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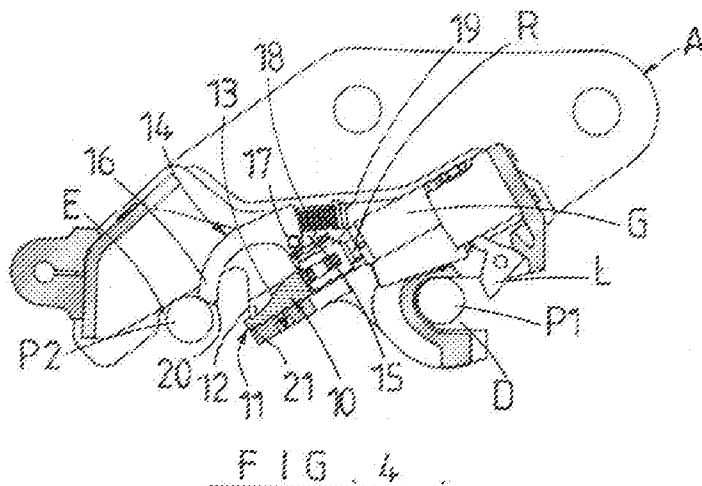
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(54) Title: A LOCKING DEVICE FOR A QUICK COUPLER



(57) Abstract: A wedge locking element (10) for a locking device of a quick coupler A for coupling the pin P2 of an attachment to earth working machinery. The wedge locking element (10) has a sloping wedge surface (13). Projecting from the wedge surface (13) is an engagement surface (12) with which the attachment pin P2 can engage but not apply any substantial driving force to the wedge locking element (10) in the event of failure of a force maintaining the wedge locking element (10) in a position where the pin P2 is retained with the coupler A. The pin engagement surface (12) lies in a plane that is substantially in line with the direction in which the locking element (10) is, in use, moved by the driving force.

Title of the Invention

A Locking Device for a Quick Coupler

Background to the Invention

This invention relates to a locking device for a quick coupler.

Quick couplers for mounting an attachment, e.g. a bucket, to an earth working machine, such as an excavator, are known. A potential danger with a quick coupler is that the coupler can fail to hold the attachment at one or both of the mounting points at which the attachment is mounted to the quick coupler. As a result the attachment can either fall off the coupler (if the coupling at each of the mounting points fails) or swing down from the coupler (i.e. swing about one of the mounting points). The mounting points on the attachment are typically formed by so called pins and these fit into recesses of docking points of the quick coupler and then locked therein.

When the coupler is mounted to the earth working machine such as an excavator, the end that is closest to the operator is referred to herein as the "front end". As a consequence the pin of the attachment that fits into the recess/docking point at the front end is referred to herein as the "front pin". Likewise the other end of the coupler is referred to as the "rear end" and the pin of the attachment that fits therein is referred to as the "rear pin".

The failure to correctly hold the attachment in place can be due to a variety of reasons. For example, if the quick coupler is of a type where the rear pin is retained by a sliding wedge component which is hydraulically operated an hydraulic failure can result in the quick coupler failing to retain the attachment in a working position. This will typically result from the rear pin applying a loading on the sloping leading surface of the wedge component which will drive the wedge "backward" to a position where the pin is no longer locked in the quick coupler. Consequently the attachment will swing down from the coupler about the axis of the front pin.

If the front pin is not retained by a locking device the attachment can fall completely from the coupler. In our New Zealand patent specification No. 552294 there is disclosed a safety locking device that retains the front pin in the coupler in the event of a failure which results in the release of the rear pin. As a result the attachment will only swing down from the coupler about the axis of the front pin.

Summary of the Invention

An object of the present invention is thus to provide a wedge locking element for a locking device of a quick coupler, the wedge locking element being such that it at least reduces the tendency of a pin retained by the wedge driving the wedge (in the event of hydraulic failure) to a position where the pin will no longer be retained by the coupler or to at least provide the public with a useful choice.

The inventive concept which achieves this object broadly resides in the leading end of the wedge having an orientation relative to a pin with which the wedge will engage in a locking relationship being such that the possibility of the pin applying a loading on the wedge to drive the wedge to a release position is at least reduced.

Broadly according to one aspect of the invention there is provided a wedge locking element for a locking device of a quick coupler for coupling the pin of an attachment to earth working machinery, the wedge locking element including a sloping wedge surface, characterised in that projecting from the wedge surface is an engagement surface with which the attachment pin can engage but not apply any substantial driving force to the wedge locking element in the event of failure of a force maintaining the wedge locking element in a position whereby the pin is wedge coupled by the wedge surface to the coupler.

Broadly in a second aspect of the invention the locking device further includes a clamp device operable to retain the pin with the pin engagement surface in the event of said failure of the driving force.

In a preferred form of the invention the pin engagement surface is located at and forms the distal leading part of the wedge.

In a preferred form of the invention the pin engagement surface is substantially planar.

In a preferred form the pin engagement surface lies in a plane that is substantially in line with the direction in which the locking element is, in use, moved by the driving force.

In a preferred form the driving force is hydraulic.

Preferably the wedge locking element is adapted to couple to an hydraulic linear actuator, and more preferably the wedge locking element forms part of the hydraulic actuator.

