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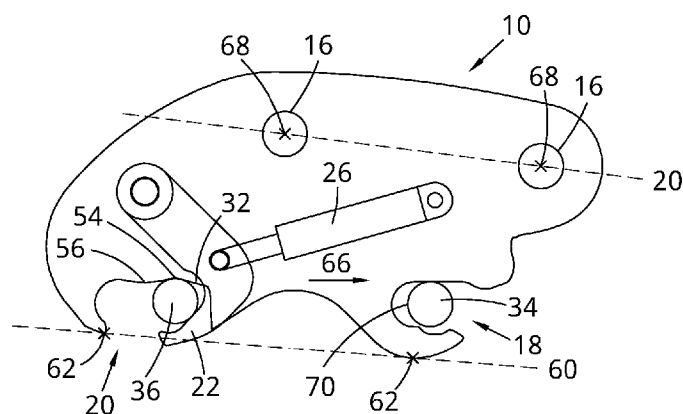


FIG. 4

(57) Abstract: A coupler (10) comprising a top part (14) for attaching to an excavator arm of an excavator and a bottom part for attaching to an accessory for the excavator, the bottom part comprising a first jaw (18) that opens in a forwards direction for receiving a first attachment pin of the accessory and a second jaw (20) opening in a downwards direction for receiving a second accessory pin of the accessory, wherein the second jaw (20) is associated with a latching member (22) that sweeps between an open condition and closed condition for selectively securing or releasing the second attachment pin of the accessory in the second jaw (20), the second jaw (20) comprising an upper wall surface (56) and a wedging surface (32), the wedging surface (32) being closer to the front of the coupler than the upper wall surface (56).

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Coupler Horseshoe

The present invention relates to a coupler comprising a modified horseshoe, in particular a coupler with a horseshoe for improving the retention of an accessory on of
5 the coupler in the event of a failure of the actuator thereof.

Excavator couplers are well known in the art. They attach to the end of an excavator arm of an excavator to allow quick coupling and decoupling of an accessory onto the arm of the excavator. As shown in Figure 1, couplers 10 generally comprise a body or
10 housing 12 that has a top part and a bottom part 16. Sometimes the two parts are visually delimited, but as illustrated in this embodiment they need not be.

The top part 14 is commonly fitted with two apertures 16 for attaching the coupler to an excavator arm by using a pair of excavator arm attachment pins, whereas the bottom
15 half 16 comprises two jaws 18 and 20, a first jaw being a front jaw 18, which generally points in a forward direction relative to the coupler and a rear jaw 20 which opens downward relative to the coupler. There is also commonly provided a latching mechanism internal of the housing 12, which in this embodiment is a pivoting latching
hook 22 which is mounted for rotation about an axle 24 and controlled by a hydraulic
20 cylinder 26. Although not shown, the hydraulic cylinder will be connected to control hydraulics from the excavator that allow an operator of the excavator to selectively open or close the latching hook as appropriate, generally from within the cab of the excavator. This may be via a switch.

25 In use, to connect the coupler to an accessory, such as a digging or loading bucket, the operator would ensure that the pivoting latching hook has been retracted by compressing the piston 28 of the hydraulic cylinder 26 of the coupler into the hydraulic cylinder 26 and would then manipulate the excavator arm, including rotating the
coupler as necessary, using the hydraulic systems provided for that purpose on the
30 excavator, to manipulate the front jaw 18 of the coupler onto a first attachment pin of the accessory, which accessory will have two such pins in parallel mounted on the frame thereof. The operator would then rotate the coupler 12 so as to lower the rear jaw 22 over the second pin of the accessory as well. The operator would then control the cylinder 26 again to re-extend the piston 28 and thus rotate the pivoting latching
35 hook 22 into engagement with the second attachment pin. When tight, the accessory is

attached. Upon a failure of the cylinder 26, however, there can be a risk of creep of the piston 28 back into the cylinder 26, which in turn could cause a release of the second attachment pin from the rear jaw or even the first attachment pin from the front jaw 18.

- 5 Systems already exist for achieving this, such as blocking bars or safety valves in the hydraulic cylinder. Nevertheless, further approaches to assist with this would be beneficial. The present invention seeks to provide a further approach for protecting against this preferably without adding to the component count of the coupler, as couplers are already complex. As such it would be useful to provide a coupler that can
10 reduce the risk of a decoupling of an accessory following a failure of the hydraulic cylinder 26, or other undesired causes of creep of the piston into the cylinder.

According to the present invention there is provided a coupler comprising a top part for attaching to an excavator arm of an excavator and a bottom part for attaching to an
15 accessory, the bottom part comprising a first jaw that opens in a forwards direction for receiving a first attachment pin of the accessory and a second jaw opening in a downwards direction for receiving a second accessory pin of the accessory, wherein the second jaw is associated with a latching member that sweeps between an open condition and closed condition for selectively securing or releasing the second
20 attachment pin of the accessory in the second jaw, the second jaw comprising an upper wall surface and a wedging surface, the wedging surface being closer to the front of the coupler than the upper wall surface.

