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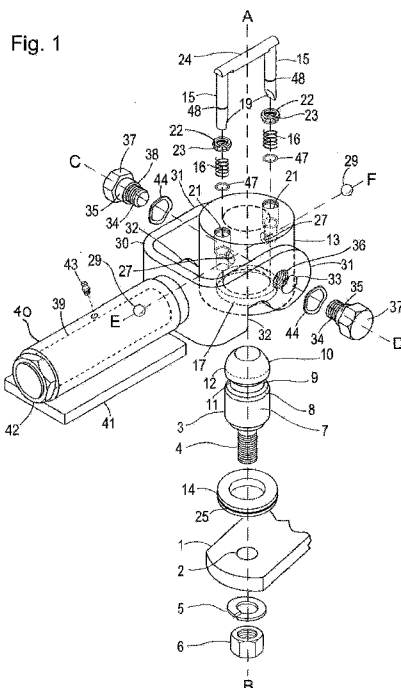
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(54) Title: A COUPLING WITH ACTUATORS



(57) Abstract: A coupling device for coupling a first vehicle to a second towed vehicle, the coupling device including a pillar (3) for mounting to a towbar attached to the first vehicle; a connector (30, 39, 40 and 41) for connection to the second towed vehicle through a sleeve (13) linked to the connector and adapted for engagement with the pillar (3) by fitting over the pillar (3); and an actuator (15 or 46) that is displaceable within a cavity (21 or 45) in the sleeve (13) between a first unlocked position in which the sleeve (13) is removable from the pillar (3) and a second locked position in which the sleeve (13) is not removable from the pillar (3).

A COUPLING WITH ACTUATORS

FIELD OF THE INVENTION

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This invention relates to a coupling device and more particularly relates to couplings or hitches for linking a first vehicle to a second vehicle, such as a trailer, for the purposes of towing the second vehicle over uneven ground where a wide range of articulation between the first vehicle and the second vehicle is required.

10 BACKGROUND OF THE INVENTION.

Existing couplings such as ball-couplings have the advantage of ease of attachment because the cup self-centres as it settles onto the spherical top of the tow-ball. However the range of articulation is restricted by the neck of the tow-ball contacting the edges of the cup.

Ball-couplings are retained on a tow-ball by a single tongue engaging the underside of
15 the head of the tow-ball. To ensure automatic primary-locking the tongue is held in the engaged position by a powerful spring. In many jurisdictions a means of automatic secondary-locking of the tongue, in the position that precludes coupling separation, is mandated. Considerable force is required to retract the tongue, against the influence of the primary-locking spring, to a position where the ball-coupling's cup can disengage the tow-ball.

20 A variety of mechanisms have been adopted to fulfill the objective of providing a hitch, between a vehicle and a trailer that will provide a greater range of articulation than is possible with a conventional tow-ball coupling. These mechanisms include:

- (1) The pintle hook;
- (2) An improved ring-type (pintle hook) coupling called the VC Coupling (Manufactured by
25 Vehicle Components Australia);
- (3) A ball-coupling with a tongue locking mechanism where secondary axes of rotation are provided between the cup, that engages a conventional tow-ball, and the trailer. The parts

involved in the secondary axes of rotation dictate a design of the tongue locking mechanism that makes disengagement of the tongue particularly difficult and hazardous to the user's hand;

(4) Couplings that have in common the manual insertion of a hitching-pin which links the vehicle and trailer components of the hitch together and thereby also provides one of three axes

5 of rotation for movement of the trailer relative to the vehicle; and

(5) A coupling that locates over a conical pillar and is retained on the pillar by a plate engaging in a circumferential groove in the pillar.

The pintle hook coupling is easy to connect but noisy and subject to wear because of the large amount of play between the ring and the hook. It is still used on heavy vehicles but has not
10 found favour with domestic users wanting to use a car or four-wheel-drive to tow a trailer into rugged terrain.

The improved VC coupling pintle hook reduces noise but linking the vehicle and the trailer requires a special spanner to do up a clamp-bolt and the manual application of a clamp-ring-assembly to stop the clamp-bolt working loose. The range of articulation is less than that
15 provided by other alternatives and the lack of automatic primary-locking and secondary-locking, against coupling disengagement, is a significant disadvantage.

The addition of supplementary axes of rotation to a ball-coupling with a tongue locking mechanism has been associated with the cup binding on the tow-ball and either damaging it or undoing it from the tow-bar. The mechanism has also been associated with difficulties
20 disengaging the tongue that locks the cup onto a conventional tow-ball because the handle used to withdraw the tongue from the locked position is not aligned with the shaft that withdraws the tongue. The mechanism is also associated with the coupling being difficult or impossible to disengage from the tow ball if there is residual tension or compression between the towing vehicle and the trailer in either a fore to aft or a sideways direction.

25 Couplings that employ hitching-pins suffer from the disadvantage of difficulty with inserting the hitching-pin when the respective vehicle and trailer components are not accurately

aligned. Alignment of the components requires an exact height match between the vehicle part and the trailer part. Every time a vehicle moves its tow-bar subtly, it changes height as power and/or brakes are applied. For this reason it is impractical to back the vehicle to a position where the trailer and vehicle components are engaged and ready to receive the hitching pin that

5 definitively links them together. Instead the trailer has to be manually manoeuvred, with jockey wheel changes as required, until the vehicle and trailer components are fully aligned.

For this reason hitching-pin couplings are not particularly suitable for heavier trailers or caravans that cannot be manhandled into an exact position for successful insertion of the hitching-pin. Problems manoeuvring a trailer to obtain accurate component-alignment for

10 hitching-pin insertion are multiplied if the wheels of the trailer are on uneven ground or in sand. Dual axle trailers are also hard to manually align because movement, other than directly fore and aft, requires sufficient force to scrub the tyres.

Hitching-pin removal can also be very difficult or impossible when the coupling is under load. The substantial lifting force of a jockey wheel, which can be used to separate a ball-

15 coupling, is of no assistance in removing a wedged in hitching-pin.

Couplings that employ hitching-pins do not incorporate automatic primary-locking against coupling disengagement. This is because any mechanism that automatically delivered and locked the long hitching-pin into position would be too cumbersome for practical use. It would also be difficult to manually disengage any automatic hitching pin insertion mechanism

20 that was forceful enough to insert the hitching-pin when the vehicle and the trailer components were not precisely aligned.

Some couplings, that employ hitching-pins, do offer an automated mechanism for secondary locking of the hitching-pin into a position that avoids coupling disengagement but this does not offer a requisite level of safety.

25 Couplings that engage over a conical pillar do self-align to a degree in a similar way to ball-based coupling but they do not have an automatic primary locking mechanism. In addition

the primary locking mechanism of the plate engaging the circumferential groove is exposed to contamination with dirt that may impair functionality. The bearing surface of the conical pillar is likewise exposed to contamination with dirt that may seize the trailer component of the coupling onto the pillar.

5 Furthermore, couplings with a long vertical dimension impede full opening of any door on the rear of a vehicle.

The recently released DO 35 and DO 45 couplings manufactured by Vehicle Components Australia do not provide automatic primary locking. This carries the risk of forgetting to lock the coupling before moving off. There is also a risk that an inquisitive person can "play" with the
10 coupling while the owner is absent and inadvertently leave it in the unlocked configuration. Few owners would routinely check a coupling after a break in their travels.

Australian patent number 2010223836 (derived from PCT Publication Number 2010/102322 and the disclosure of which is hereby incorporated by reference in its entirety) describes a coupling device that uses a collar that interacts with a sleeve to enable engagement
15 and disengagement of the sleeve from a tow-bar pillar using a series of ballbearings. The present invention however does not use a collar and has fewer components to achieve the same outcome.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a coupling device
20 for coupling a first vehicle to a second towed vehicle, the coupling device including:

a pillar for mounting to a towbar attached to the first vehicle;

a connector for connection to the second towed vehicle;

a sleeve linked to the connector that engages the pillar by fitting over the pillar,
the sleeve having cavity means; and

an actuator means positionable in the cavity means and movable with respect to the sleeve between a first unlocked position in which the sleeve is removable from the pillar and a second locked position in which the sleeve is not removable from the pillar.

The actuator means may comprise one or more separate actuators and are preferably in the form of rods. The cavity means may comprise one or more cavities with each cavity adapted to receive a respective rod.

According to a second aspect of the invention, there is provided a coupling device for coupling a first vehicle to a second towed vehicle, the coupling device including a pillar for mounting to a towbar attached to the first vehicle; a connector for connection to the second towed vehicle; a sleeve linked to the connector and adapted for engagement with the pillar by fitting over the pillar; and one or more actuators adapted to locate within respective cavities within a portion of the sleeve for movement with respect to the sleeve; wherein the actuators are movable with respect to the sleeve between a first unlocked position in which the sleeve is removable from the pillar and a second locked position in which the sleeve is not removable from the pillar.

Preferably the actuator is rotatable within or displaceable along the length of the respective cavity in the wall of the sleeve. A handle is preferably attached to the actuator to facilitate rotating the actuator within the cavity or displacing the actuator along the length of the respective cavity.

The sleeve may have at least one aperture extending through the wall from the cavity to the inside of the sleeve and a locking element positioned in each aperture of said at least one aperture. In the second locked position each locking element may have a portion that protrudes inwardly beyond an internal face of the sleeve wall and in the first unlocked position each locking element may reside at least partially within a respective aperture such that no portion of

each locking element protrudes inwardly beyond the internal face of the wall of the sleeve, to enable the sleeve to slide freely over the pillar.

In an embodiment of the invention the actuator has at least one recess and the actuator is adapted to be rotated or longitudinally displaced to a position where a recess of said at least one
5 recess is aligned with an aperture of said at least one aperture in the sleeve to enable movement of each respective locking element to either the first unlocked position or the second locked position.

Preferably, in the first unlocked position a portion of each locking element resides within a respective recess of the actuator and to move each locking element from the first unlocked
10 position to the second locked position the recess has a cam surface whereupon rotation or longitudinal displacement of the actuator the cam surface contacts the locking element to push the locking element further into the aperture to assume the second locked position.

According to an embodiment of the invention the pillar has a head, neck, part-hemispherical section and body. A circumferential groove is set into the underside of the head
15 and abuts the neck and wherein further each locking element contacts the groove whenever the sleeve is attempted to disengage from a position of full engagement on the pillar while the actuator is in the second locked position.

The zone of the pillar which forms a transition from the top of the body having a uniform diameter to the neck which has a lesser diameter is referred to as the part-hemispherical section
20 but it may have a contour such as a bevel that is not part of a hemisphere.

In the process of fully engaging the sleeve with the pillar, the actuator can be rotated or longitudinally displaced to the first unlocked position such that a respective recess is aligned with the aperture, thereafter the sleeve is preferably moved with respect to the pillar such that the head displaces each locking element to a position in a respective aperture and partially into the

aligned recess so that no portion of each locking element protrudes inwardly beyond the internal face of the wall of the sleeve. The sleeve is now free to descend to full engagement on the pillar at which juncture returning the actuator to the second locked position displaces each locking element to a position in a respective aperture where it protrudes inwardly beyond the internal
5 face of the wall of the sleeve.

In the process of disengaging the sleeve from full engagement and locking onto the pillar the actuator is rotated or longitudinally displaced such that a respective recess is aligned with the aperture, thereafter the sleeve is displaced with respect to the pillar so that each locking element bears against the groove and an underside of the head of the pillar and continued displacement of
10 the sleeve forces each element to move in the aperture and partially into the aligned recess so that no portion of each locking element protrudes inwardly beyond the internal face of the wall of the sleeve.

Preferably the vertical dimension from the bottom of the sleeve to the second axis of rotation is equal to or greater than the vertical dimension between the top of the cylindrical body
15 of the pillar to the equator of the head of the pillar.

In an embodiment, the neck and part hemispherical sections of the pillar do not impede movements of the locking elements and guide the longitudinal axis of the sleeve into alignment with the longitudinal axis of the cylindrical body of the pillar, if the longitudinal axis of the sleeve after passing over the head of the pillar is tilted with respect to the longitudinal axis of the
20 pillar.