In a preferred form of the invention the clamp device is mounted to the wedge locking element.

Preferably in one form of the invention the clamp device includes an arm mounted to be pivotable about a pivot axis, the arm incorporating a pin engagement portion distal from the pivot axis.

In the preferred form of the invention the arm is biased by biasing means. In a preferred form of the invention the biasing means is a spring.

According to a third broad aspect of the invention there is provided a quick coupler for coupling the pin of an attachment to earth working machinery, the coupler including a the combination of the wedge locking element and a clamp device as stated in the above second broad aspect of the invention.

Preferably the wedge locking element is slidably retained in the quick coupler and the clamp device is mounted for movement with the wedge locking element.

Brief Description of the Drawings

In the following more detailed description of one embodiment of the invention and its application to a quick coupler reference will be made to the drawings which form part of this specification and in which:-

Fig. 1 is a sectioned side elevation view of a prior art hydraulic quick coupler with a wedge form of pin engagement means, the drawing showing the front and rear pins of an attachment engaged in the front and rear recesses of the coupler,

Fig. 2 is a further side elevation view similar to Fig. 1 of the prior art coupler but showing the coupler in a "failed mode" in which the rear pin is able to move out of the rear recess,

Fig. 3 is a sectioned side elevation view of a coupler with which front and rear pins of an attachment are engaged and in which the leading part of the movable element (for locking the rear pin in the rear recess) has a profile according to the present invention, the movable element being shown in the fully retracted position,

Figs. 4 to 8 are a succession of sectioned side elevation views of the coupler shown in Fig. 3 showing the rear pin in the rear recess and the progression of the movable element moving into the rear recess until it reaches a fully engaged position where the rear pin is retained in the rear recess by the movable element (Fig. 8),

Fig. 9 is a view similar to Fig. 8 but showing the coupler in a failed mode where the movable element has moved into a partially retracted position yet with the rear pin retained in engagement with the movable element by the clamp arm according to the present invention,

Fig. 10 is a view similar to Fig. 9 but showing the coupler in a failed mode where the movable element has moved into a partially retracted position yet with the rear pin retained not in engagement with the movable element yet still prevented by the clamp arm from moving from the recess,

Fig. 11 is a view similar to Figs. 9 and 10 showing the coupler in a failed mode where the movable element has moved into a partially retracted position yet with the rear pin prevented from moving out of the rear recess by the clamp arm and the front pin prevented from moving from the front recess by the front recess retaining element,

Fig. 12 is an isometric view of an example of the movable element according to the invention with a mount on which the clamp arm is located,

Fig. 13 is a further isometric view of the movable element as shown in Fig. 12 but with the clamp arm coupled to the mount,

Fig. 14 is a further isometric view of the movable element as shown in of Fig. 13,

Fig. 15 is an isometric view of the movable element as shown in Figs. 14 and 15 coupled to an hydraulic cylinder,

Fig. 16 is a graphical illustration of two different diameter pins retained with the wedge by the clamp arm mechanism, and

Fig. 17 is a view similar to Fig. 16 illustrating where the smaller sized rear pin would sit if it were not for the shaped end of the clamp arm.

Description of Preferred Embodiments of the Invention

The aspects of the present invention will be described herein in relation to one form of quick coupler but it will be appreciated by the skilled addressee that other forms of quick coupler can be used.

The quick coupler as shown in Figures 1 and 2 of the drawings is a known form of quick coupler A made by our company. The quick coupler A is operated hydraulically by the hydraulics of the machine (usually an earth working machine) to which the coupler is

attached. The body B of the coupler has mounting points C whereby the coupler can be attached to say the arm of an excavator (not shown).

The coupler body B has a hook shaped front recess D into which the front mounting pin P1 of an attachment engages. As mentioned above the hook shaped recess end of the quick coupler is typically referred to as the "front" of the coupler as this is the end of the coupler that will face toward the operator of the machine (e.g. excavator).

The rear mounting pin P2 of the attachment locates in the rear recess E.

The movable locking element F, which in this form of coupler is a wedge component, (hereinafter for simplicity "wedge F") is extendible to capture the rear mounting pin P2 of the attachment in the rear recess E. The wedge F is hydraulically powered.

Thus typically the excavator operator will position recess D of the coupler onto the front pin P1 of the attachment and then crowd the coupler such that the rear pin P2 engages in the recess E. The wedge F is then extended to engage with and lock the rear pin P2 in the rear recess E. The pins P1 and P2 engaged by the coupler A are shown in Fig. 1. The attachment is thereby coupled to the coupler A in the working position.

If, for example, the hydraulic power to the coupler A fails the hydraulic cylinder G that moves and holds the wedge F in its locking position will not be able to hold the wedge in the locking position. As a result the wedge F can retract which will enable release of the mounting pin P2 from the recess E to occur (see Fig. 2).

If the front pin P1 in the hook shaped recess or docking part D is not retained in the front recess the attachment can fall from the coupler and hence fall from the excavator arm. However, if the front pin P1 is retained (by say our I-Lock device L as described and claimed in our New Zealand patent specification 552294/546893) then the attachment will not fall completely off the coupler A but will swing down on the pin P1.

