 1, où lesdits premier et deuxième moyens de raccordement comprennent chacun un boulon à filetage externe coextensif avec ledit axe.
3. Un raccord (10) selon la Revendication 2, où ledit premier moyen de raccordement comprend un boulon à filetage externe coextensif avec ledit axe et ledit deuxième moyen de raccordement comprend un trou à filetage interne coextensif avec ledit axe de façon à recevoir un boulon à filetage externe monté sur la base sur laquelle l'équipement routier ou de bord de route est destiné à être monté.
4. Un raccord (10) selon la Revendication 1, où chacune desdites deux parties coniques (60, 62, 64, 66) formant chacune desdites au moins deux parties à étranglement (16, 18) définit des angles de base alpha et bêta respectivement, en relation avec un plan normal audit axe, où lesdits angles alpha et bêta sont égaux.
5. Un raccord (10) selon la Revendication 1, où chacune desdites deux parties coniques (60, 62, 64, 66) formant chacune desdites au moins deux parties à étranglement (16, 18) définit des angles de base alpha et bêta respectivement, en relation avec un plan normal audit axe, où $\alpha + \beta = 45$ degrés,
6. Un raccord (10) selon la Revendication 1, où chacune desdites deux parties coniques (60, 62, 64, 66) formant chacune desdites au moins deux parties à étranglement (16, 18) définit des angles de base alpha et bêta respectivement, en relation avec un plan normal audit axe, où alpha et bêta sont des angles différents,
7. Un raccord (10) selon la Revendication 1, où la distance axiale entre les points d'inflexion (16', 18') desdites deux parties à étranglement (16, 18) est sélectionnée à l'intérieur de la plage d'approximativement 7,62 à 10,16 cm (3 à 4 pouces).
8. Un raccord (10) selon la Revendication 1, où lesdites parties à étranglement (16, 18) définissent des sections transversales circulaires au niveau desdits points d'inflexion (16', 18').
9. Un raccord (10) selon la Revendication 8, où les diamètres desdites parties à étranglement (16, 18) au niveau desdits points d'inflexion (16', 18') sont sélectionnés à l'intérieur de la plage d'approximativement 1,016 à 1,778 cm (0,4 à 0,7 pouce).

EP 1 477 611 B1

10. Un raccord (10) selon la Revendication 1, où ladite résistance à la traction ultime minimale est d'environ 53,8 kN et ladite résistance au cisaillement limitée ultime maximale est d'environ 5,8 kN.
- 5 11. Un raccord (10) selon la Revendication 1, où ladite résistance à la traction ultime minimale est d'environ 101,9 kN et ladite résistance au cisaillement limitée ultime maximale est d'environ 8,0 kN.
12. Un raccord (10) selon la Revendication 1, où ladite résistance à la traction ultime minimale est d'environ 131,0 kN, et ladite résistance au cisaillement limitée ultime maximale est d'environ 8,9 kN.
- 10 13. Un raccord (10) selon la Revendication 1, où ladite résistance à la traction ultime minimale est d'environ 221,5 kN et ladite résistance au cisaillement limitée ultime maximale est d'environ 24,5 kN.
14. Un raccord (10) selon la Revendication 1, où le raccord peut résister à 2 000 000 de cycles sans défaillance sous l'effet d'une plage de charge de -12,01 kN à +33,36 kN (-2,7 à +7,5 kips).
- 15 15. Un raccord (10) selon la Revendication 1, où le premier moyen de raccordement comprend un boulon à filetage externe coextensif avec ledit axe et ledit deuxième moyen de raccordement comprenant un trou à filetage interne coextensif avec ledit axe de façon à recevoir un boulon à filetage externe monté sur la base sur laquelle l'équipement routier ou de bord de route est destiné à être monté, chaque boulon à filetage externe possédant un diamètre inférieur au diamètre de la partie du raccord à partir de laquelle il fait saillie.
- 20 16. Un raccord (10) selon la Revendication 1, où ladite résistance au cisaillement limitée ultime maximale est d'environ 6,8% de ladite résistance à la traction ultime minimale.
- 25 17. Un raccord (10) selon la Revendication 1, où ladite résistance au cisaillement limitée ultime maximale est d'environ 7,85% de ladite résistance à la traction ultime minimale.
18. Un raccord (10) selon la Revendication 1, où ladite résistance au cisaillement limitée ultime maximale est d'environ 10,7% de ladite résistance à la traction ultime minimale.
- 30 19. Un raccord (10) selon la Revendication 1, où ladite résistance au cisaillement limitée ultime maximale est d'environ 11,1 % de ladite résistance à la traction ultime minimale.
- 35 20. Un raccord (10) selon la Revendication 1, où le raccord (10) comprend un premier moyen de raccordement destiné au raccordement d'une desdites extrémités axiales opposées à l'équipement routier ou de bord de route, et une zone de rupture commandée (14) comprenant sensiblement un alliage d'acier possédant une résistance à la traction minimale d'environ 1 034 213,55 kN/m² (150 000 psi), une force d'écoulement minimale d'environ 896 318,41 kN/m² (130 000 psi) à un décalage de 0,2%, un allongement moyen d'environ 10%, une réduction de superficie moyenne d'environ 37%, une usinabilité d'environ 75% comparée à l'acier 1212, une dureté Rockwell C minimale d'environ 32 HRC et une dureté Brinell minimale d'environ 302 HB.
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FIG. 1