Preferably there is a circumferential buffer zone adjacent the top of the groove set into the underside of the head of the pillar that precludes the locking elements from distorting the underside of the head of the pillar to produce a head diameter that would interfere with the sleeve freely engaging the head of the pillar.

The cavity in the sleeve may have a collar that retains the actuator within the cavity and may regulate the range of rotation and/or longitudinal displacement of the actuator within the cavity.

One or more indicia means may be located on the actuator, the handle or the sleeve to
5 indicate when no portion of any recess is aligned with a respective aperture.

The actuator or the handle may be linked to a biasing means that acts to retain the actuator in the second locked position.

The connector may include a yoke having a pair of arms and a yoke shaft connected to the yoke, the yoke shaft rotatable within a tube that is connected to the second towed vehicle
10 through a plate.

The movement between the first vehicle and the second towed vehicle through the coupling device is with respect to the first, second and third axes which are preferentially mutually at right angles to each other.

The first axis is formed by the sleeve rotating around the pillar, the second axis is formed
15 by the yoke pivoting on the sleeve and the third axis is provided by the yoke shaft rotating within the tube.

Preferably each arm of the yoke is connected to the sleeve by respective securing means. The securing means may be formed by a projection extending each from opposed sides of the sleeve to engage with a respective yoke arm. Alternatively, the securing means protrude through
20 respective bores oppositely located in the wall of the sleeve. Each bore may be threaded and the arms compressed toward one another by threading the respective securing means into a respective bore, such that friction is present between each securing means and respective bore.

The yoke is adapted for rotation about a second axis aligned with the centre of each bore through the movement of each securing means along a thread in the respective bore or through the projecting securing means forming stub axles that the yoke can rotate about.

In an alternative embodiment the ball bearings are disposed of and the actuator functions
 5 directly as the locking element rather than through regulating the movement of a separate locking element. This embodiment with the actuator directly being the locking element requires the cavity containing the actuator to run at a tangent to the sleeve (similar to a chord) and to breach the internal face of the wall of the sleeve.

With this alternative embodiment the actuator that replaces the locking element is a rod
 10 occupying the cavity and displaceable along it or rotatable within it. When any part of the rod lies within that part of the cavity that breaches the internal wall of the sleeve, it will block the movement past the actuator of any part of a pillar whose diameter matches the internal diameter of the sleeve. The mechanism is best understood by reference to Figures 6a, 6b, 7a and 7b.

BRIEF DESCRIPTION OF THE DRAWINGS.

15 Preferred embodiments of the invention will hereinafter be described, by way of example only, with reference to the drawings in which:

Figure 1 is an exploded perspective view of a coupling device according to an embodiment of the invention;

Figure 2 is a vertical sectional view of a pillar of the coupling device in Figure 1 passing
 20 through the line A-B;

Figure 3 is a vertical-sectional view through the lines A-B and E-F in Figure 1 when a sleeve of the coupling device is fully engaged on the pillar and an actuator, in the form of a rod, is in the up position such that the sleeve is free to disengage the pillar;

Figure 4 is a vertical sectional view, through the lines A-B and E-F in Figure 1, when the sleeve is fully engaged on the pillar and the actuator rod is in the down position such that the sleeve cannot disengage from the pillar;

Figure 5 is a vertical-sectional view through lines A-B and C-D in Figure 1 when the
5 sleeve is fully engaged on the pillar;

Figures 6a and 6b are respectively transverse and vertical sections of a coupling device according to a further embodiment when the actuator functions directly as a locking element or locking means rather than through regulating the movement of a separate locking element. The sleeve is fully engaged on the pillar and the actuator rod is in the retracted position such that the
10 sleeve is free to disengage from the pillar; and

Figures 7a and 7b are respectively transverse and vertical sections of the coupling device of Figures 6a and 6b when the actuator functions directly as the locking element or locking means rather than through regulating the movement of a separate locking element. The sleeve is fully engaged on the pillar and the actuator rod is in the inserted position such that the sleeve is
15 not free to disengage from the pillar.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following described features are of a coupling device according to a preferred embodiment.

A towed second-vehicle, such as a trailer, can be oriented in any position relative to a
20 towing first-vehicle if the coupling between each provides three separate axes of rotation that are mutually at right angles to each other.

The preferred embodiment of the invention provides three such axes of rotation. The first axis is the mating of a trailer-attached cylindrical sleeve to a pillar that is integral with or rigidly attached to the tow-bar on the towing first-vehicle. An automated locking mechanism maintains
25 the sleeve on the pillar while towing.

The cylindrical sleeve is attached to the second-vehicle through a connector which comprises a yoke having a shaft attached to its back. The second axis of rotation occurs where the yoke pivots on the sleeve through securing means that securely link the arms of the yoke to the opposite sides of the sleeve. The third axis of rotation occurs where the shaft on the back of the yoke is free to rotate within a tube that is securely attached to the second-vehicle.

Preferably the second axis passes through the first axis and the third also passes through the first axis. Preferably the second and third axis are at right angles to each other but need not pass through each other.

Sliding a cylindrical sleeve over a closely mated cylindrical pillar is impossible until the axis of the sleeve is accurately aligned with the axis of the pillar. To be practical, a coupling based on having a closely fitted sleeve rotate around a pillar needs a specific pillar design that avoids the sleeve jamming on the pillar part way into the required full engagement. The pillar design also has to minimise the chances of a sleeve which is free to pivot within a yoke tumbling off a pillar if it is presented to it in an off-centre manner and the yoke is progressively lowered.

To avoid jamming and/or tumbling off part way through the mating process the upper part of the pillar has a defined shape that accepts and directs a sleeve, whose axis is not initially fully aligned with the pillar's axis, into an orientation where the sleeve is correctly aligned to allow a continued smooth engagement of the sleeve over the lower part of the cylindrical body of the pillar.

A pillar shape that meets these requirements is symmetric about a vertical (first) axis and is best described as having four continuous segments which are termed, from above down, the head, the neck, the part-hemispherical-section and the body. The head is more than half a sphere, having a defining radius of length "R" and an equatorial plane that lies at right angles to the axis of the pillar. The neck extends from the underside of the head, at a level below this equatorial plane, down to the top of the part- hemispherical section which makes the transition to the body which is a right regular cylinder that has the same defining radius of length "R".

The profile can be further modified to provide means for securing the sleeve to the pillar. One such modification is for the spherical head above the neck to have set into it a circumferential groove to match the profile of a locking element or actuator that will engage it and then an abutting buffer-zone which lies above the groove but below the equatorial plane.

- 5 The groove is where the locking elements, preferably in the form of ball-bearings, located in apertures in the wall of the sleeve, will engage to retain the sleeve on the pillar whenever they are stopped by actuators from displacing to a position where they can lie outside the circumference of the equator of the head.

- 10 When the locking element is a ball bearing, the profile of the groove, as seen in a vertical section through the long axis of the pillar, is matched to the profile of the upper part of the ball bearing that will engage it when the sleeve is locked onto the pillar and an attempt is being made to lift the sleeve off the pillar.

- 15 The purpose of the buffer zone is to ensure that pressure on the groove from a locking element will not cause a protrusion of the pillar's material at the top edge of the groove to a position where it would lie outside the plane of the curved surface represented by a theoretical downward continuation of the spherical head below the level of the top of the buffer zone.

Any protrusion beyond the radius defining the desired size of the head creates a head diameter at that location that precludes engagement over it of a sleeve whose internal diameter is matched to the intended diameter of an undistorted head.

- 20 The profile of the neck, as seen in a vertical section through the long axis of the pillar, is such that it cannot obstruct the locking elements moving freely in response to the position of the actuators.

- 25 The profile of the neck, as seen in a vertical section through the long axis of the pillar, is also configured to ensure that a sleeve passing over the head will not encounter a contour in the neck's profile that would impede continued smooth descent of the sleeve over the pillar. It is self-evident that a variety of profiles can satisfy this requirement.

The profile of the neck, as seen in a vertical section through the long axis of the pillar, is also configured to ensure that a sleeve passing over the head cannot contact the hemispherical-section at an angle that would impede continued smooth descent of the sleeve over the hemispherical-section to engage the body below. It is self-evident that a variety of profiles can
5 satisfy this requirement.

The tendency for a misaligned sleeve to rotate off the pillar during attempted engagement is minimised by having the sleeve's axis of rotation within the yoke (second axis) as close as practical, in terms of strength, to the bottom of the sleeve. This arrangement maximises the probability of downward forces, applied at the axis of rotation of the sleeve in the yoke, creating
10 a moment that acts to further align the sleeve with the pillar rather than acting to increase any existing angle between the long axis of the sleeve and the long axis of the pillar.

Initial misalignment between the long axis of the sleeve and the pillar can be linear as well as angular. Extreme linear misalignment will result in the sleeve completely missing the pillar. When a linear misaligned sleeve contacts any part of the top of the head downward force
15 applied at the yoke's pivot line will create a moment that tilts the sleeve on the head.

The moment present at the point where the inside of the sleeve first contacts the top of the head tilts the sleeve away from aligning its long axis with the central axis of the pillar. The tilting of the sleeve on the pillar increases until the side of the sleeve opposite the point of initial contact reaches the pillar lower down. At that stage the sleeve may either rotate off the pillar or
20 pivot back toward improved alignment depending on the location of downward force acting at the centre line of the yoke's pivot bolts relative to the point at which the inside of the sleeve is now striking the pillar at this second point of contact.

If the location of the axis of the yoke's pivot bolts relative to the second point of contact is located between that second point of contact and the central axis of the pillar then the sleeve
25 will rotate back toward parallel alignment of the sleeve to the pillar and smooth engagement of the sleeve over the body of the pillar will ensue.

If on the other hand the location of the axis of the yoke's pivot bolts relative to the second point of contact is located outside the circumference of the pillar then the sleeve will not rotate back toward parallel alignment but will tumble off the pillar as the yoke descent continues.

- Geometry dictates that it is easier to achieve the desired rotation back to parallel alignment between sleeve and pillar when the pivot bolts are positioned as low as possible on the sleeve and the second axis passes through the central longitudinal axis of the sleeve.

- Creating a flat area on the top of the head provides users with a visual guide to how satisfactorily they have managed to achieve an initial linear alignment between the sleeve and the pillar. If the user suffers a tumbling off event from poor initial alignment the flat area helps them recognize that initial alignment needs to be accurate to the point where the inside of the sleeve first contacts the pillar beyond the flat area on top.

- Smooth engagement can be guaranteed if the pillar design is correct, the pivot bolt location on the sleeve is low enough and the customer is able to align the sleeve to the pillar to the extent of having the inside of the sleeve first contact the head beyond the flat area when the yoke is lowered.

- A jockey wheel on a second-vehicle's draw bar will provide the ability to progressively lower the cylindrical sleeve onto the pillar in a controlled manner. Any tendency toward rotating off as a consequence of exceptionally poor initial positioning can be overcome by subtly moving the second-vehicle (trailer) and or the first-vehicle (towing vehicle) to reposition the sleeve more directly over the pillar.

- A properly constructed and loaded trailer has the majority of the mass forward of the trailer wheels. This is known as "Trailer ball weight" and is defined as the downward thrust produced at the coupling end of the draw bar by gravity acting on this unequally distributed mass.

- The disclosed coupling has trailer ball weight transmitted to the sleeve at the axis of rotation of the sleeve within the yoke (second axis). Trailer ball weight therefore acts to engage

the sleeve on the pillar provided that at presentation the central long axis of the pillar falls reasonably well inside the inside-diameter of the sleeve and the trailer is free to move a small amount in response to the changing position of the sleeve as engagement with the pillar proceeds.

5 The more accurately the sleeve is initially positioned over the pillar the less the trailer needs to move as engagement progresses. The force required to move the trailer, as engagement between the sleeve and the pillar proceeds, may be provided solely by the component of the trailer ball weight down thrust that is acting in the desired direction as a consequence of the inside of the sleeve pressing upon the neck and hemispherical-section of the pillar.