In the form of coupler A shown in the drawings the wedge F is part of an operating means formed by hydraulic cylinder G which applies a driving force to control the extension and retraction of the wedge F via the piston rod R of the cylinder G. This is only one example of the form that the cylinder G and wedge F arrangement may take.

As shown in Figs. 1 and 2 the leading or distal end of the wedge F includes an inclined or sloping surface M. In the event of compound hydraulic failure working forces will cause the pin P2 to drive the wedge F backward (as indicated by arrow Y in Fig. 1). This is due to the sloped face M (and the applied normal forces indicated by the arrow X in Fig. 1). Consequently, the rear pin P2 moves down the wedge face M to a point where it

is no longer retained in the rear recess by the wedge F (Fig. 2) and the attachment will be free to swing about the front pin P1 as described above.

For a given attachment the distance between pins P1 and P2 is rigidly fixed, as is the diameter of the pins. In the embodiment shown and described herein the quick coupler caters to attachments which have pin diameters and pin centres which fall within the range provided by the rear recess E, relative to the front recess D. The wedge locking element of the invention thus suits multiple attachment pin centres, but could equally be applied to a single pin centre design.

According to the present invention we have devised a wedge 10 (an example of which is shown in Figs. 12 to 15) that includes at the leading end a projecting part 11 that provides a substantially flat (planar) pin engagement surface 12. This flat surface 12 extends beyond the lower extremity of the sloping wedge surface 13. The angle between the sloping surface 13 and the flat surface 12 is obtuse.

The configuration of the example of wedge shown in Figs. 12 to 15 is one which is specific to the type of coupler shown in Figs. 1 and 2. It will be appreciated by those skilled in the art that a flat projecting pin engagement surface 12 at the leading end of the wedge (as provided by the present invention) could be incorporated with other types and configurations of wedges having a sloping pin engagement surface.

The surface of the pin engagement surface 12 is substantially normal to the direction of forces (indicated by arrow "X") that will be applied by the pin P2 to the wedge 10 in a failed state of the coupler. Thus when the pin P2 reaches the end of the sloped wedge section 13 it is no longer possible to apply a loading on the wedge 10 in the same manner as is applied when the pin P2 is engaged with the sloped face 13. In other words there will be no load which would drive the wedge backward in the direction of arrow "Y".

It will be appreciated that the plane in which pin engagement surface 12 lies is substantially in line with the direction in which the wedge locking element moves back and forth.

Once the rear pin P2 reaches the pin engagement surface 12 of the wedge 10, it may still be possible to apply load to the wedge 10 due to friction between the pin P2 and the pin engagement surface 12. This frictional contact can cause the wedge 10 to move backward (in direction Y) in small cyclic amounts to the point where the pin P2 can pass the extreme edge 21 of the wedge. Thus pin P2 will be able to move away from the recess to be free of the coupler such that the attachment will release from the coupler allowing the attachment to swing on pin P1.

Addition of a means of substantially retaining the relationship between the rear pin P2 and the wedge 10 is thus advantageous and the drawings illustrate such a means in the form of a clamp device 14. The presence of the clamp device 14 will ensure that after the wedge 10 has moved back by the above mentioned amount it is then pulled back again as the pin P2 moves in a direction opposite to direction Y. This clamp device 14 will thus prevent the pin P2 from passing beyond the distal end 21 of the pin engagement surface 12 of the wedge 10 and become disengaged with the coupler.

According to the present invention the clamp device 14 does not require additional hydraulic actuators to operate the clamp device. This not only reduces costs but improves reliability.

The clamp device 14 is coupled to the wedge 10 via a suitable mount 15 so as to be moveable with the wedge 10. The coupling of the clamp 14 to the wedge 10 thereby ensures that the clamp 14 may retain the appropriate relationship with the pin P2 in any wedging position of the wedge 10 with pin P2.

In the illustrated form of the clamp 14 the clamp includes a solid clamp arm 16. In the illustrated and preferred form the clamp arm 16 is substantially in the shape of an arc and is pivotally coupled at one end at 17 to the mount 15.

The clamp arm 16 is biased, preferably sprung biased, and thus in one form the clamp arm 16 is biased by a compression spring 18 (as shown) or other biasing means such as a torsional spring. As illustrated the spring 18 is engaged with the clamp arm 16 at a point spaced from but adjacent to the axis of pivot 17. The other end of the spring 18 is coupled to a cross piece 19 of the mount 15.

The mount 15 is, as described above, carried by the wedge 10. In the illustrated form the mount 15 is located in a suitably shaped recess 15a provided in the wedge 10.

The clamp arm 16 is of a design and configuration such that the pin P2 can force the clamp arm 16 to move against the bias effect of spring 18 during movement of the pin P2 into the recess E. This provides the necessary clearance to enable the pin P2 to move into the recess.

Thus, for example, the leading and pin contacting portion 20 of the clamp arm 16 is suitably profiled so that it smoothly and positively engages with and rides over the pin P2 during both the engagement of the pin P2 into recess E (when the coupler A is engaging with the attachment) and disengagement from the coupler (when the attachment is being released from the coupler A).