The accessory is likely to be a digging or loading bucket.

25

The first jaw is commonly referred to as the front jaw as it is the first jaw to engage a pin of an accessory when attaching the accessory to the coupler, whereby the coupler moves "forward" into an engagement with that first pin in the first step of that attachment. The second jaw is thus commonly referred to as the rear jaw.

30

The upper wall surface is the surface against which the second attachment pin of the accessory is thereafter clamped by the latching member when the accessory is secured onto the coupler. For that purpose, the latching member has a pin engagement face that is not parallel to the upper wall surface, but which instead opens

relative to the upper wall surface as it extends towards a free end of the latching member.

5 As the two attachment pins of the accessory are parallel and a fixed space apart, by virtue of them being fixed to the frame of the accessory, either temporarily or permanently, upon clamping the second attachment pin of the accessory between the upper wall surface of the rear jaw and the pin engagement face of the latching member, the first attachment pin of the accessory will be clamped to the back of the front jaw in the accessory secured condition.

10

As the pins are being released, however, the clamping against that upper wall surface will relax, thus providing room between the second attachment pin and the two clamping surfaces of the latching means and the upper wall surface. That room can thus result in a rattling connection if the coupler was to have its front end pointed
15 downwardly, or if the accessory was otherwise in a condition to tend to move the pins thereof in a forward direction. This relaxation can occur if the latching member was to creep towards an open condition.

20 With the wedging surface, however, upon such opening the latching member, the second attachment pin will eventually contact the wedging surface, and be pushed out from the line of the upper wall surface and into firm(er) engagement with the pin engagement face of the latching member. This reduces the amount of rattle in the connection. The wedging surface thus provides an advantage.

25 Preferably the wedging surface kinks angularly from the frontward end of the convex top surface. In this manner it gives the impression of a slice being cut off the shape of the forward corner of the rear jaw 20, or it provides a chord like cut across that corner.

30 The wedging surface thus cooperates with the latching member to grip or position the rear attachment pin in engagement with the latching member if the latching member was to be swept back into a non-secured latching position.

35 Due to the angle of the wedging surface away from the upper wall surface, the wedging surface, when in use, provides a shortened distance between the contact point of the pin on the latching member and the contact point on the rear jaw compared to the

contact point of the pin on the latching member and the upper wall surface of the rear jaw in the secured latching position.

5 Preferably the top part of the coupler comprises two pin attachment points for attaching the coupler to the excavator arm using two pins through those pin attachment points. Preferably the centres of those pin attachment points between them define an imaginary line that extends forwards and back, the front jaw opening substantially parallel to that line, or within a variance of up to 15 degrees therefrom.

10 Preferably the rear jaw opens in a direction substantially perpendicular to that line, or within a variance of up to 15 degrees therefrom.

15 Preferably the latching member is a pivotal latching hook, it thus sweeps along a generally circular path, preferably co-axial to a convex upper wall surface. However, it may be a linear sliding latch, sliding parallel to a flat upper wall surface.

Preferably the latching member is driven by a hydraulic ram comprising a cylinder and a piston.

20 Preferably the latching member has a pin latching region comprising the pin engagement face. Preferably there is a tip at the free end of the pin latching region, with an upstanding lip. Between the lip and the pin engagement face there may be a recess into which an attachment pin can rest in the event that the accessory is not in a secured and clamped condition.

25 Preferably the lip defines at least a portion having a normal line coincident with the radial arm of the hook. This makes it harder for a pin, in the pin latching region, to fall out of the pin latching region, as contact with the tip must put a return force on the latching member, which will move, or tend to move, the latching member into a latching position.

30

Preferably the wedging surface extends between the upper wall surface through to a front side of the rear jaw.

35 Preferably the front side is flat.

Preferably the front side is steeply angled from the base wall of the coupler

5 Preferably the front side of the rear jaw is arranged to provide no partial closing of the rear jaw, with no closing lip at the free end thereof.

10 Preferably a tangent at the point of contact of the tip of the latching member against the second attachment pin when the attachment pin is seated in a condition of two point contact with the tip and the pin engagement surface or recess of the latching member is substantially parallel to a tangent at the point of contact between the wedging surface and the second attachment pin when the latching member is retracted into a position of such contact, with up to a 10 degree variance.

15 Alternatively those two tangents are such that the intersection between the tangent lies rearward of the second pin.

20 Alternatively those two tangents intersect in front of the rear pin, the angle between the tangents not exceeding 15 degrees, or more preferably 10 degrees, and ideally about 8 degrees, plus or minus 1 degree. This is in order to maintain a sufficient pinch on the second pin between the lip and the wedging surface to hold that pin.

25 Ideally the two tangents do not intersect between the first and second pins. As such they intersect either forward of first pin or behind the second pin. The force of the pinch will thus serve to retain the pin within the pinch, rather than forcing the pin out of the pinch.