10 Subtle manual adjustment of the trailer's position or movement of the towing vehicle will be necessary if the trailer ball weight is too small in comparison to any resistance to trailer movement. The same situation prevails when a conventional ball-coupling is mated with a conventional tow-ball. In both instances the inherent tendency of the coupling to self-centre is advantageous when compared with the extremely precise degree of initial alignment required to
15 insert a hitching-pin in a pin-based coupling mechanism.

 The coupling device described herein can be connected by using a jockey wheel to keep the height of the sleeve above the height of the pillar while the towing vehicle is maneuvered to position the pillar below the sleeve. With this technique there are no issues with subtle changes in tow-bar height precipitated by first-vehicle manoeuvring causing the pillar to push the sleeve
20 out of alignment. Once the sleeve is located above the pillar it can be lowered to full engagement.

 The coupling device described herein can also be connected by facing the open end of the sleeve toward the pillar. The height of the draw bar is then set so that the head of the pillar on the towing vehicle can be backed into the open "mouth" of the coupling. Backing the head into the
25 sleeve makes the sleeve roll over the pillar by rotating around the second axis. The sleeve is

lowered to full engagement on the pillar once the rolling action has reached the point of the sleeve's long axis being reasonably aligned with the pillar's long axis.

The coupling device described herein can ensure smooth release of the sleeve from the pillar regardless of any residual load in any direction between the towing and the towed vehicles.

- 5 Achieving smooth release under load requires having the correct length of pillar body relative to the distance the centre of the yoke pivot (axis 2) has to move up from full engagement before it lies above the level of the equator of the head of the pillar. With the correct relationship, the sleeve as it is raised on the pillar will reach a point at which it rolls off the pillar in response to any residual load between the towing and the towed vehicles. The rolling action is the reverse of
- 10 that just described in respect of coupling by backing the pillar into the mouth of the coupling.

- If the correct relationship is not met, then the sleeve will tilt in response to residual forces between the towing and the towed vehicle in a manner that makes the sleeve hook under the head of the pillar and uncoupling will not proceed until the residual forces are relieved by repositioning either the towed or the towing vehicle. The undesirable process of the sleeve
- 15 hooking onto the head of the pillar will occur if the vertical dimension from the bottom of the sleeve to the second axis of rotation is less than the vertical dimension between the top of the cylinder body of the pillar to the equatorial plane (equator) of the head of the pillar.

- In a preferred embodiment the coupling device does not require trailer ball weight to be transmitted to the head of the pillar. Trailer ball weight is preferably supported by the bottom of the sleeve. When fully engaged on the pillar the bottom of the sleeve weight bears directly onto
- 20 the tow bar or preferably onto a bearing-washer interposed between the bottom of the pillar and the tow-bar.

- In an alternative embodiment trailer ball weight is transmitted to the head of the pillar by closing over the upper end of the sleeve and matching the contour of the inside of the closure to
- 25 the contour of the top of the head.

The coupling device does not transmit any longitudinal or sideways towing forces to the head of the pillar. The head, neck and part-hemispherical section of the pillar exist to facilitate smooth engagement of the sleeve with the body of the pillar. All longitudinal and sideways towing forces are transmitted through the body of the pillar. This is achieved by making the

5 internal diameter of the upper part of the sleeve, which at full engagement on the pillar will lie opposite the equator of the head of the pillar, greater than the diameter of the head of the pillar.

The disclosed coupling device has, in an embodiment, an automated means of anchoring the sleeve to the pillar. The adopted locking mechanism involves a locking element, preferably a ball-bearing, creating interference to longitudinal displacement of the sleeve on the pillar by

10 simultaneously engaging with the groove in the pillar and a hole that extends into the wall of the sleeve.

Locking and unlocking the locking mechanism involves controlling whether the ball-bearing can be pushed back into the aperture in the wall of the sleeve so that it no longer rigidly engages the groove, buffer zone or head and thereby allows the sleeve to be displaced

15 longitudinally on the pillar.

The element controlling whether the ball-bearing is obliged to engage the groove is called an actuator and is preferably in the form of a rod. The rod has a recess therein that is deep enough to allow the ball-bearing to disengage the head when the recess overlies the aperture in the wall of the sleeve.

20 When the ball-bearing's diameter exceeds the length of the aperture in the wall of the sleeve the movement of the rod, to a position where the recess does not overlie the aperture, causes a cam surface of the recess to push the ball-bearing inwards to a position where it will engage the groove if an attempt is made to lift the sleeve upwards from a resting position of full engagement on the pillar.

25 The diameter of the inner end of the aperture in the wall of the sleeve is restricted in a manner that stops the ball-bearing escaping the aperture when the sleeve is not engaged with the

pillar. The restriction in the diameter of the aperture in the wall of the sleeve at its inner end is not so tight that the ball-bearing cannot move sufficiently to securely engage the groove in the pillar.

A biasing means, preferably a spring, automatically locks the sleeve to the pillar
5 (primary-locking) by moving the rod to the position where the recess does not overlie the aperture in the wall of the sleeve.

A spring operated secondary-lock can also be incorporated so that manual movement of the rod, to a position where the recess overlies the hole in the wall of the sleeve, is only possible after manual release of this secondary-lock.

10 The primary and secondary locking mechanisms are configured to ensure they are readily accessible and operable with any position of the sleeve within the yoke.

An antitheft mechanism, such as a padlock, may also be incorporated to deny separation of the sleeve from the pillar by directly restricting movement of the rod or indirectly by restricting release of the secondary lock. The antitheft mechanism is simultaneously operative to
15 avoid removal of the rod from the sleeve.

Preferably the antitheft mechanism can be in place during towing over uneven terrain.

Removal of the rod from the sleeve, when the antitheft mechanism is not engaged is required for servicing of the moving internal components of the coupling (such as the spring acting as a primary lock and the ball-bearings).

20 Friction is introduced into the pivoting of the sleeve within the yoke (about the second axis of rotation) in order to stop an uncoupled sleeve from toggling over, under the influence of gravity, to an orientation that would make coupling difficult. A wave washer interposed between the sleeve and the yoke or between the yoke and the head of a pivot bolt securing means is the preferred option.

25 A protrusion on the yoke and/or the sleeve blocks the sleeve from rotating within the yoke to a degree that would allow the sleeve to present to the pillar while the yoke was upside

down. The protrusion does not limit the desired range of vertical articulation of the yoke on the sleeve when the sleeve is connected to the pillar. Thus, the yoke has a protrusion extending therefrom which does not impede articulation about the second axis of the engaged coupling from 90 degrees up to 90 degrees down but does prevent continued rotation of the sleeve about the second axis beyond this range when the sleeve is disengaged from the pillar. This prevents the coupling device from being placed or assembled in an upside down orientation.

In the alternative embodiment the actuator functions directly as the locking element rather than through regulating the movement of a separate locking element. This embodiment with the actuator directly being the locking element requires the cavity containing the actuator to run at a tangent to the sleeve and to breach the internal face of the wall of the sleeve.

With this alternative embodiment the actuator replacing the locking element is a rod occupying the cavity and displaceable along it or rotatable within it. When any part of the rod lies within that part of the cavity that breaches the inside wall of the sleeve, it will block the movement past the actuator of any part of the pillar whose diameter matches the internal diameter of the sleeve. The mechanism is best understood by reference to Figures 6a, 6b, 7a and 7b.

Referring now to the specific embodiment depicted in the Figures.

Figure 1

The line A-B runs vertically from A above to B below, lines C-D and E-F pass through the line A-B at a right angle.

The tow-bar 1 has a pillar-hole 2. The part of the tow-bar 1 that is rigidly linked to the rear of a first towing vehicle (not depicted) is drawn of indefinite length to distinguish it from the free end which is furthest from the rear of the vehicle and has a rounded outline.

In the following description the term 'front' applies to being nearer to the towing vehicle and the term 'rear' applies to being further away from the vehicle to which the tow-bar 1 is attached.

The first vehicle component of the coupling device is a pillar 3. The features of the pillar 3 are recorded below under the full description of Figure 2.

The trailer component of the coupling that links to the pillar 3 is a cylindrical sleeve 13 adapted to matably receive and rotate around the pillar 3. The rotation of the sleeve 13 around the pillar 3 forms a first axis for movement of the towed vehicle relative to the towing vehicle. The lower end of the sleeve 13 has a skirt 17 that surrounds the bearing-washer 14 when the sleeve 13 has fully engaged the pillar 3 and is resting on the top face of the bearing-washer 14.

The relationship between a head 10, a part-hemispherical-section 8 and a body 7 of the pillar 3 ensures that, once the bottom of the sleeve 13 has reached the level of the top of the body 7, the axis of the sleeve 13 is fully aligned with the axis of the body 7 to form a first axis and continued engagement of the sleeve 13 over the pillar 3 is not impeded. The relationship between the part-hemispherical-section 8, the head 10 and the body 7 also ensures that the sleeve 13 does not hold up on the neck 9 if the axis of the sleeve 13 is not fully aligned with the axis of the pillar 3 at the initiation of their engagement.

The sleeve 13 has two cavities 21 which each receive an actuator rod 15 which can move along the cavity 21 within defined limits. The rod 15 is retained within the cavity 21 by a collar 22 that is screwed into the threaded upper end of the cavity 21. The inner aspect of the collar 22 is fitted with an O-ring 23 that seals against the ingress of contaminants alongside the rod 15 as it passes through the collar 22. A biasing means, in the form of a spring 16, is located in the cavity 21 and surrounds the rod 15. The spring 16 acts to push the rod 15 down by contacting above the underside of the collar 22 and against a circlip 47 located in a circlip-groove 48 in the rod 15.

The rod 15 has a recess 18 and part of the wall of the recess 18 presents a cam surface 19. The rod in the front cavity 21 is connected to the rod in the back cavity 21 by a handle 24.

An aperture 27 is formed between the cavity 21 and the inside of the sleeve 13. The aperture 27 has a uniform diameter except at its inner end where there is a localised narrowing 28 (see Figures 3 and 4 for a magnified view of aperture 27). A locking element, such as a ball-bearing 29 is free to move back and forth along the aperture 27 between limits imposed by the narrowing 28 at the inner end and at the outer end by what part of the rod 15 lies opposite the aperture 27.

Raising the rod 15, to the position where the recess 18 lies opposite the aperture 27, allows part of the ball-bearing 29 to prolapse into the recess 18 to an extent which ensures that no part of the ball-bearing 29 protrudes inside the line of the internal face of the wall of sleeve 13. This allows the sleeve 13 to slide freely over the pillar 3.

Lowering the rod 15 back, from the position where the recess 18 lies opposite the aperture 27, causes the cam surface 19 to push the ball-bearing 29 along the aperture 27. Continued lowering of the rod 15, until all of the recess 18 is below the level of the middle of the ball-bearing 29 ensures that the ball-bearing 29 protrudes inside the line of the internal face of the wall of sleeve 13.

The groove 11 lies opposite the aperture 27 when the sleeve 13 is engaged with the pillar 3 to the point of resting on the bearing-washer 14. When so engaged, the position of the rod 15 determines whether part of the ball-bearing 29 protrudes from the inner end of the aperture 27 into the groove 11 thereby locking the sleeve 13 to the pillar 3 while remaining free to track around the groove 11 in accordance with any rotation of the sleeve 13 around the pillar 3.

When the sleeve 13 is resting on the bearing-washer 14 the inside of the skirt 17 surrounds the sides of the bearing-washer 14 and seals against a further O-ring 25 positioned in an O-ring groove 26.

The profile of the groove 11 located on the underside of the head 10, as viewed in a vertical section taken through the middle of the pillar 3, is matched to receive that part of the ball-bearing 29 which protrudes from the inner end of the aperture 27 when the rod 15 is in the

full down position and an attempt is made to lift the sleeve 13 off the pillar 3 so that the ball-bearings 29 contact groove 11 to prevent any further disengagement of the sleeve 13 from pillar 3.

The dimensions are arranged so that the sleeve 13 firstly separates from the upper face of the bearing-washer 14 before the ball-bearings 29 restrains further disengagement of the sleeve 13 from the pillar 3. This ensures that the rod 15 can readily be returned to the locked position even if a small amount of debris is stopping the sleeve 13 from fully seating on the bearing-washer 14.