Figure 3 of the drawings shows the profiled end 20 of the clamp arm 16 approaching the pin P2 as the wedge 10 starts to extend under the action of the cylinder G while Fig. 4 shows end 20 of the clamp arm 16 having come into contact with the pin P2 as the wedge 10 continues to extend. Further advancement of the wedge 10 causes the end 20 of the clamp arm 16 to ride over the pin P2 (see Figs 5 and 6).

As the wedge 10 continues to advance (Fig. 7) the spring bias on clamp arm 16 causes the end 20 to ride down over the opposite side of the pin P2. Ultimately, with the wedge 10 extended as far as it can go because of the rear pin P2 being fully engaged between the wedge 10 and the opposing surface of the recess E the clamp arm 16 will lie over the pin P2 and in contact with the pin (Fig. 8).

The force available from the hydraulic cylinder G is very large in comparison to the clamp force of the clamp arm 16 provided by the biasing means (e.g. spring 18). Hence the movement of the wedge 10 will result in the clamp arm 16 easily moving against the bias of the spring 18 when engaging and disengaging with the pin P2 during normal function. Thus no additional hydraulic actuators are required to drive or operate the clamp device 14.

Fig. 8 of the drawings shows the coupler A in the engaged position with pins P1 and P2 and hence the attachment locked onto the coupler. In this position the pin P2 is in the rear recess E and the wedge 10 is extended by cylinder G so that the pin P2 is held between the wedge 10 (in this case sloping surface 13) and the surface of the recess E.

In the case of a larger diameter pin P2 (see Fig. 16) the drawing appears to show pin P2 engaged on both the sloping surface 13 and the pin engagement surface 12 but in reality there is actually a small clearance. Because of this clearance there is substantially no contact between the pin engagement surface 12 and surface of the recess E at the same time thereby avoiding wear which would occur at every engagement/disengagement.

However, if the wedge 10 retracts (e.g. due to absence of hydraulic pressure) to the point that the pin P2 could become disengaged (see Fig. 9 or 10) the presence of the clamp arm 16 substantially retains the relationship between the pin P2 and wedge 10 thereby resulting in the pin P2 automatically being retained in engagement with the wedge 10. Consequently in a failed mode of the coupler the rear pin P2 will be retained against movement out of the rear recess E.

The retention of the attachment pins P1 and P2 relies on the front pin P1 being retained by a retention means such as our I-Lock safety locking device mentioned previously. In other words the front pin P1 can only move between its normal position and the locking feature (i.e. the I-Lock) as illustrated in Fig. 11. As a result due to the fixed distance

between the front and rear pins P1 and P2 of any one attachment the rear pin P2 may only move by the same amount as the front pin P1.

The skilled addressee will appreciate from the foregoing and the drawings that the coupler and in particular the rear end locking mechanism is able to work with pins of different diameters. Fig.16 of the drawings provides an illustration of two different pin diameters e.g. small and large diameter pins. Fig 17 of the drawings illustrates where the smaller pin P2 would sit if not for the shaped end 20 of the clamp arm 16.

To this end the shape and configuration of the inside surface of the distal end of the clamp arm 16 is, preferably, shaped so that it will retain the smaller diameter pin as far as possible from the distal end 21 of the flat section 12. This is shown graphically in Figs. 16 and 17 where the large and small diameters of pin P2 are shown and the smaller diameter pin is shown to be retained closer to the distal edge 21. The smaller pin P2 thus must move further, which in-turn causes the load applied by the clamp device 14 to be higher (i.e. more spring compression).

In the foregoing description the arm 16 is referred to as a clamp arm 16. However, the form and function of the arm 16 is, as will be appreciated by the skilled addressee, such that the arm 16 can be described as a "safety" arm.

The invention is open to modification. For example, the sprung clamp arm 16 can be formed by a spring member.

The present invention has been described and illustrated by way of a specific embodiment, and the embodiment has been described in detail in relation to a known type of quick coupler. It is not the intention of the Applicant to restrict or in any way limit the scope of the invention to such detail.

Additional advantages and modifications will be readily apparent to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative means of manufacture and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of the Applicant's general inventive concept.

