(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 231 946 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.10.2017 Bulletin 2017/42

(51) Int Cl.:
E02F 3/36 *(2006.01)* ***A01B 59/06*** *(2006.01)*
F16L 37/00 *(2006.01)*

(21) Application number: **17161895.2**

(22) Date of filing: **20.03.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **11.04.2016 GB 201606120**

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(54) **AN APPARATUS COMPRISING A COUPLING ARRANGEMENT**

(57) The present disclosure provides an apparatus (9) comprising a coupling arrangement (11), an input device and a control unit. The coupling arrangement (11) comprises an intermediate element (30) and a first quick coupler (31) operable to selectively couple the intermediate element (30) to a machine (10). The intermediate element (30) comprises a second quick coupler (32) operable to selectively couple a tool (15) to the intermediate element (30). The first and second quick couplers (31, 32) are each selectively actuatable to lock the intermediate element (30) to the machine (10) or tool (15) respectively. The control unit is configured to determine whether the intermediate element (30) is coupled to the machine (10) and receive an input signal from the input device. In response to the input signal the control unit restricts the unlocking of the first quick coupler (31) when the intermediate element (30) is coupled to the machine (10).

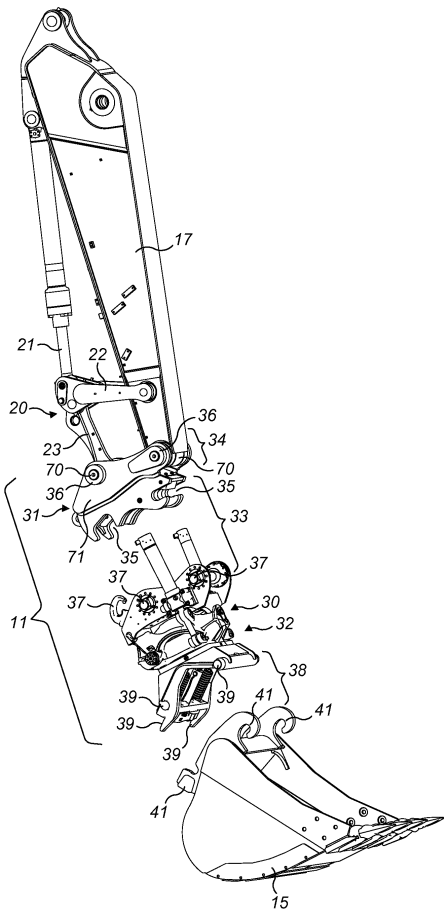

FIG. 2

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Description

Technical Field

[0001] This disclosure is directed towards an apparatus comprising a coupling arrangement and a method of controlling such an apparatus.

Background

[0002] Machines, particularly those in construction, mining, earth moving, goods handling, forestry, agriculture or other such industries, typically utilise a tool controlled by an operator to perform work. A variety of tools may be attached to an arm arrangement of a multipurpose machine via a coupling arrangement for performing different types of work.

[0003] The coupling arrangement may comprise a quick coupler, which allows coupling and decoupling of a tool and machine in a particularly efficient and quick operation. The quick coupler is typically controlled by an operator from a cab of the machine via a control system and associated actuators. The coupling arrangement may further comprise an intermediate element located between the arm arrangement and tool. The element may comprise a tiltrotator, which enables controlled rotation of the work tool about a rotational axis and controlled tilting of the work tool relative to a tilt axis.

[0004] WO2014/168540 discloses a method of controlling a tiltrotator attached by a quick coupler to a tool and attached by pins to an arm arrangement. The quick coupler is unlocked and locked based upon two checking procedures in two separate control units. However, the method only relates to the control of the quick coupler between the tiltrotator and tool.

Summary

[0005] The present disclosure provides an apparatus comprising: a coupling arrangement comprising an intermediate element and a first quick coupler operable to selectively couple the intermediate element to a machine, the intermediate element comprising a second quick coupler operable to selectively couple a tool to the intermediate element, the first and second quick couplers each being selectively actuatable to lock the intermediate element to the machine or tool respectively; an input device; and a control unit configured to determine whether the intermediate element is coupled to the machine, receive an input signal from the input device and, in response to the input signal, restrict the unlocking of the first quick coupler when the intermediate element is coupled to the machine.