30 Preferably the height of the lip at the tip of the latching member, as measured perpendicular to the lowest or radially outermost part of the pin engagement face or the recess, is 0.2x or 20% of the diameter of the attachment pin.

The shortest distance between the tip of the latching member and the upper wall surface of the jaw still needs to remain larger than the diameter of that attachment pin, however, to ensure that the pin can be accommodated into the latch of the latching member.

35

It is important to note that creep is unusual in couplers. However, it can occur due to the weight of the accessory if the hydraulic cylinder is not pressurised, thus causing compression of the piston into the cylinder. Commonly, however, the cylinders have non return valves to stop this. The creep then might occur due to a failure of the seals or valves of the cylinder.

Preferably the wedging surface is straight over at least 50% of its length. However, it need not be straight. It may be part curved, but preferably the middle 80% is either straight or has a radius of curvature of at least 10cm. It may be concave or convex. The region between the upper wall surface and the wedging surface, however, is to be concave.

More preferably the wedging surface has a radius of curvature between flat and the radius, if any, of the upper wall surface of the rear jaw.

Either or both of the end 10% of the wedging surface may be curved, for example by rounding the juncture of it with the upper wall surface or base wall of the coupler.

Preferably the wedging surface kinks from the upper wall surface. The kink may be rounded or a sharp kink. Preferably the radius of the kink, where present, is smaller than half the radius of the second attachment pin of the accessory.

The kink will invert the wedging surface out from the upper wall surface towards the base wall of the coupler, and where present will invert from the convex curve of the upper wall surface, which create a concavity between the upper wall surface and the wedging surface.

Preferably the latching member defines a hook with the tip being a free end thereof.

Preferably the latching member comprises a sprung member to resist lifting of the second attachment pin up and over the tip of the latching member. Preferably a free end of the sprung member is located adjacent the mouth of the hook of the latching member.

Preferably the sprung member comprises a sprung retention pin located in a body of the latching member to extend out from the upper wall surface just rearward of the tip of the latching member. Creep or withdrawal of a piston into a hydraulic cylinder for controlling motion of the latching member can be resisted by that sprung retention pin. By being sprung, however, the sprung member can retract if suitably forced, e.g. by the hydraulics powering the latching member into an unlatching condition to release the pin, or conversely to allow clicking in of a pin into the hook upon moving the latching member into a latching condition by use of the hydraulics.

10

Preferably the maximum extension of the sprung member beyond the upper wall surface closes the mouth of the latching member to a height up to 15% smaller than the diameter of the second attachment pin, or up to 100% of the height of the lip at the tip of the latching member, as previously defined.

15

The gap between the sprung member's free end and the tip of the latching member is preferably at least 5% smaller than the diameter of the second attachment pin.

Preferably the mechanism for providing the spring bias for the sprung member is a bore within the back of the retention pin and a compression spring or a rubberised spring extending therein and out the top thereof, with a retention plate then securing the free end thereof relative to the body of the latching member.

20

Preferably the sprung member slides or moves with the latching member as the latching member opens or closes the rear jaw.

25

These and other features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings in which:

Figure 1 shows a prior art coupler having a rear jaw or horseshoe, a pivotal latching member and a hydraulic ram for movement thereof;

30

Figure 2 shows a further design of coupler having a rear jaw or horseshoe – the latching member and ram are not shown for clarity – the would be fitted within the coupler;

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Figures 3 to 6 show a modified coupler of Figure 2, with the lifting eye removed, but with the rear jaw profile modified to be in accordance with the present invention; and

- 5 Figure 7 shows an alternative form of coupler - with a sliding latching member, which embodies an alternative mode of jamming for an attachment pin between the latching member and the jaw.

10 Referring first to Figure 1, it has already been described above. Further discussion thereof is not necessary other than to indicate the additional presence of a non-essential lifting eye 30. Such lifting eyes 30 can commonly be moulded or provided onto the housing 12 of the coupler during manufacture of the coupler housing 12. Some couplers, however, do not have them.

15 Referring next to Figure 2, an alternative coupler 10 is shown, again with a lifting eye 30. As can be seen, in the top part there is once again a pair of holes for attachment pins for attachment of the coupler 10 to an accessory arm of an excavator (not shown, but which is conventional). Yet further, in the bottom part there are the two jaws for accommodating attachment pins of an accessory, such as a digging or loading bucket.

20 These jaws are commonly referred to as a front jaw 18 and a rear jaw 20, with the front jaw open to the front of the coupler and the rear jaw open to the bottom of the coupler. This coupler also has a generally conventional shape for its rear jaw, with a convex top wall, and roundings either side thereof. In this version the roundings partially close the jaw at both the front and rear ends of the jaw. However, this is non-essential.