CLAIMS:-

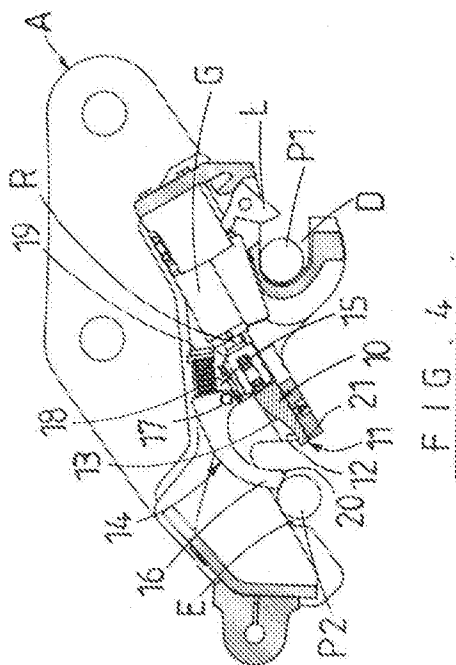
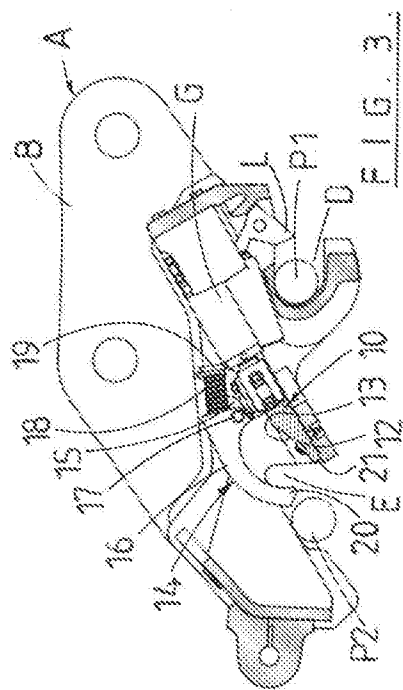
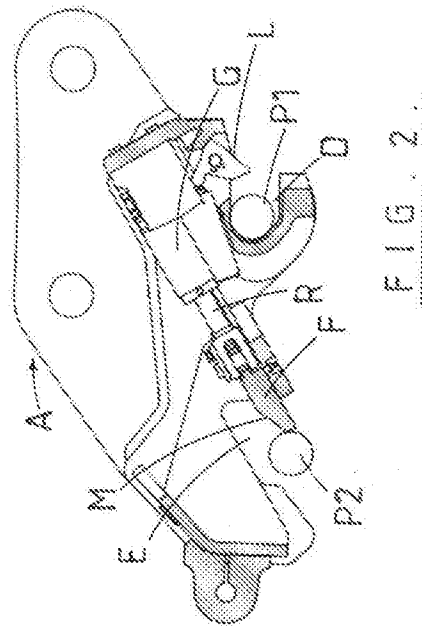
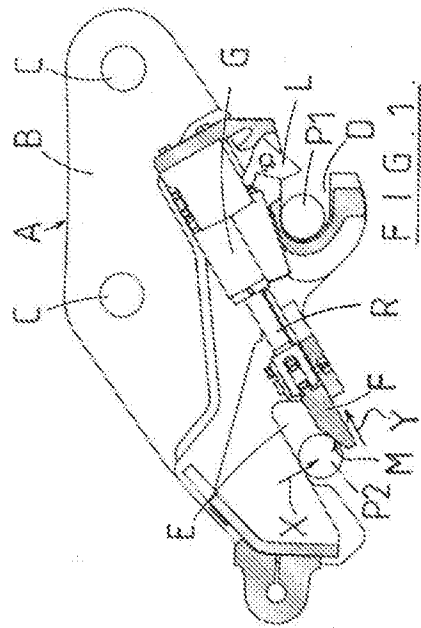
1. A wedge locking element for a locking device of a quick coupler for coupling the pin of an attachment to earth working machinery, the wedge locking element including a sloping wedge surface, characterised in that projecting from the wedge surface is an engagement surface with which the attachment pin can engage but not apply any substantial driving force to the wedge locking element in the event of failure of a force maintaining the wedge locking element in a position whereby the pin is wedge coupled by the wedge surface to the coupler.
2. A wedge locking element as claimed in claim 1 wherein the pin engagement surface is located at and forms the distal leading part of the wedge.
3. A wedge locking element as claimed in claim 1 or 2 wherein the pin engagement surface is substantially planar.
4. A wedge locking element as claimed in claim 1, 2 or 3 wherein the pin engagement surface lies in a plane that is substantially in line with the direction in which the locking element is, in use, moved by the driving force.
5. A wedge locking element as claimed in any one of the preceding claims wherein the wedge locking element is adapted to couple to an hydraulic linear actuator.
6. A wedge locking element as claimed in claim 5 wherein the wedge locking element forms part of an hydraulic actuator.
7. A quick coupler for coupling the pin of an attachment to earth working machinery, the coupler including a wedge locking element as claimed in any one of the preceding claims and a clamp device operable to retain the pin with the pin engagement surface in the event of said failure of the driving force.
8. A quick coupler as claimed in claim 7 wherein the clamp device is mounted to the wedge locking element.
9. A quick coupler as claimed in claim 7 or 8 wherein the clamp device includes an arm mounted to be pivotable about a pivot axis, the arm incorporating a pin engagement portion distal from the pivot axis.
10. A quick coupler as claimed in claim 7, 8 or 9 wherein the arm is biased by biasing means.
11. A quick coupler as claimed in claim 10 wherein the biasing means is a spring.