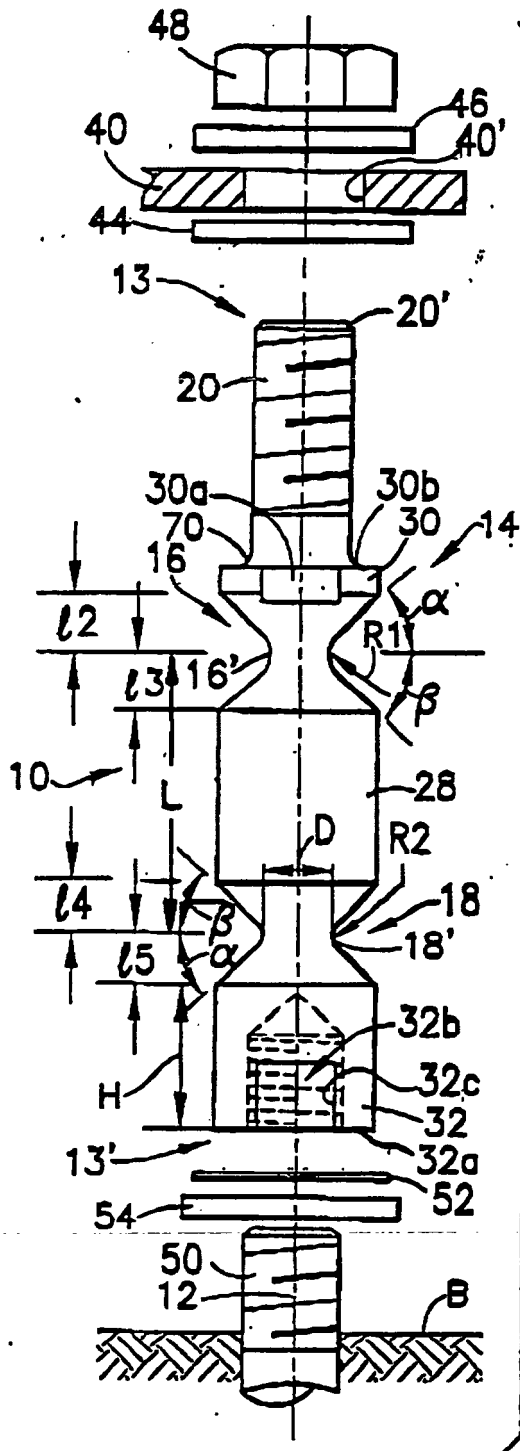
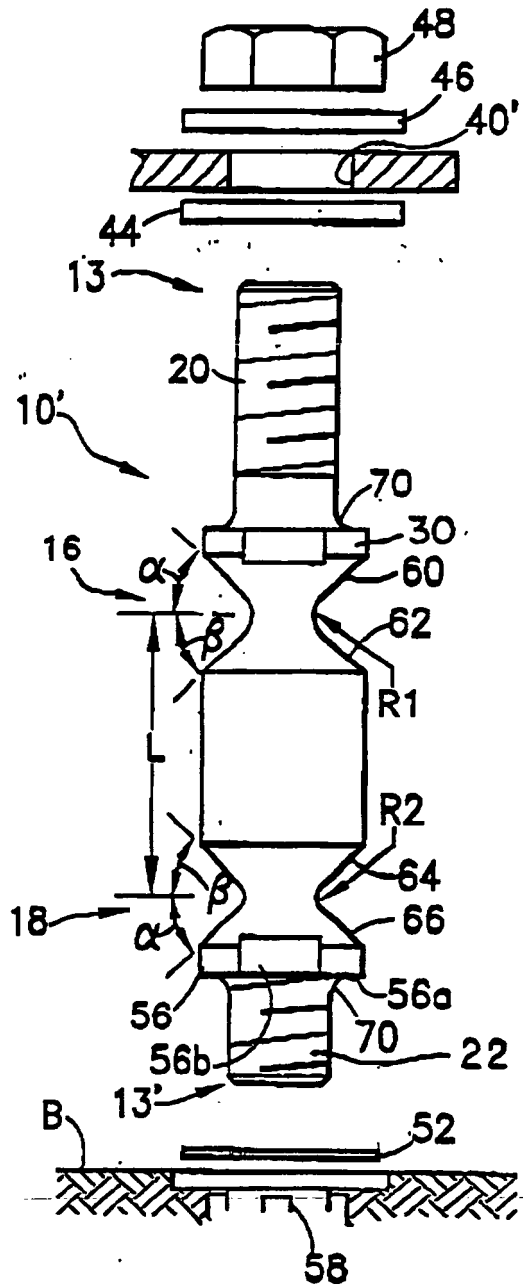