25 Referring next to Figures 3 to 6, an embodiment of the present invention is shown. It comprises a pivoting hook associated with a rear jaw or horseshoe 20, but it can be seen that the rear jaw 20 has now been modified to have a wedging surface 32 kinking off a frontward end 54 of the convex top surface 56 of the rear jaw 20, which gives the impression of a slice being cut off the shape of the upper-forward corner 58 (see Figure

30 2) of the rear jaw 20. The wedging surface 32 can be seen to extend between the convex curve 56 of the top wall through to the front wall 52 of the rear jaw 20.

In this embodiment, there is a flat front wall 52. The flat wall, however, is non-essential as that wall may again be curved, as per Figures 1 and 2, or it may even be flat to the wedging surface 32, thus effectively extending the wedging surface 32.

5 The flat front wall 52 of this embodiment is steeply angled from the base line 60 of the coupler, the base line being defined as the line 60 across the lowest extents 62 of the housing of the coupler, as shown in Fig 4. In this embodiment it is also angled relative to an imaginary line 64 extending between centres 68 of the two attachment holes 16 in the top part of the coupler 10, as also shown in Figure 4. The base line 60 and the
10 imaginary line 64 may be parallel, but in this example they are not.

Preferably, as shown, the angle to the imaginary line 64 for the flat front wall is approximately 80 degrees, with no partial closing of the rear jaw, the angle thus being acute to the front of the coupler. Thus, in this embodiment the front wall will not snag a
15 pin when the pin exits the jaw 20.

Furthermore, the latching hook has a lip 38 at its free end, which is similar to the previous hook of Figure 1. This lip 38 is provided to beneficially co-operate with the wedging surface 32, especially in a condition of cylinder creep – where the cylinder 26
20 (again see Figure 4) undesirably allows the piston to compress into the cylinder, usually occurring only upon a failure of part of the hydraulics system of the excavator or coupler. That creep, if it ever occurs, would potentially allow the latching hook 22 to open the rear jaw 20, which in turn relaxes the securement of the accessory, ultimately allowing the two pins 34, 36 in the two jaws 18, 20 to move around. With adequate
25 creep, the accessory may move in a generally forwards direction, as indicated by the arrow 66 in Fig 4, such that the front pin 34 of the accessory starts to lift from the back 70 of the first jaw 18, as shown in Figure 4. This movement occurs simultaneously with a forwards movement of the second pin 36 in the rear jaw 20, as the two pins 34, 36 are locked together by the structure of the accessory.

30

The front jaw 18 is designed to accommodate such forward movement, by being much deeper than the diameter of the pin 34. Nevertheless, such movement does loosen the accessory.

Such creep may be through a failure of the hydraulics for the cylinder, or the electronics/valves therefor, and the weight of the accessory usually will cause the forward movement 66. The creep might even occur in response to an inadvertent triggering of a release, or partial release, of the coupler.

5

With the wedging surface 32, however, as the rear latch 22 starts to open the rear jaw 20 in response to creep, whereupon the front pin starts to lift from the back of the first jaw 18, as can be seen from the successive images of Figures 3 to 6 the second pin (in the rear jaw) starts to slide along the top wall 56 of the rear jaw 20, and then onto the wedging surface 32, following which the second pin 32 is pushed by the wedging surface radially outwards relative to the pivot axis of the pivoting hook (or the centre of rotation of the convex surface, as they are typically one and the same), as shown in Figure 5. This thus maintains the rear pin in firm engagement with the latching hook 22, thus reducing rattle of the accessory on the coupler. This thus already provides better security of the accessory on the coupler.

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As also shown in figure 5, this radial movement is accompanied by the second pin 36 sliding across the engagement face 72 of the latching hook 22 towards the tip 38 of the latching hook 22.

20

As the tip 38 lifts relative to that engagement face 72, or as shown since there is a concavity between the engagement face 72 and the tip 38 defining a recess 40, the pin 36 eventually hits that lip 38 or recess 40, as shown in figure 6, forming a two point contact against the hook 22, which along with the single point contact with the wedging surface serves to hold the accessory pin 36.

25

This holding of the pin results in a pinching of the pin 36 between the tip 38 of the hook 22 and the wedging surface 32. Such a pinching of the pin 36 resists further retraction of the latching hook and further sliding of the pin against either the engagement face of the latching hook 22 or the wedging surface 32, thus effectively jamming the rear pin 32 in the jaw 20 of the coupler 10, which thus maintains a more secure coupling of the accessory on the coupler 10.

30

In this illustrated embodiment, a tangent 74 at the point of contact 76 of the tip 38 against the pin 36 is angled relative to a tangent 78 at the point of contact 80 of the

35

wedging surface against that pin 36 such that the meeting point 82 of the tangents is forward of second pin 36. As in this embodiment, as shown in Figure 6, it is preferred to be forward of the first pin 34 as well. Preferably the meeting point does not lie between the first and second pins, as this presents a wider angle between the tangents in a manner that can allow the rear pin to pop out of the pinch between the wedging surface and the lip.