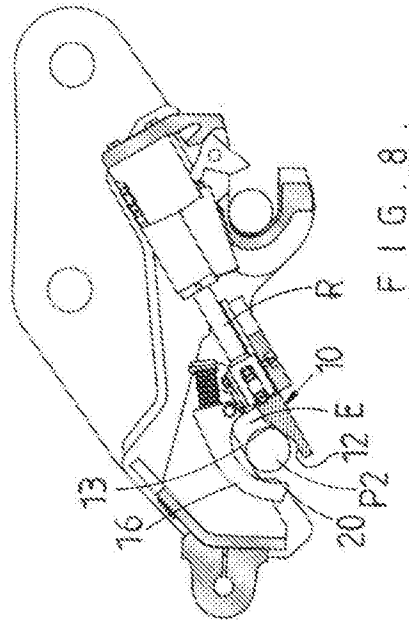
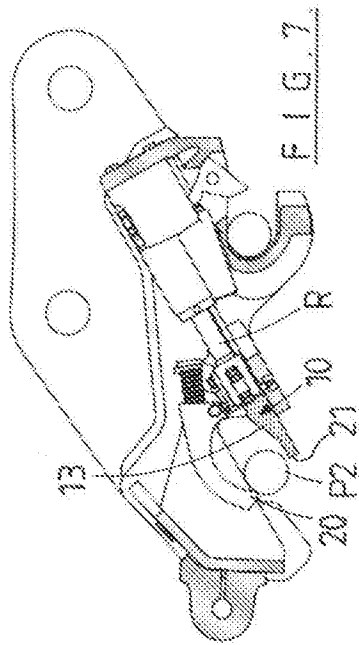
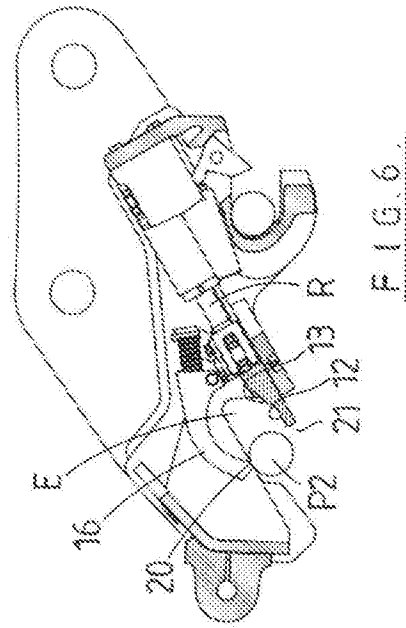
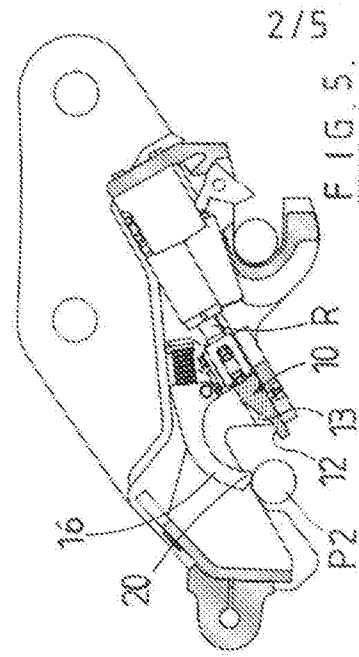
12. A quick coupler as claimed in any one of claims 7 to 11 wherein the wedge locking element is slidably retained in the quick coupler and the clamp device is mounted for movement with the wedge locking element.

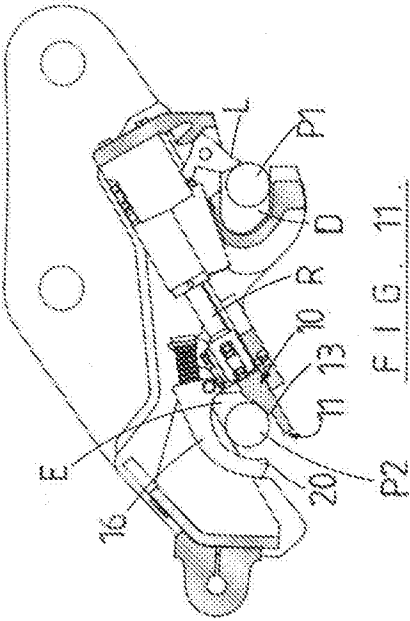
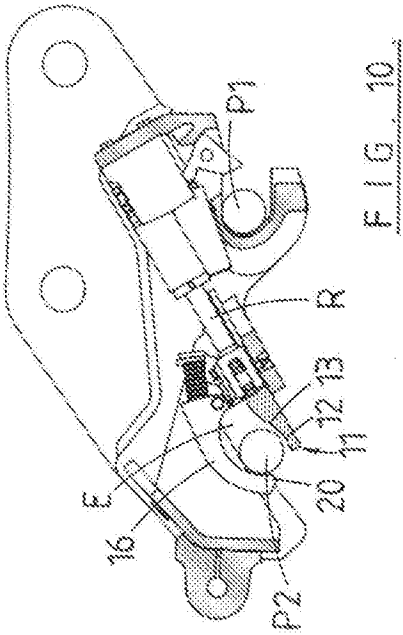
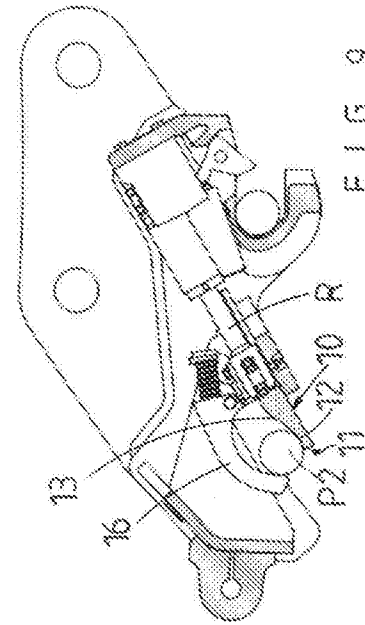
13. A quick coupler as claimed in any one of claims 7 to 12 wherein the driving force is hydraulic.