To allow engagement of the sleeve 13 with the pillar 3 the rod 15 is raised to the first unlocked position such that a respective recess 18 is aligned with the aperture 27 and thereafter the sleeve 13 is lowered onto the pillar 3 such that the head 10 displaces each ball bearing 29 to a position in a respective aperture 27 and partially into the aligned recess 18 so that no portion of each ball bearing 29 protrudes inwardly beyond the internal face of the wall of the sleeve 13.

The spring 16 is pre-compressed so that it acts to maintain the rod 15 in the down position where no part of the recess 18 aligns with the aperture 27. Lifting the rod 15 to the position where the recess 18 aligns with the aperture 27 increases the stored compression forces in the spring 16. Each locking element 29 is free to move to the first unlocked position when the rod 15 is fully raised against the resistance of spring 16.

A connector which is connected to the second towed vehicle (trailer) includes a yoke 30 having two arms 31 joined by a web in a substantially U-shaped configuration. Each arm 31 has a notch 32 and a hole 33 for receiving a securing means, in the form of a bolt 34. The shank 35 of the bolt 34 is a precise fit in the hole 33.

Extending out from the back of the yoke 30 is a rigidly attached cylindrical shaft 39 that is free to rotate inside a tube 40 that in turn is rigidly attached to a base-plate 41.

The base-plate 41 is attached to the trailer's draw-bar by any means obvious to those skilled in the art. The shaft 39 is restrained from pulling out of the tube 40 by a nut 42 screwed onto a rear

end of the shaft 39. Rotating shaft 39 inside a tube 40 forms a third axis for movement of the trailer relative to the towing vehicle. The third axis preferably passes through the first axis.

The bolts 34 pass through the holes 33 and screw into bores, in the form of threaded-holes 36, in the sides of the sleeve 13. The threaded-holes 36 share a common second axis that
5 preferably passes through the first axis passing down the middle of the sleeve. The bolts 34 have a land 38 which is tensioned against the side of the sleeve 13 so that the shank 35 acts as a stub axle for the yoke 30 to pivot on.

Sideways movement of an arm 31 away from the sleeve 13 is limited by a bolt-head 37. A wave washer 44 is located on the bolt 34 between the outer face of the arm 31 and the bolt-
10 head 37. The wave washer 44 generates friction to avoid a top heavy sleeve 13 from adopting under the influence of gravity an undesired orientation when the sleeve 13 is not coupled to the pillar 3.

Marked rotation of the sleeve 13 on the pillar 3 (trailer nearing a jackknife position) brings one of the bolts 34 to a location above the tow-bar 1. In these circumstances downward
15 hinging of the yoke 30 is limited by an arm 31 impinging on the tow-bar 1. The notches 32 increase the available range of downward hinging of the yoke 30 whenever the sleeve 13 is markedly rotated to either side.

"Trailer ball weight" is defined as the downward thrust present at a trailer coupling due to a greater part of a trailer's mass being forward of the trailer's wheels. The intersection of the axis
20 of the bolts 34 (second axis) with the central axis of the sleeve 13 ensures that trailer ball weight does not generate a bending moment on the pillar 3 when the sleeve 13 is fully engaged on the pillar 3.

Grease nipples 43 are located in the arms 31 and the tube 40 to supply lubricant to underling bearing surfaces.

Two protrusions (not illustrated) on the inside of an arm 31 are positioned to strike against a protrusion (not illustrated) on the outside of the sleeve 13 to control the range of rotation of the sleeve 13 around the second axis.

Figure 2

5 This is a vertical sectional view of the pillar in Figure 1 passing through the line A-B.

The pillar 3 is securely linked to the tow-bar 1 by passing the threaded shank 4 down through the bearing-washer 14 and pillar-hole 2 then locating the spring-washer 5 on the shank 4 and locating and tightening the securing-nut 6 on the shank 4. A sealing ring, in the form of an O-ring 25 is located in an O-ring-groove 26 (see Figures 3 and 4) on the outer face of the bearing-washer 14 and this seals against the inner aspect of the sleeve's skirt 17 when the sleeve 13 is fully engaged on the pillar 3.

The pillar 3 and bearing-washer 14 as further described hereunder, can be manufactured as an integral part of the tow-bar 1 in which case the shank 4, spring-washer 5 and securing-nut 6 are redundant.

15 The pillar 3 has a cylindrical body 7 that rests upon the bearing-washer 14 and is surmounted by a part-hemispherical-section 8 joined by a neck 9 to the bottom of a truncated spherical head 10. A circumferential groove 11 is set into the head 10 below the level of the equator 12. The shank 4, the body 7, the part-hemispherical-section 8, the neck 9, the head 10 and the groove 11 are all symmetrical about the long axis of the pillar as represented by line A-
20 B. The same radius length defines the curvature of the body 7, the part-hemispherical-section 8 and the head 10.

The neck 9 extends from the head 10 down to the part-hemispherical-section 8. The groove 11 is set into the head 10 below the level of the equator 12. The profile of the groove 11 is matched to the profile of a segment of the upper and inner quadrant of the ball-bearing 29.

25 The groove 11 is not designed to engage an entire quadrant of ball-bearing 29, but only a segment, approximately from about 285 degrees to 330 degrees (looking front-on into the plane

of Figure 3) engages the groove 11. The projected spherical contour of the head 10 at its junction with the upper limit of the groove 11 is stepped in to create a buffer-zone 20 that does not engage with the ball-bearing 29.

Any distortion of the groove 11 where it meets the buffer-zone 20, as a consequence of pressure from the ball-bearing 29, therefore lies inside the projected continuation of the spherical contour of the head 10 in the region of the buffer-zone 20. With any distortion occurring inside the projected contour of the spherical head 10 there is no impediment to passing the head 10 into a sleeve 13 that has an internal diameter matched to the diameter of the head 10.

The neck 9 is confluent with the head 10 below the level of the groove 11. The section of the neck 9 that lies opposite the level of the aperture 27, when the sleeve 13 is resting on the bearing-washer 14, has a diameter that ensures it cannot impede the ball-bearings 29 moving freely in response to the position of the rod 15.

The profile of the neck 9, below the level of the aperture 27, when the sleeve 13 is resting on the bearing-washer 14, is configured to ensure that a sleeve 13 passing over the head 10 will not encounter a contour that would impede continued smooth descent of the sleeve 13 over the pillar 3. It is self-evident that a variety of profiles can satisfy this requirement.

The profile of the neck 9 is also configured to ensure that a sleeve 13 passing over the head 10 cannot contact the part-hemispherical-section 8 at an angle that would impede continued smooth descent of the sleeve 13 over the part-hemispherical-section 8. It is self-evident that a variety of profiles can satisfy this requirement.

Figure 3

This is a vertical-sectional view through the lines A-B and E-F of Figure 1. The line E-F corresponds with the centre line of apertures 27. It depicts the situation when the sleeve 13 is fully engaged on the pillar 3 to sit upon the bearing-washer 14 and the rod 15 is in the up position such that the sleeve 13 is free to disengage the pillar 3.

For simplicity of illustration two apertures 27 and ball-bearings 29 are illustrated. Alternative embodiments may involve a plurality of apertures 27 containing respective ball-bearings 29 that engage a groove 11 or a plurality of grooves 11. Multiple apertures 27 are preferably distributed uniformly around the circumference of the sleeve 13. A plurality of
5 apertures 27 requires a respective plurality of cavities 21 containing rods 15 with a recess 18 and a cam surface 19.

The diameter of the ball-bearing 29 has a working tolerance to the diameter of the aperture 27. The aperture 27 passes between the cavity 21 and the internal surface of the sleeve 13. The length of the aperture 27 is less than the diameter of the ball-bearing 29 and
10 consequently the ball-bearing 29 is obliged to always protrude from at least one end of the aperture 27. The inner end of the aperture 27 has a localised-narrowing 28 that stops the ball-bearing 29 escaping to the void inside the sleeve 13 when it is not engaged on the tow-pillar 3.

The depth of the recess 18 is less than half the diameter of the ball-bearing 29 so the equator of the ball-bearing 29 does not escape beyond the outer end of the aperture 27. The depth
15 of the recess 18 and the length of the aperture 27 are dimensioned to ensure that the ball-bearing 29 can prolapse into the recess 18 to an extent whereby the ball-bearing 29 does not protrude beyond the internal face of the sleeve 13 when the recess 18 is aligned over the aperture 27 as depicted. In the situation depicted the ball bearing 29 is free to move out of the way if an attempt is made to lift the sleeve 13 off the pillar 3.

20 The spring 16 has been further compressed by the lifting of the rod 3 against its preloaded resistance. The spring 16 acts to return the rod 15 from the position illustrated in Figure 3 to the position illustrated in Figure 4.

Automatic primary locking, of the sleeve 13 to the tow-pillar 3, occurs whenever the spring 16 returns the rod 15 from the position depicted in Figure 3 to the position illustrated in
25 Figure 4. Moving the rod 3 to the up position depicted in Figure 3 may be performed manually or it could be achieved through an electric motor or electromagnet.

The obligation for a ball-bearing 29 to always protrude, from one or other end of aperture 27, can also be satisfied by embodiments having a series of two or more matching ball-bearings aligned adjacent each other within aperture 27 of appropriate length and diameter.

A further embodiment employing a rod with hemispherical ends fulfills the function of
5 one or more ball-bearings 29 provided the diameter and length of the rod is appropriately matched, according to criteria explained above, to the diameter and length of the aperture 27.

A number of mechanisms, that would be obvious to those skilled in the art, can produce a latch that ensures the sleeve 13 is locked to the pillar 3 by blocking the rod 15 being displaced to the point that the ball-bearing 29 no longer is obliged to intrude into the interior of the sleeve's
10 central cavity. The latch can be constituted by a trigger (not illustrated) that is biased to the actuator-hold position by incorporating a further-biasing means (not illustrated and independent of spring 16) that moves the latch's trigger into the position which blocks displacement of the rod 15 to the position where any part of the recess 18 aligns with the aperture 27.

A number of mechanisms, that would be obvious to those skilled in the art, can produce a
15 locking-means that ensures the trigger cannot move away from the actuator-hold position where it blocks the actuator moving to the first unlocked position or alternatively the locking means directly blocks the actuator moving to the first unlocked position

It is not possible to directly observe the ball-bearing 29 locking into the position where it precludes the fully engaged sleeve 13 from disengaging the pillar 3. It is therefore desirable to
20 incorporate indicia means or an external marker to indicate when sleeve 13 is securely locked to the pillar 3. The external marker can take any form that would be obvious to those skilled in the art.

The internal diameter of the sleeve 13 is uniform up to a level that lies above the top of the aperture 27 but below the level corresponding to the equator 12 when the sleeve is resting on
25 the top of the bearing-washer 14. Above this level the internal diameter of the sleeve is increased

so that no towing forces can be transmitted between the sleeve 13 and the head 10 when the sleeve 13 is secured to the pillar 3 by the ball-bearing 29.

Figure 4

This is a vertical-sectional view through the lines A-B and E-F of Figure 1. The line E-F
5 corresponds with the centre line of apertures 27. It depicts the situation when the sleeve 13 is fully engaged on the pillar 3 to sit upon the bearing-washer 14 and the rod 15 is in the down position such that the sleeve 13 is not free to disengage the pillar 3. The parts are numbered the same as in Figure 3.

The pre-compressed spring 16 is holding the rod 15 in the position that mandates the ball-
10 bearing 29 will obstruct any attempt to disengage the sleeve 13 from the pillar 3.

A disengaged sleeve 13 (not illustrated) is unable to slide all the way down over the pillar 3 if the rod 15 is positioned as illustrated in Figures 4. This is because the complete engagement of the sleeve 13 with the pillar 3 is blocked by the ball-bearing 29 coming into contact with the top of the head 10 and is unable to move out of the way along the aperture 27 when the rod 15
15 is in the down position.

Incomplete engagement of the sleeve 13 on the pillar 3 when the rod 15 is in the down position is readily recognized by observing that the skirt 17 has not engulfed the bearing-washer 14.

Successful complete engagement and locking of a disengaged sleeve 13 to the pillar
20 3 requires lifting up the handle 24 to raise the rods 15 against the resistance of the pre-compressed springs 16 from the position depicted in Figure 4 to the position depicted in Figure 3.