More preferably the two tangents are such that there is no intersection between the tangents, i.e. the tangents are parallel, or such that the intersection point between the tangents lies rearward of the second pin 36, such that the force of the pinch serves to retain the pin rather than to push out the pin. This can be achieved by enlarging the lip at the tip 38 and/or by curving it more upward.

The angle between the tangents should ideally be small, if in front of the second attachment pin to make it unlikely that the second attachment pin 36 will squeeze out of the engagement of the latching member. Preferably that angle should not exceed 15 degrees, and more preferably it should be between 10 and zero degrees, or between 5 and zero degrees. In this embodiment it is about 8 degrees. These angles should maintain an effective pinch on the pin 36 between the lip 38 and the wedging surface.

If instead the meeting point 82 lies behind the rear pin, substantially any acute angle between 0 and 90 degrees can serve this function of resisting the pin 36 from exiting the securement of the pinch.

Creep is unusual in couplers. However, it can occur due to the weight of the accessory if the hydraulic cylinder is not pressurised, thus causing compression of the piston into the cylinder. Commonly, however, the cylinders have non return valves to stop this. The creep then might occur due to a failure of the seals or valves of the cylinder.

The wedging surface 32 is shown to be generally straight. However, it need not be straight. Typically it is much flatter than the convex surface 56, and it kinks away from it. The kink may be a radiused kink or a sharp kink. Preferably the radius of the kink is smaller than half the radius of the second attachment pin 36 of the accessory. The kink, however, inverts the convex curve to create a concavity between the convex surface and the wedging surface.

Referring next to Figure 7, a similar result is achieved but in this case with a sliding hook. In this embodiment, there can likewise be provided a wedging surface 32, which as before kinks from the (this time flat) top wall 84 of the rear jaw. This wedging surface then operates in the same way as for the first embodiment of Figures 3 to 6 in that the wedging surface 32 causes a pin 36 to become pinched against a tip of the hook 42, which in this embodiment again has an upward lip 44 on its free end, which provides a recess 46 into which a rear attachment pin 36 can reside and lock between the wedging surface 32, the tip 44 and the engagement surface 72, thus preventing further withdrawal of the sliding hook 42 towards the front of the coupler when the pin 36 is resting against the hook 42. However, in this embodiment, there is also a further feature to prevent the rear pin from lifting up and over that lip before that jamming. This optional feature is a separate invention.

This product has a sprung retention pin 48 located in the body of the sliding hook just forward of the lip but in the upper wall thereof. Creep or withdrawal of the piston 28 into the hydraulic cylinder 26, as used to control sliding of the sliding hook 42, can be resisted by that sprung retention pin 48. That sprung retention pin is spring biased into its extended condition as shown, in which it bears against the second attachment pin 36.

The illustrated mechanism for providing the spring bias is a bore within the back of the retention pin 48 that accommodates a compression spring or a rubberised spring. There is then a retention plate 50 that bolts onto a body of the sliding hook mechanism to retain the compressed spring from above. This sprung retention pin then slides or moves with the whole hook mechanism, and thus is located to resiliently move across and back from across a mouth of the hook 42, without otherwise moving relative to the hook.

The spring force provided by the spring thereof resists the over-riding of the rear pin 36 past the free end of that sprung retention pin 48 until driven to do so by actuation of the hydraulic ram 26. The stronger the spring, the stronger the retention. A skilled person would recognise, however, that this needs to be over-rideable by the hydraulics cylinder to allow the coupling processes to be performed. However, unintentional creep

of the hook in situations where the front pin 34 will not lift out of the back 70 of the front jaw 18 can still then be resisted from opening the jaw as the sprung retention pin will contact or be contacted against the pin, thus resisting that creep.

- 5 Such a sprung retention spring could likewise be mounted relative to the pivoting latching hook to provide a similar function for that pivoting hook..

10 These and other features of the present invention have been described above purely by way of example. Modifications in detail may be made to the invention within the scope of the claims as appended hereto.

CLAIMS:

1. A coupler comprising a top part for attaching to an excavator arm of an excavator and a bottom part for attaching to an accessory for the excavator, the bottom
5 part comprising a first jaw that opens in a forwards direction for receiving a first attachment pin of the accessory and a second jaw opening in a downwards direction for receiving a second accessory pin of the accessory, wherein the second jaw is associated with a latching member that sweeps between an open condition and closed condition for selectively securing or releasing the second attachment pin of the
10 accessory in the second jaw, the second jaw comprising an upper wall surface and a wedging surface, the wedging surface being closer to the front of the coupler than the upper wall surface.
2. The coupler of claim 1, wherein the latching member has a pin latching region
15 with a pin engagement face that selectively opposes, but is not parallel to, the upper wall surface, and which instead opens relative to the upper wall surface as it extends towards a free end of the pin latching region.
3. The coupler of claim 1 or claim 2, wherein the wedging surface kinks from the
20 frontward end of the convex top surface.
4. The coupler of any one of the preceding claims wherein the latching member is a pivotal latching hook.
- 25 5. The coupler of any one of claims 1 to 3, wherein the latching member is a linear sliding latch, sliding parallel to the upper wall surface of the rear jaw.
6. The coupler of any one of the preceding claims, wherein there is a tip at the free
30 end of the pin latching region, with a lip that is upstanding towards the upper wall surface.
7. The coupler of claim 6, wherein a recess is located between the lip and the pin engagement face.