14. A wedge locking element for a locking device of a quick coupler for coupling the pin of an attachment to earth working machinery substantially as herein described with reference to the accompanying drawings.

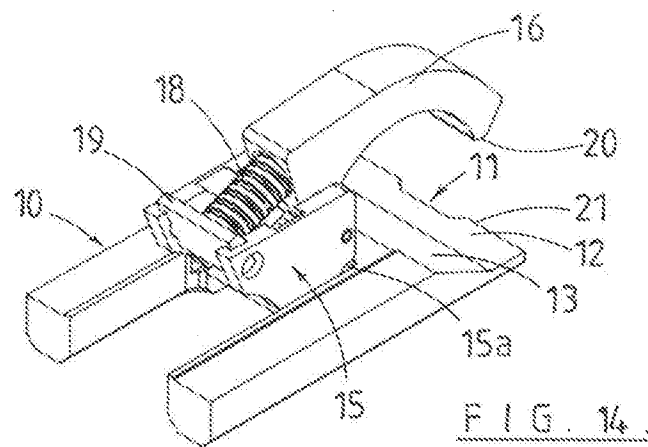
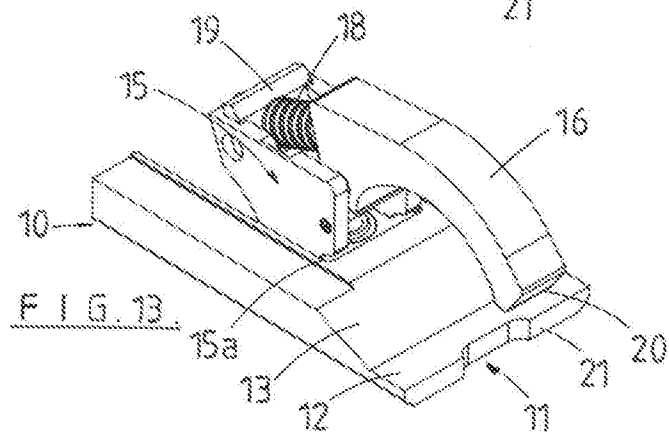
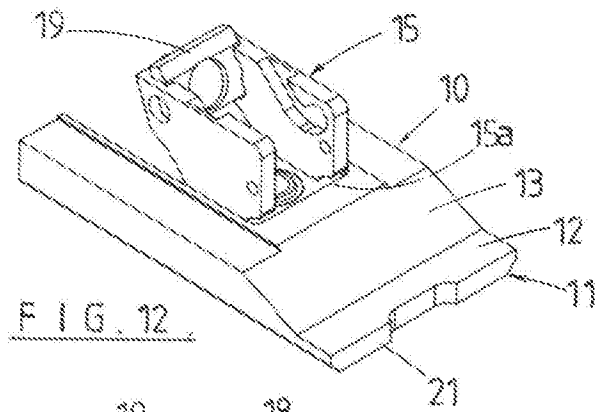
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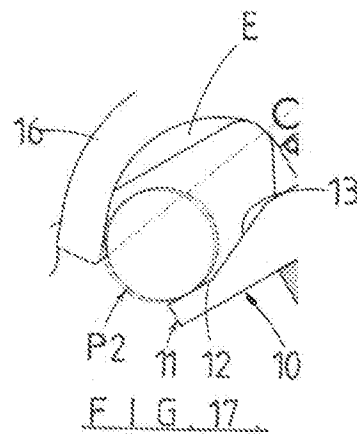
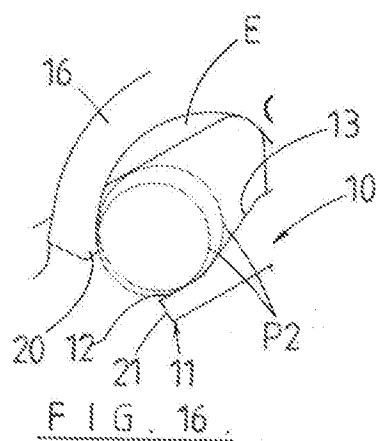
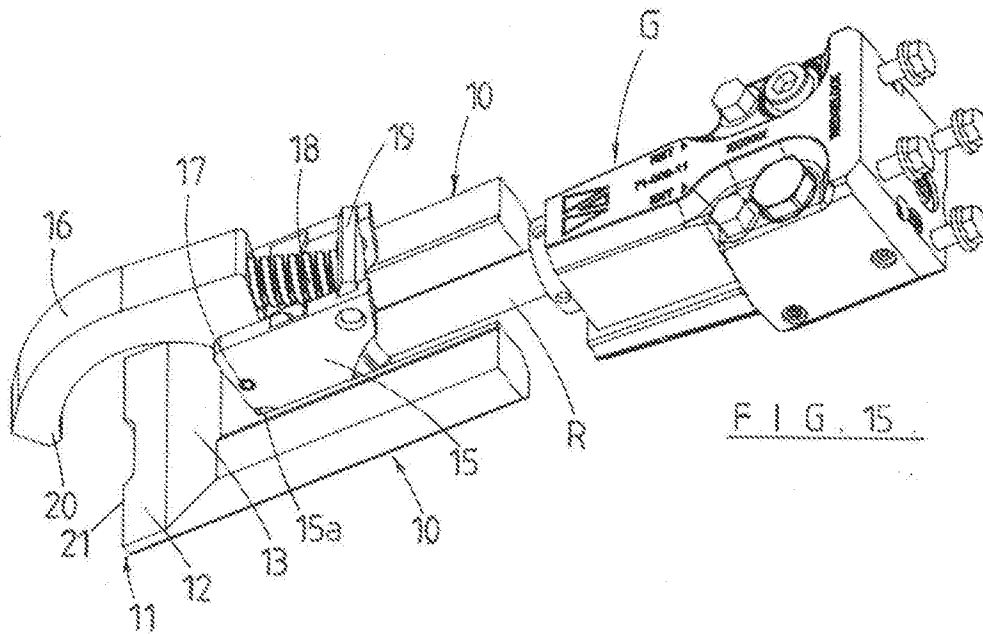