[0006] The present disclosure further provides a method of operating an apparatus, the apparatus comprising an input device and a coupling arrangement comprising an intermediate element and a first quick coupler operable to selectively couple the intermediate element to a machine, the intermediate element comprising a second quick coupler operable to selectively couple a tool to the intermediate element, the first and second quick couplers each being selectively actuatable to lock the intermediate element to the machine or tool respectively, the method comprising: receiving an input to the input device; determining at a control unit whether the intermediate element is coupled to the machine; and in response to the input signal, restrict the unlocking of the first quick coupler when the intermediate element is coupled to the machine.

[0007] By way of example only, embodiments of an apparatus are now described with reference to, and as shown in, the accompanying drawings.

Brief Description of the Drawings

[0008]

Figure 1 is a side elevation of an embodiment of an exemplary apparatus of the present disclosure;

Figure 2 is a perspective view of an embodiment of an arm arrangement, coupling arrangement and tool of the apparatus of Figure 1; and

Figure 3 is a flow diagram illustrating an exemplary method of operation of the present disclosure.

Detailed Description

[0009] The present disclosure is generally directed towards the control of a first quick coupler located between an arm arrangement of a machine and an intermediate element and the control of a second quick coupler for coupling the intermediate element and a tool. It is desirable that it is clear, particularly to an operator located in a cab of the machine, whether the first or second quick coupler should be engaged or disengaged during operation. This prevents, for example, an operator disengaging the first quick coupler rather than the second quick coupler. It also prevents the operator from unintentionally releasing the intermediate element and tool simultaneously.

[0010] Figure 1 illustrates an embodiment of an apparatus 9 comprising a machine 10, in this case an excavator, and at least one coupling arrangement 11 for coupling a tool 15 to the machine 10. The machine 10 may be any suitable type of machine, including multipurpose machines, such as excavators, backhoes, loaders, dozers, shovels, fellers, harvesters, material handlers and other such work machines. The machine 10 may comprise a main body 12 having a cab 8 for an operator and a power unit therein, such as an internal combustion engine, for providing power to ground engaging means 13, such as tracks or wheels. The machine 10 may comprise an arm arrangement 14 to which a tool 15 may be connected via the coupling arrangement 11. In the illustrated embodiment the tool 15 comprises a bucket. The tool 15 may be of any other suitable type, such as a fork, ham-

mer, plow, handling arm, multi-processor, pulveriser, saw, shears, blower, grinder, tiller, compactor, trencher, winch, auger, blade, broom, cutter, planer, delimber, felling head, grapple, mulcher, ripper, rake or the like.

[0011] The arm arrangement 14 may comprise a first arm 16, which may be a boom, pivotally attached to the main body 12 and a second arm 17, which may be a stick, pivotally attached to the first arm 16. A first hydraulic actuator 18 may be connected between the first arm 16 and the main body 12 to pivot the first arm 16 relative to the main body 12. A second hydraulic actuator 19 may be connected between the first and second arms 16, 17 to pivot the second arm 17 relative to the first arm.

[0012] The arm arrangement 14 may comprise a linkage arrangement 20 and the coupling arrangement 11 may be pivotally attached to the linkage arrangement 20 and arm arrangement 14, particularly to the second arm 17. A third hydraulic actuator 21 may be connected between the second arm 17 and linkage arrangement 20 to pivot the linkage arrangement 20 and coupling arrangement 11 relative to the second arm 17. The linkage arrangement 20 may comprise at least one first link 22 pivotally attached to the third hydraulic actuator 21 and the second arm 17. The linkage arrangement 20 may comprise at least one second link 23 pivotally attached to the coupling arrangement 11 and pivotally attached to the third hydraulic actuator 21 and at least one first link 22. In a preferred embodiment the machine 10 comprises one second link and two first links 22 mounted on either side of the second arm 17 and second arm 17.

[0013] Figure 2 illustrates an exemplary embodiment of the coupling arrangement 11. The coupling arrangement 11 may comprise an intermediate element 30 located between the arm arrangement 14 and the tool 15. The coupling arrangement 11 may comprise a first quick coupler 31 arranged to selectively couple the machine 10 and the intermediate element 30 together. The coupling arrangement 11, and particularly the intermediate element 30, may further comprise a second quick coupler 32 arranged to selectively couple the intermediate element 30 and the tool 15 together.