FIG. 2



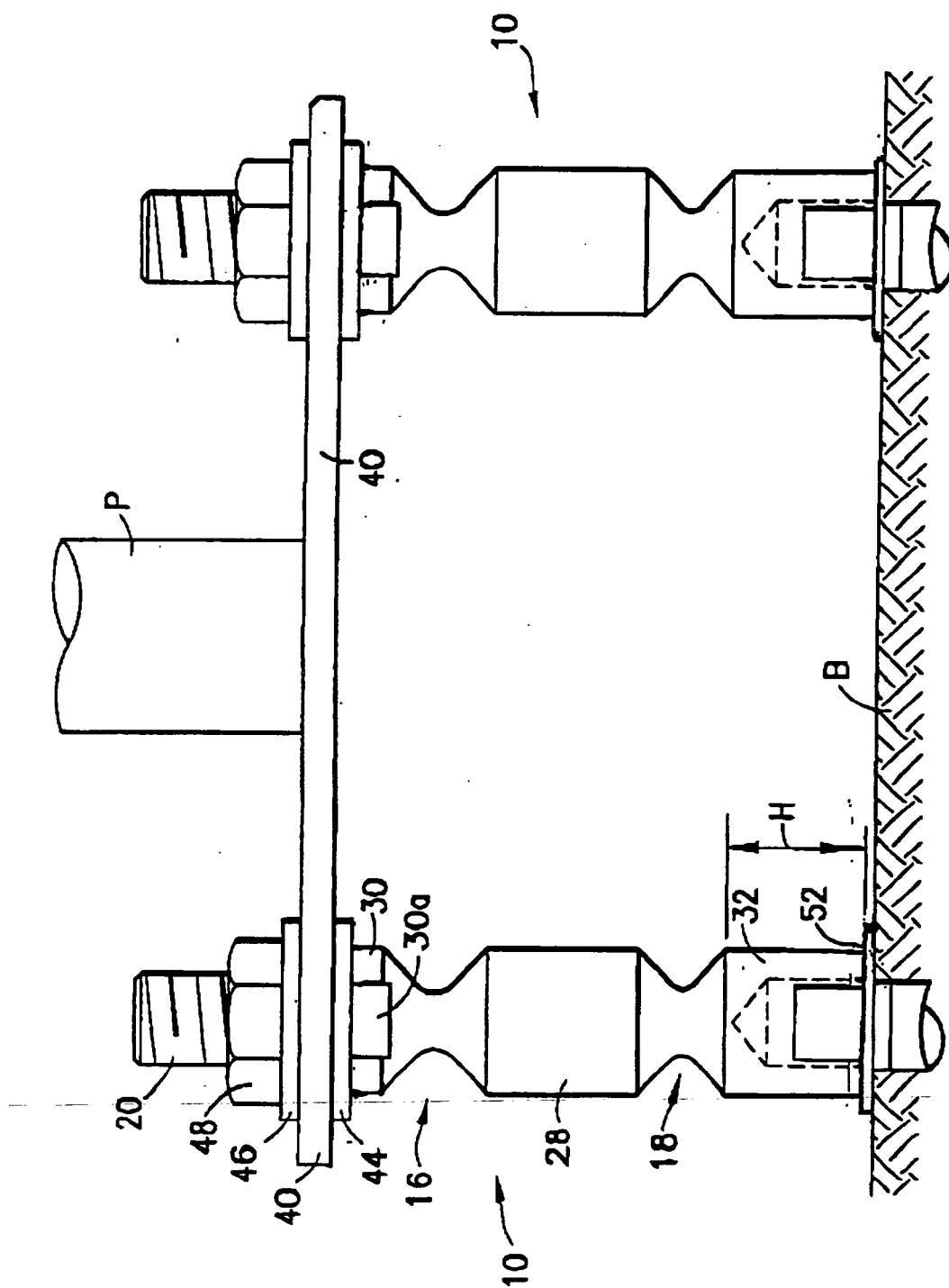


FIG. 3

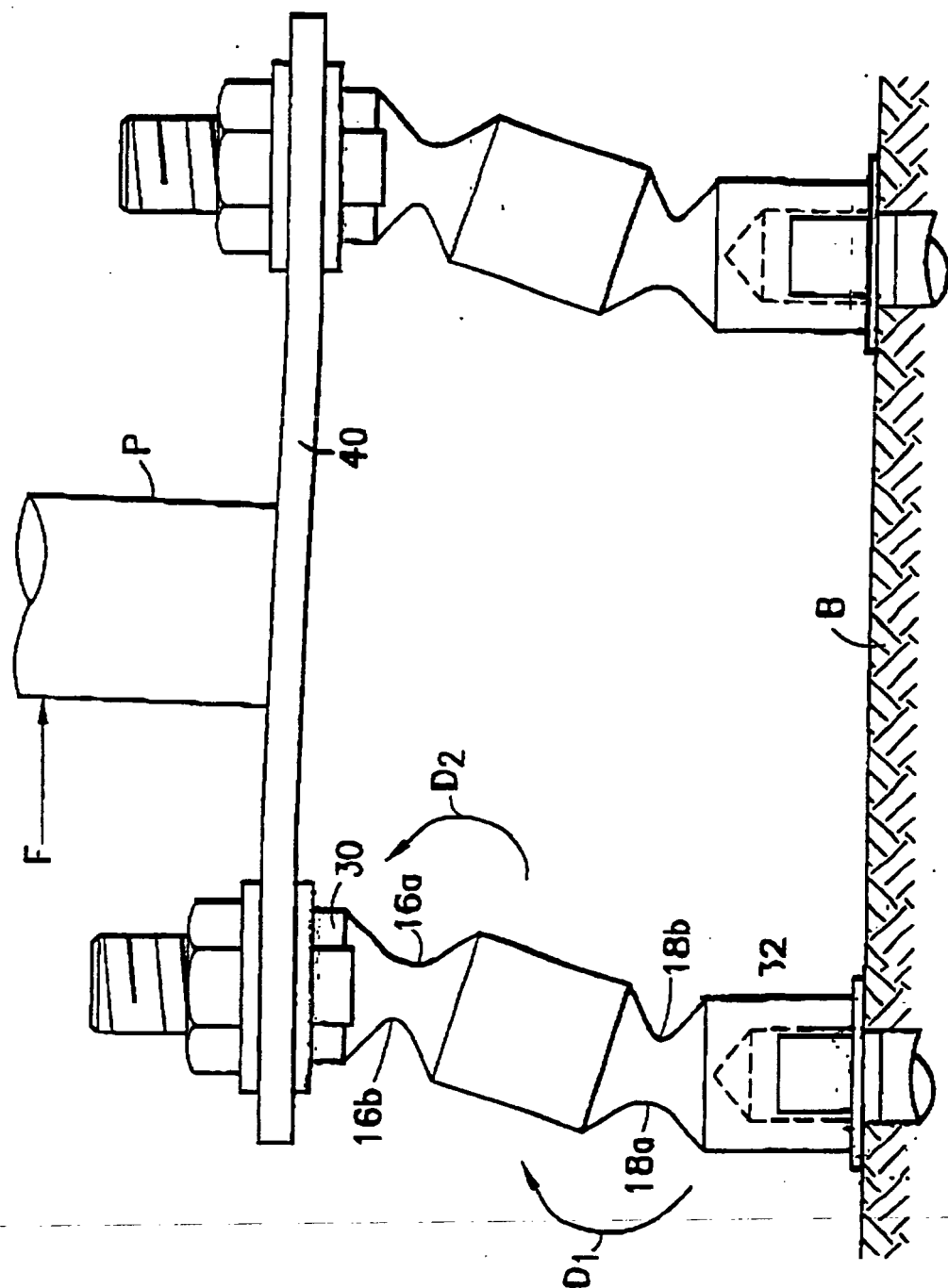