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INTERNATIONAL SEARCH REPORT

 International application No.
PCT/NZ2016/050189

A. CLASSIFICATION OF SUBJECT MATTER

E02F 3/36 (2006.01) E02F 3/96 (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)

Databases & classification marks: WPIAP, EPODOC & public cluster TXTE, IP Australia Internal databases, Espacenet (Worldwide), Google Search & Google Patents; IPC/CPC: E02F3/364, E02F3/365, E02F3/3622, E02F3/3627, E02F3/3645, E02F3/3609, E02F3/36, E02F3/96, B60D1/00, A01B59/00, F16B2/14, F16B45/00.

Keywords: project, protrude, distal, tongue, nose, lip, lead, flat, planar, safety, fail, redundant, catch, hook, wedge, ramp, taper, incline, slope, pitch, coupler, couple, hitch, pin, shaft, force, lock, latch, secure & similar terms; also wedgelock, JB coupler, coupler, quick hitch, pin, wedge, hydraulic, failure, safety, ride up, excavator & similar terms.

Applicant/Inventor: Wedgelock Equipment; Anderson, Andre; Calvert, David; Calvert, Matthew; Rider, Andrew; Rider, Michael

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

* "A"	Special categories of cited documents: 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
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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 20 February 2017	Date of mailing of the international search report 20 February 2017
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustalia.gov.au	Authorised officer Ernst le Roux AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 02 6283 2497

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including
2. ☒ Claims Nos.: **14**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
See Supplemental Box
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. PCT/NZ2016/050189
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/035883 A1 (HILL) 31 March 2011 Abstract; pages 14, 16 & 20; figs. 1, 2 & 3	1-11 & 13
X	WO 2006/083172 A1 (GJERSTAD MEK. INDUSTRI AS) 10 August 2006 Abstract; pages 1, 4, 5; fig. 2	1-11 & 13
X	EP 1445385 B1 (CANGINI BENNE S.R.L.) 22 November 2006 Title; paragraphs 0009, 0017, 0023 & 0024; figs. 1, 5 & 6	1-4, 7-11 & 13
A	WO 2009/110808 A1 (WEDGELOCK EQUIPMENT LIMITED) 11 September 2009 Pages 6, 7, 9; figs. 6 - 8	7-11, 13
P,X	WO 2016/153360 A1 (WEDGELOCK EQUIPMENT LIMITED) 29 September 2016 Abstract; page 6; figs 19-23	1-6

Supplemental Box**Continuation of Box II**

The claim does not comply with Rule 6.2(a) because it relies on references to the description and/or drawings.

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/NZ2016/050189	
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 2011/035883 A1	31 March 2011	WO 2011035883 A1	31 Mar 2011
		AU 2010297579 A1	10 May 2012
		AU 2010297579 B2	08 Sep 2016
		CN 102667005 A	12 Sep 2012
		CN 102667005 B	07 Oct 2015
		EP 2470724 A1	04 Jul 2012
		EP 2470724 B1	26 Mar 2014
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		NZ 599352 A	20 Dec 2013
		US 2011243654 A1	06 Oct 2011
		US 8403590 B2	26 Mar 2013
		US 2012177472 A1	12 Jul 2012
		US 9469965 B2	18 Oct 2016
WO 2006/083172 A1	10 August 2006	WO 2006083172 A1	10 Aug 2006
		EP 1844199 A1	17 Oct 2007
		NO 20063445 A	26 Jul 2006
EP 1445385 B1	22 November 2006	EP 1445385 A1	11 Aug 2004
		EP 1445385 B1	22 Nov 2006
		IT BO20030056 A1	08 Aug 2004
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		AU 2009220315 A1	11 Sep 2009
		AU 2009220315 B2	05 Nov 2015
		CA 2686622 A1	11 Nov 2009
		EP 2262956 A1	22 Dec 2010
		MX 2009011590 A	14 Dec 2009
		US 2010232920 A1	16 Sep 2010
WO 2016/153360 A1	29 September 2016	WO 2016153360 A1	29 Sep 2016
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			