8. The coupler of claim 6 or claim 7 and claim 4, wherein the lip defines at least a portion having a normal line coincident with a radial arm of the hook.

5 9. The coupler of claim 6 or claim 7 and claim 5, wherein the lip defines at least a portion having a normal line arranged substantially parallel to the wedging surface, with no more than a 10 degree variance.

10 10. The coupler of any one of the preceding claims, and claim 6, wherein a tangent at a point of contact of the tip of the latching member against a second attachment pin when the second attachment pin is seated in a condition of two point contact with the tip and the pin engagement surface, or a recess therebetween, is parallel to a tangent at the point of contact between the wedging surface and the second attachment pin when the latching member is retracted into a position of such contact.

15 11. The coupler of any one of claims 1 to 9, and claim 6, wherein an intersection between a tangent at a point of contact of the tip of the latching member against a second attachment pin when the second attachment pin is seated in a condition of two point contact with the tip and the pin engagement surface, or a recess therebetween, and a tangent at the point of contact between the wedging surface and the second
20 attachment pin when the latching member is retracted into a position of such contact, lies beyond the second pin in a direction extending away from the first jaw.

25 12. The coupler of any one of claims 1 to 9, and claim 6, wherein a tangent at a point of contact of the tip of the latching member against a second attachment pin when the second attachment pin is seated in a condition of two point contact with the tip and the pin engagement surface, or a recess therebetween, is angled up to 15 degrees relative to a tangent at the point of contact between the wedging surface and the second attachment pin when the latching member is retracted into a position of such contact.

30 13. The coupler of claim 13, wherein the angle is about 8 degrees, plus or minus 1 degree.

35 14. The coupler of any one of claims 1 to 19, and claim 6, wherein an intersection between a tangent at a point of contact of the tip of the latching member against a

second attachment pin when the second attachment pin is seated in a condition of two point contact with the tip and the pin engagement surface, or a recess therebetween, and a tangent at the point of contact between the wedging surface and the second attachment pin when the latching member is retracted into a position of such contact,
5 does not lie between the first and second pins.

15. The coupler of any one of claims 6 to 14, wherein the height of the tip of the latching member, as measured perpendicular to the lowest or radially outermost part of the pin engagement face, or a recess if present, is 0.2x or 20% of the diameter of the
10 second attachment pin.

16. The coupler of any one of the preceding claims, wherein the wedging surface extends between the upper wall surface and a front side of the rear jaw, wherein the front side of the rear jaw is arranged to provide no partial closing of the rear jaw, with
15 no closing lip at the free end thereof.

17. The coupler of any one of the preceding claims, wherein the wedging surface is straight over at least 50% of its length.

20 18. The coupler of any one of the preceding claims, wherein a middle 80% of the wedging surface is either straight or has a radius of curvature of at least 10cm.

19. The coupler of any one of the preceding claims, wherein a region between the upper wall surface and the wedging surface is concave.

25

20. The coupler of any one of the preceding claims, wherein the latching member comprises a sprung member to resist lifting of the second attachment pin up and over the tip of the latching member.

30 21. The coupler of claim 20, wherein a free end of the sprung member is located adjacent a mouth of the latching member.

22. The coupler of claim 21, wherein the sprung member comprises a sprung retention pin located in a body of the latching member to selectively extend an end
35 thereof out though and into a position below the upper wall surface of the rear jaw.

5

23. The coupler of claim 22, wherein the maximum extension of the sprung member below the upper wall surface has a height up to 15% smaller than the diameter of the second attachment pin, or up to 100% of the height of a tip of the latching member.

24. The coupler of any one of claims 20 to 23, wherein the sprung member slides or moves with the latching member as the latching member opens or closes the rear jaw.