[0014] The first quick coupler 31 may comprise at least one first coupling element 35 and the intermediate element 30 may comprise at least one intermediate coupling element 37 corresponding to the at least one first coupling element 35 of the first quick coupler 31. The first quick coupler 31 and intermediate element 30 may be configured to selectively engage the first and intermediate coupling elements 35, 37 so as to couple the first quick couplers 31 to the intermediate element 30. The first and intermediate coupling elements 35, 37 of the first quick couplers 31 and intermediate element 30 may thereby form a first coupling 33.

[0015] The arm arrangement 14 may comprise at least one arm coupling element 70 and the first quick coupler 31 may comprise at least one second coupling element 36 corresponding to the at least one arm coupling element 70. The first quick coupler 31 and/or arm arrangement 14 are configured to selectively engage the at least one second coupling element 36 and at least one arm coupling element 70 so as to couple the first quick coupler 31 with the machine 10 via the arm arrangement 14. In particular, the first quick coupler 31 may selectively engage with the arm arrangement 14 via at least one arm coupling element 70 located on the second arm 17 and via least one arm coupling element 70 located on the at least one second link 23. The at least one second coupling element 36 of the first quick coupler 31 and at least one arm coupling element 70 may thereby form a machine coupling 34.

[0016] The tool 15 may comprise at least one tool coupling element 41 and the second quick coupler 32 of the intermediate element 32 may comprise at least one second coupling element 39 corresponding to the at least one tool coupling element 41. The second quick coupler 32 and/or tool 15 are configured to selectively engage the at least one tool coupling element 41 and at least one second coupling element 39 so as to couple the second quick coupler 32 with the tool 15. The at least one tool coupling element 41 and at least one second coupling element 39 of the second quick coupler 32 may thereby form a second coupling 38.

[0017] The first quick coupler 31 may comprise a body 71 and the first and second coupling elements 35, 36 of the first quick coupler 31 may be located towards or at opposing ends of the body 71. The at least one intermediate coupling element and at least one second coupling element 39 of the second quick coupler 32 may be located towards or at opposing ends of the intermediate element 30.

[0018] The first and second quick couplers 31, 32 may each be actuatable between locked configurations, in which the intermediate element 30 and the machine 10 and/or tool 15 are coupled to one another such that they cannot be separated, and unlocked configurations, in which the intermediate element 30 can be uncoupled from the machine 10 and/or tool 15 such that they can be separated from one another. Therefore, the first quick coupler 31 is operable to selectively lock the intermediate element 30 to the machine 10 via the first coupling 33 and the second quick coupler 32 is operable to selectively lock the tool 15 to the intermediate element 30 via the second coupling 38.

[0019] In particular, the first and second quick couplers 31, 32 may comprise at least one locking actuator for selectively engaging the at least one first and second coupling elements 35, 36, 39 with the at least one intermediate coupling element 37, at least one arm coupling element 70 and at least one tool coupling element 41. For example, the at least one first and second coupling elements 35, 36, 39, at least one intermediate coupling element 37, at least one arm coupling element 70 and at least one tool coupling element 41 may comprise corresponding pin(s) or recess(es) and the at least one locking actuator is configured to for extend or retract a pin from a recess. The pin may be spring biased into the extended

orientation. The pin may be located on the intermediate element 30 and the recess on the machine 10 or tool 15 and vice-versa. The locking actuator may comprise an electric actuator, such as an electronically activated solenoid, and/or a hydraulic actuator, such as a piston and cylinder. The at least one first and second coupling elements 35, 36, 39, at least one intermediate coupling element 37, at least one arm coupling element 70 and at least one tool coupling element 41 may be of any other suitable type known in the art and may, for example, comprise at least one wedge, pin, hook or the like. Some of the at least one first and second coupling elements 35, 36, 39, at least one intermediate coupling element 37, at least one arm coupling element 70 and at least one tool coupling element 41 may be configured to only provide support during coupling and are not actuatable. For example, one or more of the at least one first and second coupling elements 35, 36, 39, at least one intermediate coupling element 37, at least one arm coupling element 70 and at least one tool coupling element 41 may comprise corresponding fixed pin(s) or wedge(s) and support recess(es) or mount(s).