Presenting a disengaged sleeve 13 to the pillar 3 with the handle 24 pulled up as depicted in Figure 3 allows the ball-bearings 29 to move progressively into the recess 18 in response to
25 contacting the head 10.

When the sleeve 13 sits on the bearing-washer 14 the aperture 27 becomes aligned with the void around the neck 9 and the cam face 19 can drive the ball-bearing 29 into the locked position illustrated in Figure 4.

Releasing the hold on the handle 24 after the sleeve 13 has come to rest on the bearing-washer 14 allows the compressed springs 16 to return the rods 15 to the down position depicted in Figure 4.

When the sleeve 13 is in contact with the bearing-washer 14 the aperture 27 lies at a level where the inwardly displaced ball-bearing 29 is slightly below the level where it would make full contact with the groove 11. The clearance between the ball-bearing 29 and the groove 11, when the sleeve 13 rests on the bearing-washer 14 ensures that the ball-bearing 29 is not under load while the trailer ball weight keeps the sleeve 13 in contact with the bearing-washer 14. This clearance also ensures that there is no obstruction to the compressed spring 16 fully displacing the rod 15 to the locked position depicted in Figure 4.

If downward displacement of the rod 15 is incomplete and the recess 18 is partially aligned with the aperture 27 outward pressure on the ball-bearing 29 can induce, by pressing on the cam surface 19, upward displacement of the rod 15 to the unlocked position depicted in Figure 3.

Figure 5

The bolts 34 pass through the bolt-holes 33 and screw into threaded-holes 36 in the opposite sides of the sleeve 13. The threaded-holes 36 share a common second axis. The bolts 34 have a land 38 which is tensioned against the side of the sleeve 13 so that the bolt-shank 35 acts as a stub axle for the yoke's 30 arms 31 to pivot on. Grease nipples 43 are located in the arms 31 to supply grease to the articulation between the bolt-shank 35 and the arm 31. A wave washer 44 is located between the bolt-head 37 and the outside face of the arm 31.

Figures 6a and 6b

Figures 6a and 6b respectively show transverse and vertical sections of the coupling device in a further embodiment. Figure 6a is a transverse section view along line E-F in Figure 6b, while Figure 6b is a vertical section view along line A-B with rod 46 and cavity 45 superimposed.

- 5 There is a pillar 3 as described above and comprising from above down: a head 10, a groove 11, a neck 9, hemispherical section 8, a cylindrical body 7 and a shank 4. The shank 4 is used to anchor the pillar to a tow-bar 1. A sleeve 13 is adapted to fit over the pillar 3 and rest upon the tow-bar 1. A cavity 45 passes into the wall of the sleeve 13 (equivalent of cavity 21) along a line parallel to a tangent to its wall and thereby breaches the interior of the sleeve 13.
- 10 The cavity 45 contains an actuator rod 46 (equivalent of rod 15) which can be moved back and forth along the cavity 45 between a retracted and an inserted position.

The hitch is depicted with the rod 46 in the retracted position where the sleeve 13 is free to engage or disengage the pillar 3. For simplicity the drawing omits details of how the sleeve 13 is held within the yoke 30 (but will be similar to that described in Figure 1); that the sleeve 13 as

15 drawn here may incorporate a skirt 17 as detailed above and that a bearing-washer 14 can be interposed between the bottom of the pillar 3 and the tow-bar 1 as detailed above. Also for simplicity the drawing omits details of a biasing means (along the same lines as the biasing means for control of the rod 15 in the above preferred embodiment) that can be introduced to control the resting position of the shaft 46.

20 **Figures 7a and 7b**

Figures 7a and 7b respectively show transverse and vertical sections of the coupling device of Figures 6a and 6b. Figure 7a is a transverse section view along line X-Y (equivalent to C-D in Figure 1 but generally at a different height/level), while Figure 7b is a vertical section view along line A-B.

The hitch is depicted with the rod 46 in the inserted position where the sleeve 13 is not free to engage or disengage the pillar 3. The numbering of parts is the same as for Figures 6a and 6b. The cavity 45 may be positioned parallel to line E-F in Figure 1, and may extend entirely through the sleeve 13 or have a blind end.

5 There may be a plurality of cavities 45 with a rod 46 positioned respectively in each said cavity. Each of the cavities 45 may extend in suitable directions and/or differing heights with respect to the sleeve 13, and be clear of the yoke 30 (see Figure 1). The rod(s) 46 may be linked to a handle (not illustrated) to move it/them to a desired position in the cavity 45. A biasing means (not illustrated) may be incorporated to act to retain the rod 46 in the inserted position
10 illustrated in Figures 7a and 7b.

A further but not illustrated variant of the embodiment depicted in Figures 6a, 6b, 7a and 7b would involve the rod 46 rotating within the cavity 45 to a position where a longer-recess (akin to but more extensive recess than the recess 18 in the rod 15) in the side of the rod 46 would allow the pillar 3 to pass in or out of the sleeve 13 when the rod 46 was rotated to an
15 orientation where the remainder of the rod opposite the longer-recess lay outside the internal face of the sleeve 13. Therefore, the rod 46 can remain within cavity 45 and is simply rotated at an exposed end to effect an engaged locked position and a disengaged unlocked position between sleeve 13 and pillar 3. The longer recess would follow the curvature of the inside wall of the sleeve 13 and would therefore having a length on the rod 46 that is equivalent to the gap in the
20 inner wall of the sleeve 13 created by cavity 46 (from portion 50 of the inner wall to portion 51 of the inner wall of sleeve 13). To free or disengage the sleeve 13 from pillar 3, a user would rotate the rod 46 and be guided by indicia means on the rod to indicate that the longer recess is exactly facing opposite groove 11 and neck 9. To engage or lock the sleeve 13 to the pillar 3 the reverse occurs, where the user turns the rod 46 in the opposite direction, again guided by indicia

means, until the indicia means indicates that the side diametrically opposite the longer recess on rod 46 is facing the groove 11.

In summary the coupling device of the present invention provides a range of articulation between a towing vehicle and a trailer that meets any conceivable requirement. The design provides for 360 degrees of rotation around the long axis of the vehicle so that trailer rollover does not inevitably result in vehicle rollover. Side to side movement, about the long axis of the pillar, is possible through to the full jack-knife position. Upward angulation to 90 degrees is possible with all degrees of side to side movement. Downward angulation to 90 degrees is possible when the trailer is directly behind the vehicle. There is some restriction of downward angulations when the trailer is off to the side and approaching a jackknife position. Even then downward angulation to 70 degrees is possible.

The coupling device disclosed herein provides automatic primary and automatic secondary locking of the trailer to the vehicle.

Locking the engaged coupling device, against trailer theft, with a padlock or similar device is easy with the coupling device disclosed herein. The padlock can also remain in place while the vehicle and trailer are in motion over any terrain.

The pillar mechanism as disclosed provides a much greater range of articulation than that provided by a conventional tow-ball based coupling device.

The sleeve disclosed in this coupling device will not bind onto the pillar whereas mechanisms that have relied upon adding additional points of articulation to a modified cup, which couples with a conventional tow-ball, are prone to this undesirable event that can culminate in undoing the tow-ball from the tow-bar or snapping the tow-ball off the tow-bar.

During coupling the disclosed mechanism has self-centering properties that are not present in couplings which rely upon the insertion of a hitching pin to achieve linkage. This self-centering property makes coupling far easier especially when there is an impediment to manhandling the trailer to the precise location required to achieve linkage.

The impediment may be either the weight of the trailer and/or the nature of the terrain over which the trailer's wheels have to move to achieve the desired alignment for coupling to proceed.

The presence of any load on a hitching-pin will tend to lock the hitching-pin in its engaged position. Removing a hitching-pin in these circumstances can be exceedingly difficult
5 and may require hammering it out which may in turn cause damage. By comparison, with the disclosed pillar mechanism any impediment to disengagement, caused by loading tending to lock the sleeve onto the pillar, can be overcome by using the progressive lifting power of the trailer's jockey wheel or the lifting power of a draw bar stand.

The maximum height of an engaged coupling, above a tow-bar, influences the ability to
10 open a door on the rear of the towing vehicle. Four-wheel-drives frequently have such doors. The overall height of the coupling disclosed in this embodiment can be kept well below the height of the handle that controls the release of the tongue which secures a conventional ball-coupling to a conventional tow-ball.

Traction or compression forces, in the line of the long axis of the trailer, cause the cup of
15 a ball-coupling to ride-up on the tow-ball. The tongue of the ball-coupling stops disengagement but in so doing the tongue may become wedged under the head of the tow-ball to an extent that makes its withdrawal, to the released position, difficult or impossible until the traction or compression forces are relieved. By comparison, with the coupling device disclosed in this embodiment such traction or compression forces are transmitted to a pillar which does not
20 deflect the force in an upward direction. Consequently there is no tendency for the sleeve to ride-up on the pillar and thereby wedge the ball-bearing against the contact zone in a manner that would make it difficult to move the recess to the position that allows separation of the sleeve from the pillar.

With the pillar mechanism as disclosed the manual force required to overcome the
25 springs operating the automatic primary locking mechanism is less than that required to pull back

the locking tongue on a typical ball-coupling. Physically weaker individuals are thus able to operate the ball-bearing based locking mechanism.

The disengaging of the locking tongue on a Hyland Hitch is even more difficult than a conventional ball coupling because the handle for the tongue does not lie along the line of withdrawal. This unsatisfactory arrangement is mandated by other aspects of the Hyland's overall design.

The height above the tow-bar at which traction forces are transmitted, between the vehicle and the trailer, is lower with this pillar coupling than with a tow-ball coupling. As a consequence the shank anchoring the pillar to the tow-bar is subject to less stress than is the shank anchoring a conventional tow-ball that is subjected to the same traction load and where the pillar and seating-flange of the tow-ball have the same diameter.

The pillar of the disclosed coupling device has a diameter greater than the diameter of a conventional tow-ball and it is therefore impossible to inappropriately connect a conventional ball coupling to the pillar's head.

The greater diameter of the pillar in the disclosed coupling device in comparison with the flange on a conventional tow-ball means that there is less stress on the shank of the pillar as compared with the stress on the shank of a conventional tow-ball.

The broad area of contact and fine working tolerance between the sleeve and the pillar avoids noise emanating from the sleeve slogging on the pillar at the commencement of acceleration or breaking. Some conventional ball-couplings have an adjustment screw to remove the slack, between the tow-ball, the cup and the locking tongue, which generates such undesirable slogging and noise. The pillar mechanism as disclosed does not need such an adjustment screw or the inconvenience of trying to set it correctly.

The broad area of contact between pillar and sleeve minimises wear between these lubricated articulating surfaces.

The incorrect setting of the adjustment screw on a conventional ball-coupling can also impede the locking tongue properly engaging under the head of the tow-ball and/ or generate difficulty in disengaging the locking tongue. No such dangers or difficulties can arise with the pillar based coupling as disclosed herein.

- 5 The primary locking mechanism and articular surfaces between pillar and sleeve are sealed against contamination with dust or water by strategically located O-ring seals.

The cleanliness of the pillar, when the sleeve is not attached, is provided by a dust cover that takes advantage of the O-ring seal on the bearing washer.

- 10 When the sleeve engages the pillar to the level of the hemispherical-section it is sufficiently advanced for it to be safe to grip the handle to operate the release of the automatic locking mechanism.

- All articulations have readily accessible grease nipples that are placed to avoid grease on the user, damage to grease nipples or injury to a user knocking against an exposed grease nipple. Currently available off-road couplings either have no grease nipples or have grease nipples that
15 are located where they are subject to damage, to cause injury or to contaminate the user with grease if they brush against the coupling.

The disclosed coupling device is not based on a tow-ball and therefore the draw-bar and coupling can be mounted higher than within the limited range stipulated in the Australian design Rules for 50mm tow-balls.