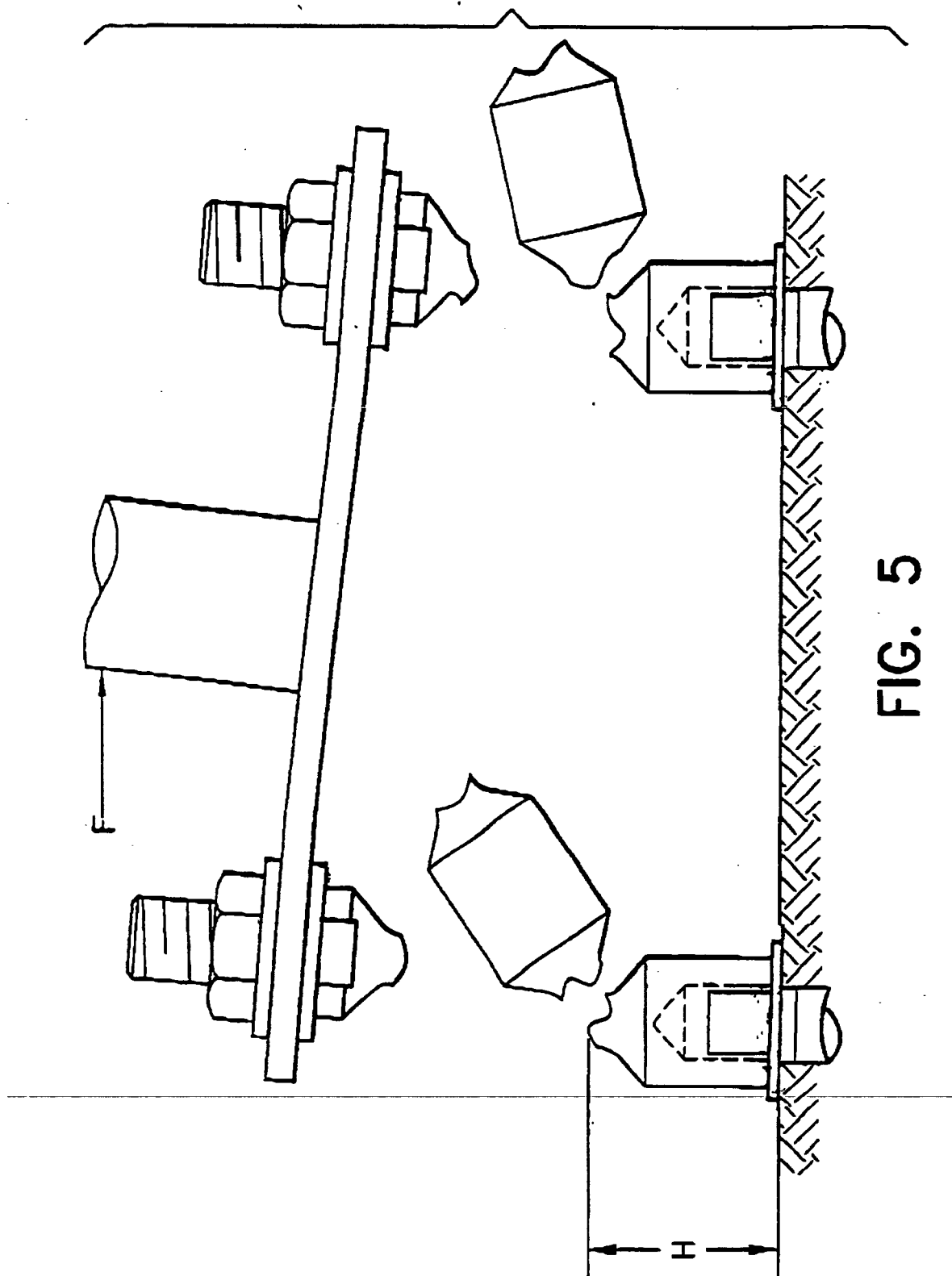


FIG. 4



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FIG.

REFERENCES CITED IN THE DESCRIPTION

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