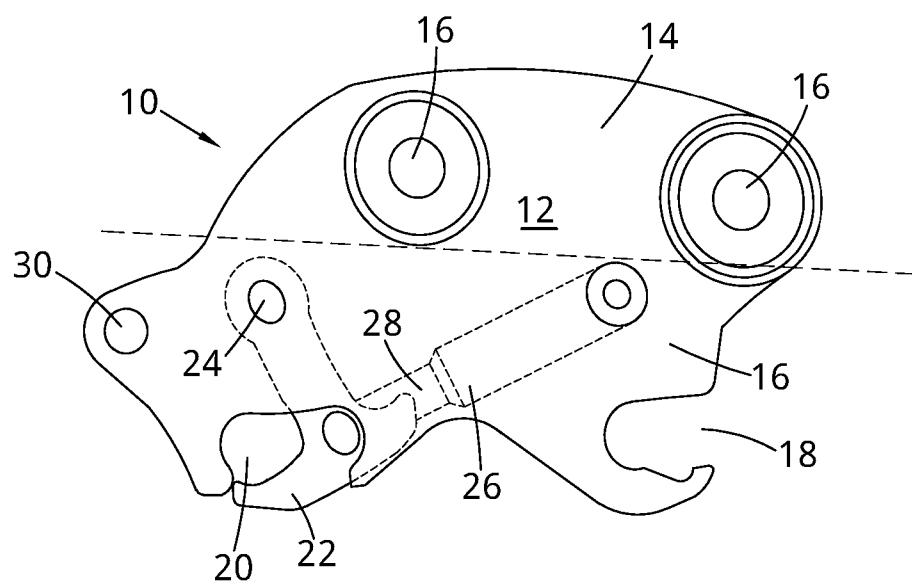


FIG. 1

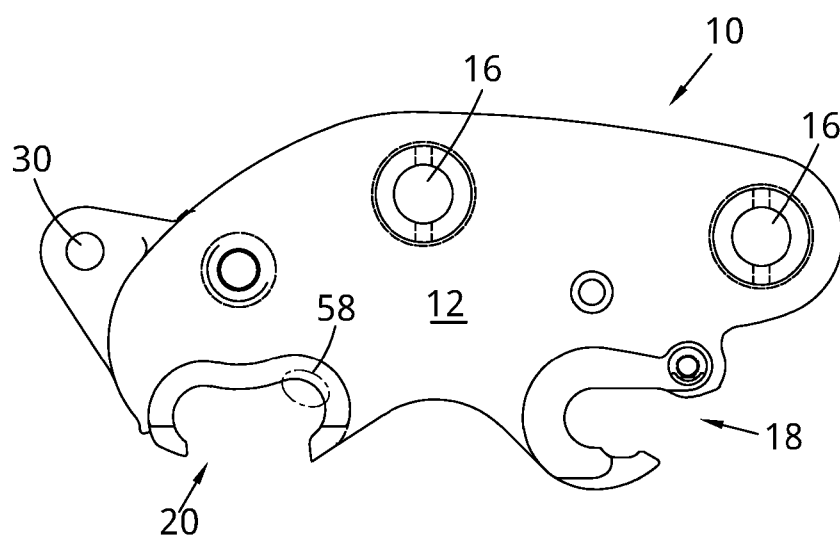


FIG. 2

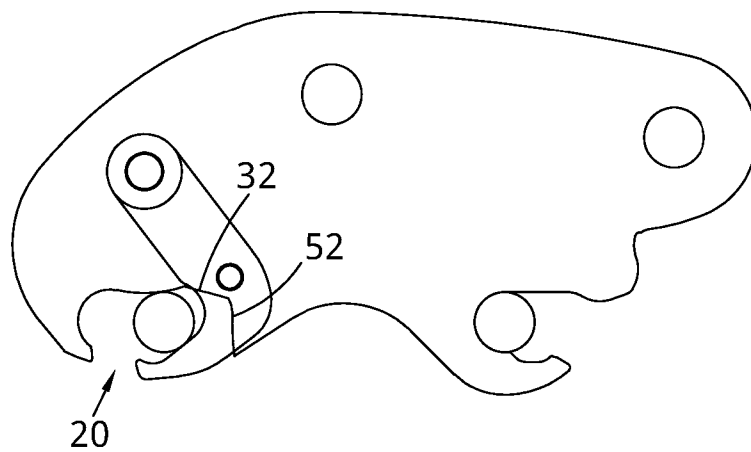


FIG. 3

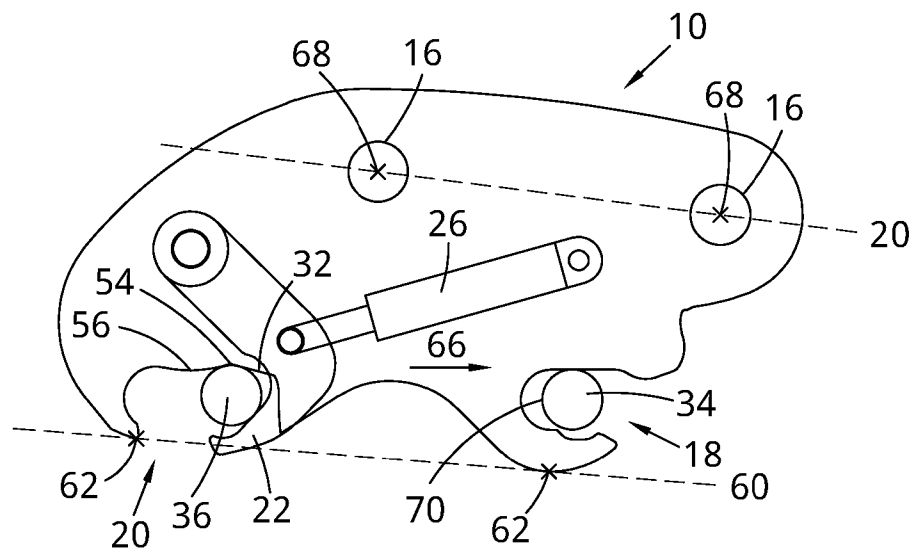


FIG. 4

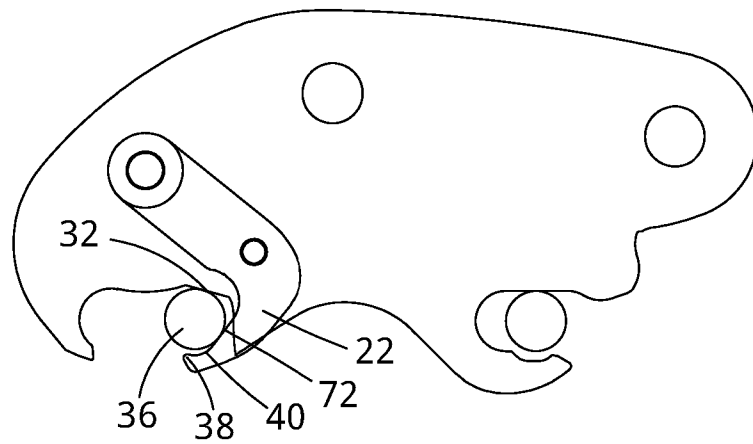


FIG. 5

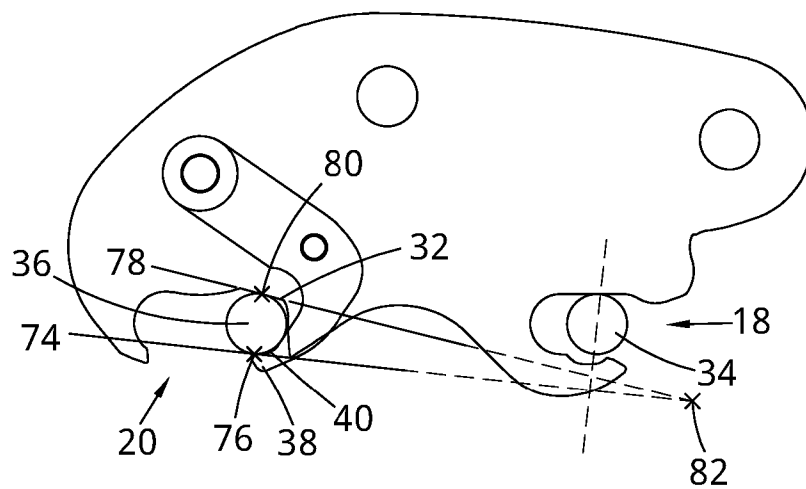


FIG. 6

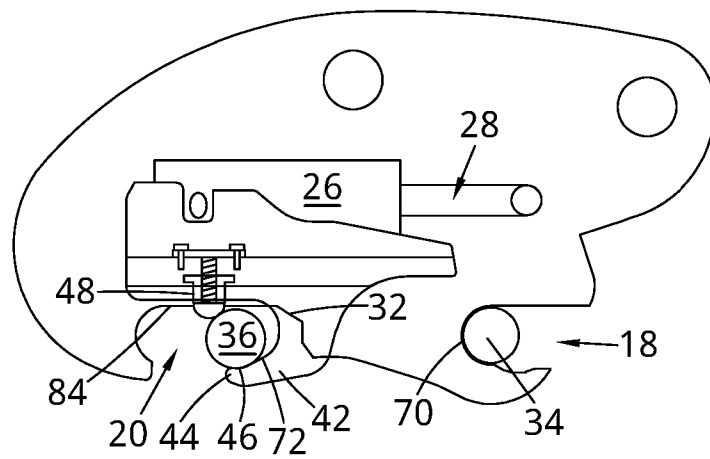


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2019/051747

A. CLASSIFICATION OF SUBJECT MATTER
 INV. E02F3/36
 ADD.

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)
 E02F

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 205 299 A (BALEMI WILLIAM JOHN) 7 December 1988 (1988-12-07) figure 2	1,2,4, 16-19
X	GB 2 473 942 A (HILL IAN [GB]) 30 March 2011 (2011-03-30) figures 1,2,10	1-4,6-8, 15-19
X	GB 2 330 570 A (MILLER RONALD KEITH [GB]; MILLER GARY [GB] ET AL.) 28 April 1999 (1999-04-28) figures 6,7,9,10,11	1,2,4, 6-8,15, 19
X	WO 2017/099610 A1 (WEDGELOCK EQUIPMENT LTD [NZ]) 15 June 2017 (2017-06-15) page 8, paragraph 6; figures	1,2,5, 16-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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