CLAIMS:

1. A coupling device for coupling a first vehicle to a second towed vehicle, the coupling device including:
 - 5 a pillar for mounting to a towbar attached to the first vehicle;
 - a connector for connection to the second towed vehicle;
 - a sleeve linked to the connector that engages the pillar by fitting over the pillar, the sleeve having cavity means; and
 - an actuator means positionable in the cavity means and movable with respect to the sleeve between a first unlocked position in which the sleeve is removable from the pillar and a second locked position in which the sleeve is not removable from the pillar.
2. A coupling device according to claim 1 wherein the pillar comprises a body, a part hemispherical section, a neck, and a head which is more than half a sphere having a complete
 - 15 equatorial plane that lies orthogonal to a longitudinal axis of the pillar.
3. A coupling device according to claim 1 or claim 2 wherein the actuator means is displaceable longitudinally within the cavity means or rotatable within the cavity means.
4. A coupling device according to any one of claims 1 to 3 wherein the cavity means breaches an internal face of the sleeve.
5. A coupling device according to claim 4 wherein in the second locked position a portion
 - 20 of said actuator means protrudes inwardly beyond an internal face of the sleeve wall to engage said pillar and in the first unlocked position no portion of said actuator means protrudes inwardly beyond the internal face of the wall of the sleeve to thereby enable the sleeve to slide freely over the pillar.
6. A coupling device according to claim 1 wherein the actuator means has a recess and is rotatable within said cavity means, said cavity means having a portion coexistent with the inner space of the sleeve, such that to effect the first unlocked position the actuator means is rotated so

that the recess faces the pillar and to effect the second locked position the actuator means is rotated such that a portion of the actuator means opposite the recess engages said pillar.

7. A coupling device according to claim 2 wherein the cavity means does not breach an internal face of the sleeve and the sleeve has at least one aperture extending through the wall of the sleeve between said cavity means and an internal face of the sleeve and further wherein a locking element is positioned in each aperture of said at least one aperture.

8. A coupling device according to claim 7 wherein in the second locked position each locking element has a portion that protrudes inwardly beyond an internal face of the sleeve wall and engages said pillar and in the first unlocked position each locking element resides at least partially within a respective aperture such that no portion of each locking element protrudes inwardly beyond the internal face of the wall of the sleeve, to enable the sleeve to slide freely over the pillar.

9. A coupling device according to claim 8 wherein the actuator means has at least one recess and the actuator means is able to be displaced or rotated to a position where a recess of said at least one recess is aligned with an aperture of said at least one aperture in the sleeve to enable movement of each respective locking element to either the first unlocked position or the second locked position.

10. A coupling device according to claim 9 wherein in the first unlocked position a portion of each locking element resides within a respective recess of the actuator means and to move each locking element from the first unlocked position to the second locked position the recess has a cam surface whereupon displacement or rotation of the actuator means the cam surface contacts the locking element to push the locking element further into the aperture to assume the second locked position.

11. A coupling device according to claim 10 further including a circumferential groove set into the underside of the head of the pillar and the profile of the groove is matched to the profile

of the portion of the locking element which engages in the groove when the actuator means is moved to assume the second locked position and a force is applied to lift the sleeve up from its fully engaged position on the pillar.

12. A coupling device according to claim 11 wherein when the sleeve is fully engaged on the pillar in order to move each locking element from the second locked position to the first unlocked position, the actuator means is displaced or rotated such that a respective recess is aligned with the aperture, thereafter the sleeve is displaced with respect to the pillar so that each locking element bears against the groove and an underside of the head of the pillar and continued displacement of the sleeve forces each element to move in the aperture and partially into the aligned recess so that no portion of each locking element protrudes inwardly beyond the internal face of the wall of the sleeve.

13. A coupling device according to claim 9 wherein in the process of fully engaging the sleeve with the pillar, the actuator means is displaced or rotated to the first unlocked position such that a respective recess is aligned with the aperture, thereafter the sleeve is moved with respect to the pillar such that the head displaces each locking element to a position in a respective aperture and partially into the aligned recess so that no portion of each locking element protrudes inwardly beyond the internal face of the wall of the sleeve.

14. A coupling device according to any one of claims 6 and 8 to 13 further including a biasing means connected to the actuator means and to the sleeve, the biasing means being biased at all times to move the actuator means to the second locked position.

15. A coupling device according to claim 14 in which a user displaces or rotates the actuator means to the first unlocked position thereby increasing the resting tension or compression in the biasing means, thereafter the actuator means returns to the second locked position under the action of the increased tension or compression in the biasing means.

16. A coupling device according to claim 14 further including a trigger moveable between an actuator-release position and an actuator-hold position, such that in the hold position the trigger prevents displacement or rotation of the actuator means within the cavity means from the first locked position and in the release position allows the actuator means within the cavity means to
5 be displaced or rotated to the second unlocked position.

17. A coupling device according to claim 16 wherein the trigger is biased by a further-biasing means to remain in the actuator-hold position until manually moved to the actuator-release position which increases the tension or compression in the further-biasing means, thereafter the trigger returns to the actuator-hold position under the action of the increased
10 tension or compression in the biasing means.

18. A coupling device according to any one of the preceding claims wherein the actuator means is restrained from moving to the first unlocked position by a locking means.

19. A coupling device according to any one of the preceding claims in which the sleeve is rotatable with respect to the pillar about a first axis and wherein the connector includes a yoke
15 having a pair of arms and a shaft connected to the yoke, the shaft rotatable about a third axis within a tube that is connected to the second towed vehicle through a plate.

20. A coupling device according to claim 19 wherein each arm of the yoke is connected to the sleeve by respective securing means that protrude through respective bores oppositely located in the wall of the sleeve and adapted to allow rotation of the yoke about a second axis
20 aligned with the centre of each bore.

21. A coupling device according to claim 1 or claim 2 whereby the vertical dimension from the bottom of the sleeve to the second axis of rotation is equal to or greater than the vertical dimension between the top of the cylindrical body of the pillar to the equator of the head of the pillar.

22. A coupling device according to any one of the preceding claims further including one or more indicia means located on the actuator means or sleeve to indicate when the actuator means is in the second locked position.
23. A coupling device according to any one of claims 4 to 7 wherein the neck and part
5 hemispherical sections of the pillar do not impede movements of the locking elements and guide the longitudinal axis of the sleeve into alignment with the longitudinal axis of the cylindrical body of the pillar, if the longitudinal axis of the sleeve after passing over the head of the pillar is tilted with respect to the longitudinal axis of the pillar.
24. A coupling device according to claim 9 wherein the actuator is retained within the cavity
10 means by a collar that incorporates a sealing ring to limit the ingress of foreign matter into the cavity means.
25. A coupling device according to any one of the preceding claims wherein the sleeve has a skirt and the device has a bearing-washer interposed between the body of the pillar and the surface it is mounted on and having a fitted seal between the skirt and the bearing-washer to
15 restrict the ingress of foreign matter into the space between the sleeve and the pillar and the space between the upper face of the bearing-washer and the bottom of the sleeve.
26. A coupling device according to any one of claims 7 to 13 wherein each aperture has a narrowing section at the internal face of the sleeve to prevent complete inward escape of a respective locking element from the aperture.
- 20 27. A coupling device according to any one of claims 19 to 21 wherein the yoke has a protrusion extending therefrom which does not impede articulation about the second axis of the engaged coupling from 90 degrees up to 90 degrees down but does prevent continued rotation of the sleeve about the second axis beyond this range when the sleeve is disengaged from the pillar.

28. A coupling device according to any one of claims 19 to 21 or claim 27 wherein each arm of the yoke has a notch at a lower portion thereof to enable an increased range of downward pivoting of the yoke about the second axis in circumstances where there is rotation of the sleeve about the pillar with respect to a longitudinal axis of the towbar.
- 5 29. A coupling device according to claim 11 wherein there is a circumferential buffer zone adjacent the top of the groove set into the underside of the head of the pillar that precludes the locking elements from distorting the underside of the head of the pillar to produce a head diameter that would interfere with the sleeve freely engaging the head of the pillar.
30. A coupling device according to claim 20 wherein a wave washer on the securing means
- 10 generates friction between the yoke and the sleeve or between the yoke and the securing means.

Fig. 2

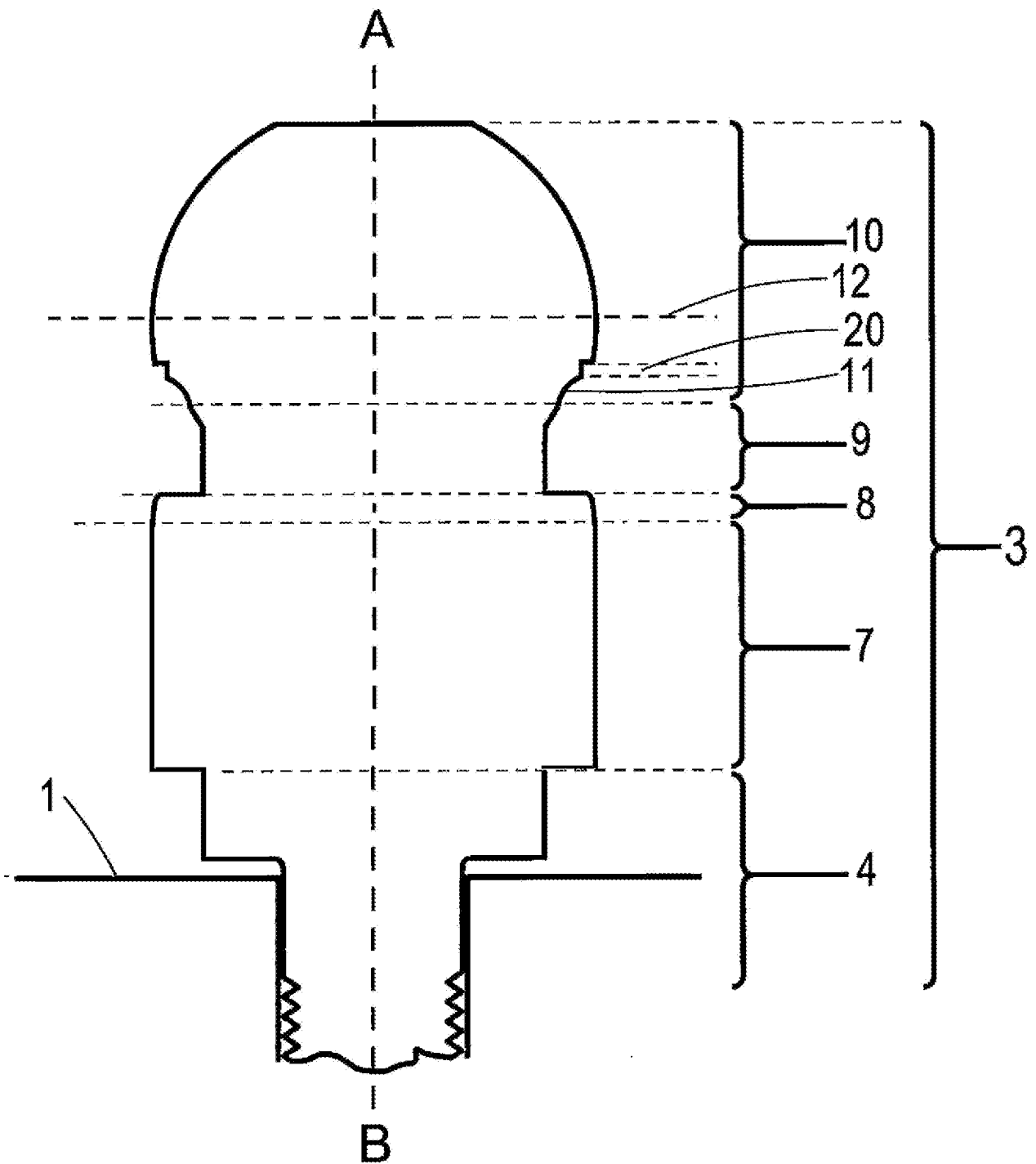


Fig. 3

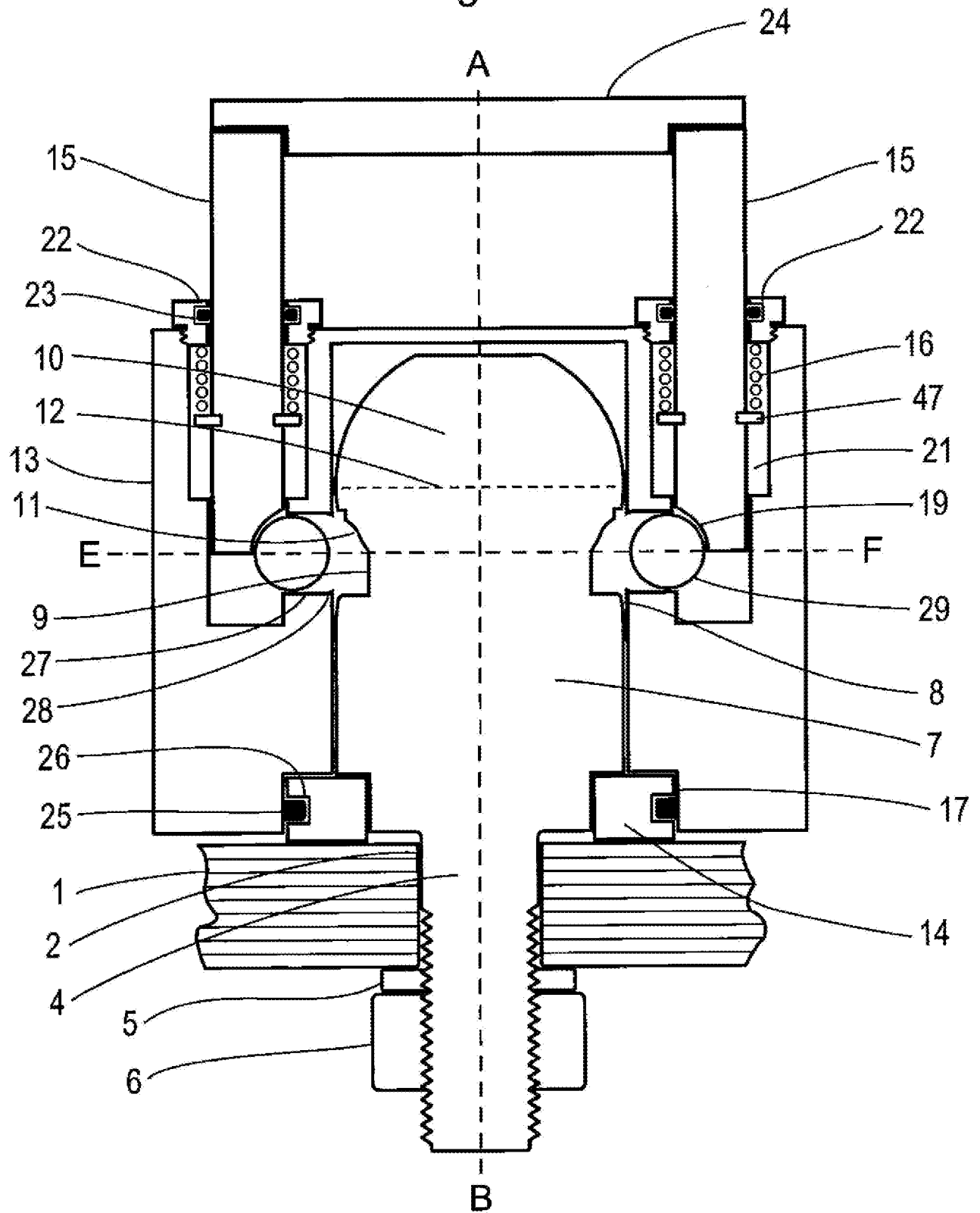


Fig. 4

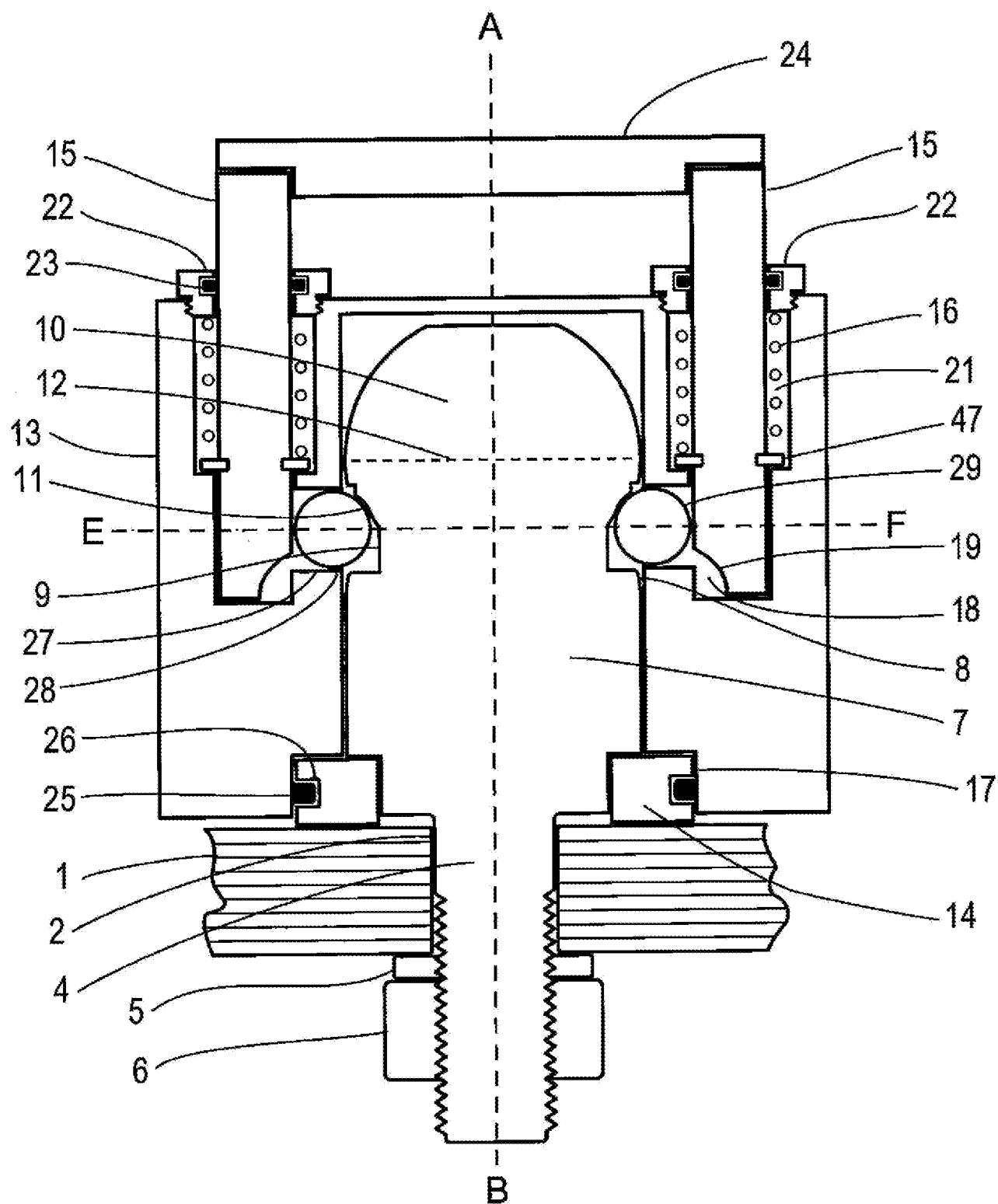


Fig. 5

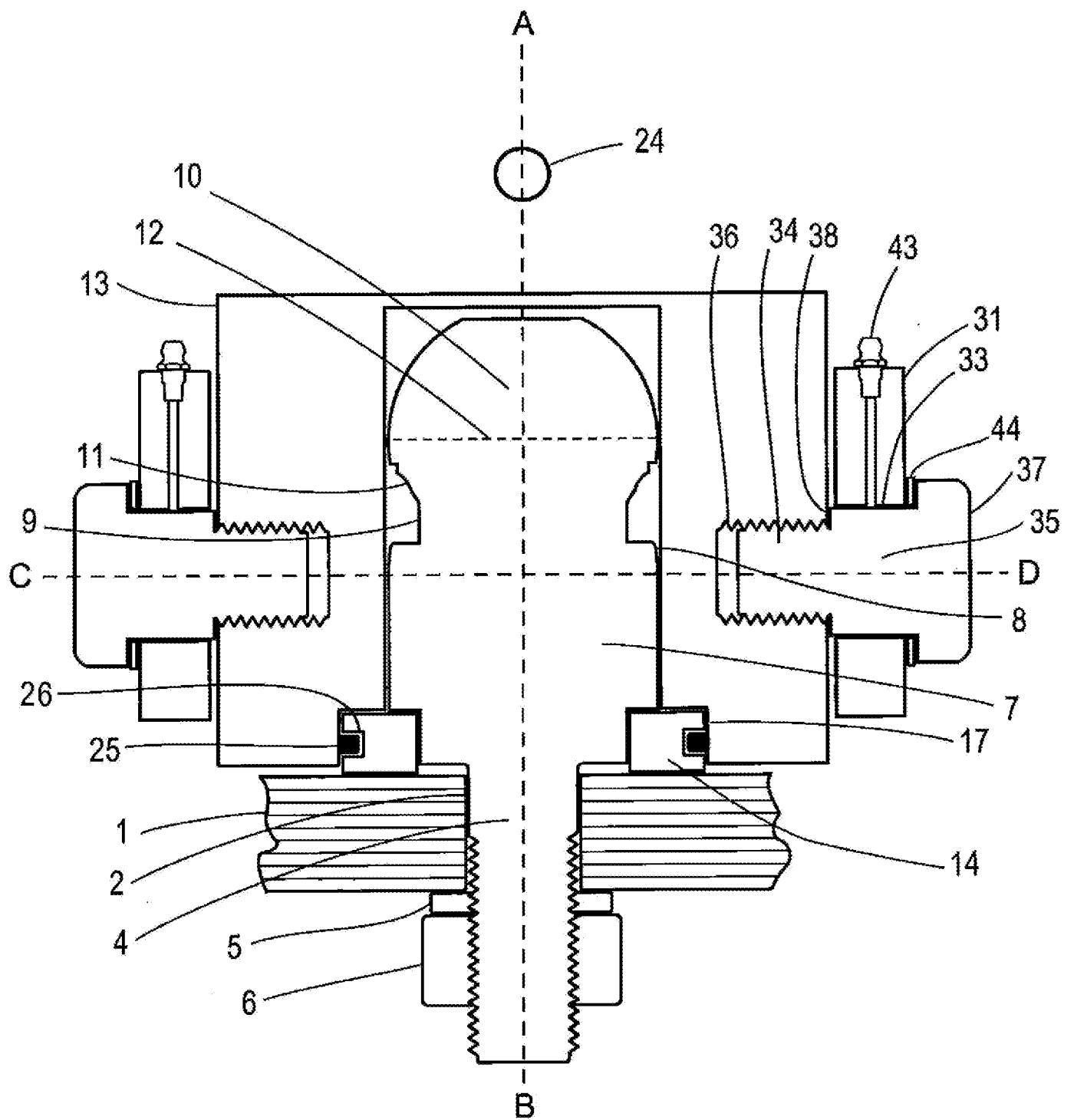


Fig. 6a

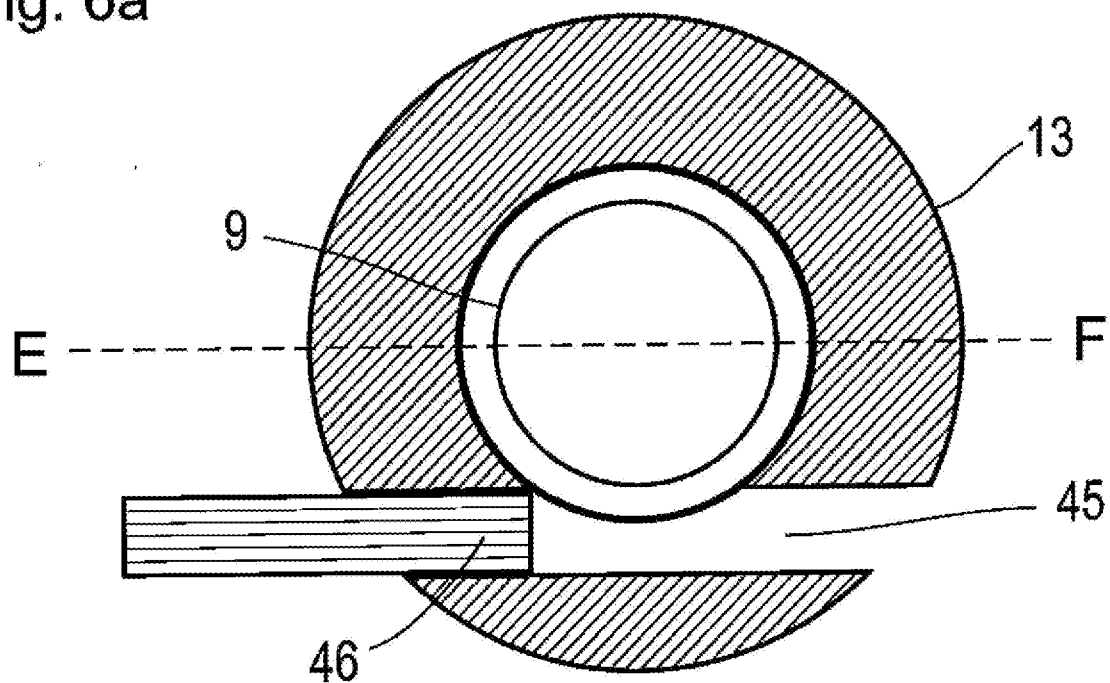


Fig. 6b

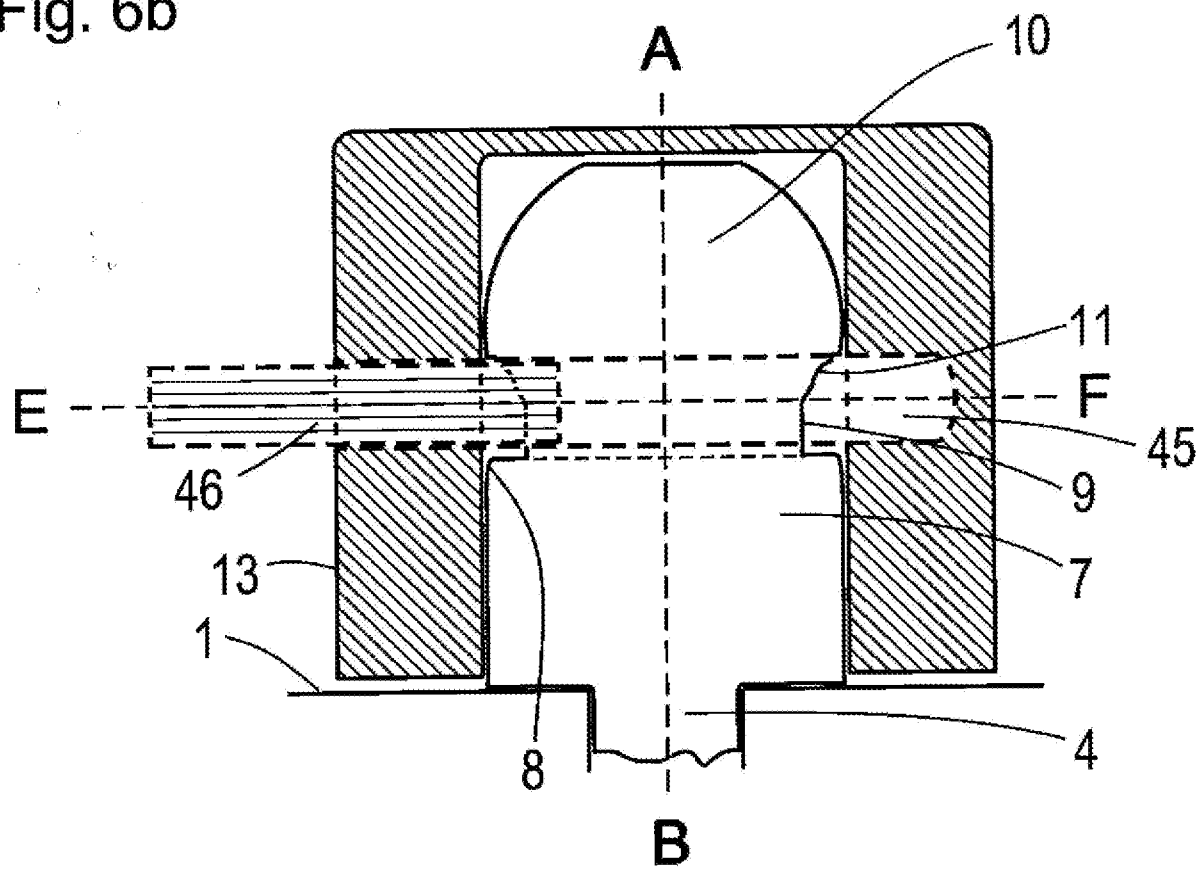


Fig. 7a

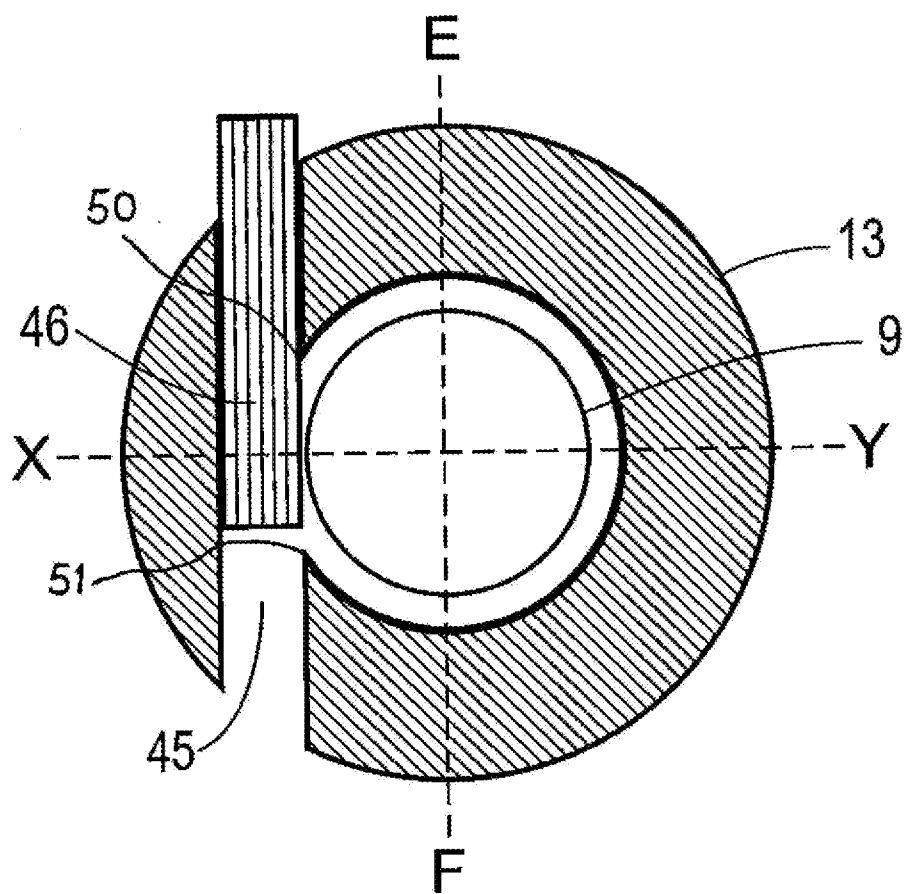
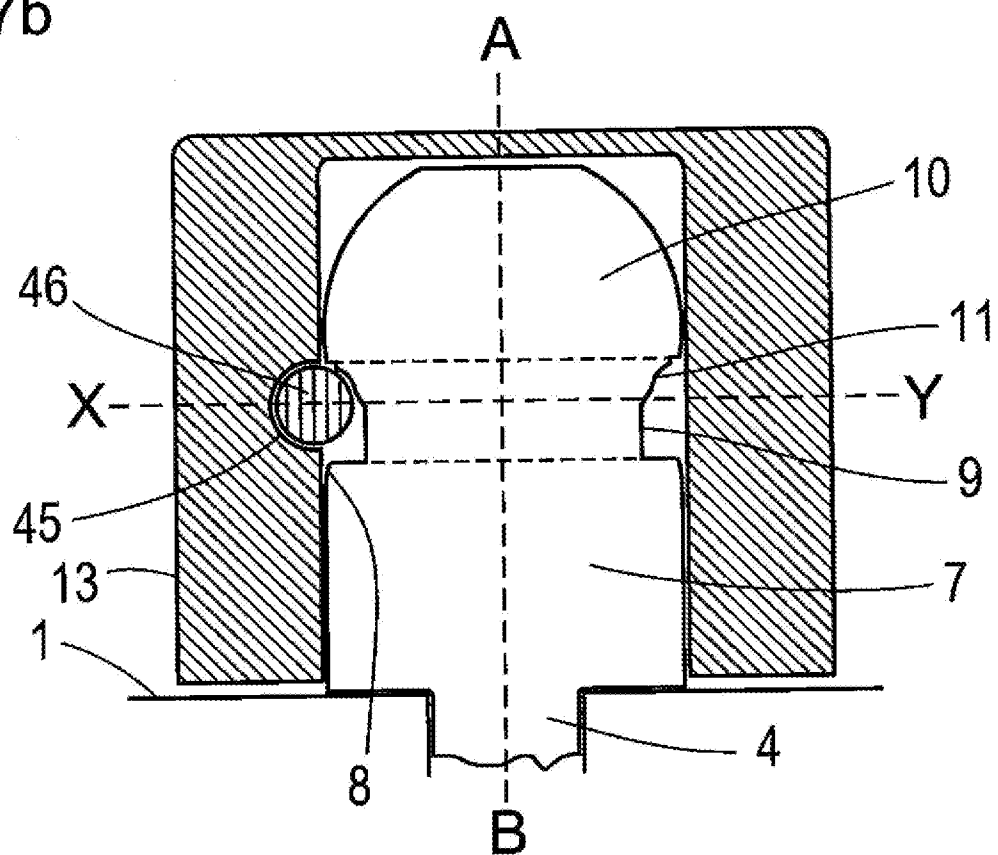


Fig. 7b



INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2014/000399**A. CLASSIFICATION OF SUBJECT MATTER****B60D 1/06 (2006.01) B60D 1/00 (2006.01)**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, IPC: B60D1/ic/cc, US Classification: 280/504/uc, 280/508/uc, 280/511/uc, 403/322.1/uc, 403/322.2/uc, 403/322.4/uc, and Keywords: sleeve+, surround+, outer, hous+, enclos+, cup+, cylind+, tub+, collar?, socket?, annular+, spring?, bias+, resilient+, auto+, actuat+, urg+, return+, compress+, lock+, secur+, engag+, prevent+, connect+, fasten+, ball?, hitch?, tow_bar?, tow_hitch+ and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
23 May 2014

Date of mailing of the international search report
23 May 2014

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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2014/000399
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/102322 A1 (ALLSOP et al.) 16 September 2010 Figures 1-2 & 4, Pages 6-8, 16-17 & 21	1-5, 18-22, 25, 27-28, 30
X	US 6540426 B2 (CLOYD et al.) 01 April 2003 Figures 1-3, Columns 3-4	1-5
A	FR 2690109 A1 (LOCHET) 22 October 1993 The whole document	1-30
A	US 2011/0193320 A1 (KRAMER) 11 August 2011 The whole document	1-30

Form PCT/ISA/210 (fifth sheet) (July 2009)

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/AU2014/000399	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2010/102322 A1	16 Sep 2010	AU 2010223836 A1	18 Aug 2011
		AU 2010223836 B2	20 Oct 2011
		US 2011309600 A1	22 Dec 2011
US 6540426 B2	01 Apr 2003	US 6540426 B2	01 Apr 2003
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US 2011/0193320 A1	11 Aug 2011	US 8505955 B2	13 Aug 2013
		WO 2011100312 A2	18 Aug 2011
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