[0020] The intermediate element 30 may be a device and may comprise at least one element actuator for manipulating the orientation and/or functionality of the tool. The intermediate element 30 may comprise a dedicated element control unit mounted thereon or on the machine 10 and arranged to control the at least one element actuator via a hydraulic and/or electric circuit. As illustrated in Figure 2, the intermediate element 30 may comprise a tool orientation device and more particularly may comprise a tiltrotator, which may enable the rotation of the tool 15 about a rotational axis and may enable the tilting of the tool 15 relative to a tilt axis as is known in the art. The tool orientation device may alternatively only enable the rotation of the tool 15 about a rotational axis or the tilting of the tool 15 relative to a tilt axis. The at least one element actuator and/or tool orientation device may be located between the intermediate coupling element 37 and the second coupling elements 39 of the second quick coupler 32.

[0021] The apparatus 9 may comprise a control system for controlling the first and second quick couplers 31, 32 based upon an input received at an input device from an operator. The input device may be located in the cab 8 or on any other suitable part of the machine 10. Preferably the control system is operable to control the first and second quick couplers 31, 32 via a single input device and, more preferably, the single input device is the only means within the cab 8 or on the main body 12 that enables the unlocking and locking of the first and second quick couplers 31, 32. The input device is preferably a binary actuation device such as a two-way switch, push button switch or the like. The input device may be in the form of a monitor or other such interface in which the operator is provided with a single option for providing an input to control the first and second quick couplers 31, 32.

[0022] The control system may comprise at least one electric and/or hydraulic circuit for conveying the input from the input device as a signal to the first and second quick couplers 31, 32. The control system may comprise at least one electric and/or hydraulic connections for connecting the at least one electric and/or hydraulic circuits across the machine 10, intermediate element 30 and tool 15. The at least one hydraulic circuit may comprise at least one pump and at least one valve for controlling the flow of hydraulic fluid between at least one hydraulic fluid reservoir, at least one hydraulic actuator and at least one hydraulic conduit. The at least one locking actuator, at least one element actuator and first, second and third hydraulic actuators 18, 19, 21 may be connected to the at least one hydraulic circuit. The electric circuit may comprise at least one electrically driven actuator controlled by signals from an electronic machine control unit and arranged to control the at least one valve of the hydraulic circuit, thereby controlling the at least one hydraulic actuator.

[0023] The machine control unit may be configured to receive an electric input signal from the input device, interpret the input signal and issue signals to the at least one electric actuator. The machine control unit may also be operable to receive signals and/or data from at least one sensor arranged to sense parameters relating to the first and/or second quick couplers 31, 32, such as whether the at least one first and second coupling elements 35, 36, 39, at least one intermediate coupling element 37, at least one arm coupling element 70 and/or at least one tool coupling element 41 are locked or unlocked and/or whether the intermediate element 30 is coupled to the machine 10. The machine control unit and element control unit may each comprise at least one memory, at least one input, at least one output and at least one processing unit. The memory may store instructions to perform the method disclosed herein and the processing unit may be configured to perform the instructions by controlling the electric circuit via the at least one input and at least one output.

[0024] Figure 3 is a flow chart illustrating an exemplary embodiment of a method of, or routine for, operating the coupling arrangement 11. At step 60, an operator may provide an input to the input device and the control system may receive an input signal from the input device. The input signal may be transferred to the machine control unit.

[0025] At step 61, the machine control unit may determine whether the intermediate element 30 is coupled and/or locked to the arm arrangement 14 by the first quick coupler 31 at the first coupling 33. For example, the machine control unit may receive a signal from a proximity sensor arranged at the end of the first quick coupler 31 to detect and verify that the intermediate element 30 is present in such a way that confirms that the intermediate element 30 is coupled to the machine 10 by the first coupling 33. The machine control unit may also communicate with at least one sensor arranged in the first quick coupler 31 to determine whether the at least one first coupling

element 35 of the first quick coupler 31 is in its locked configuration. Alternatively, the machine control unit may be in communication with the element control unit via the at least one electric connection and determine that the intermediate element 30 is coupled to the arm arrangement 14 by identifying that such communication is possible. The element control unit or machine control unit may control the locking actuator of the first quick coupler 31 and can thereby store a status indicating whether it is locked or unlocked. The machine control unit may then determine whether the element is locked to the machine 10 by retrieving this status.

[0026] The machine control unit may also determine the type of intermediate element 30 attached to first quick coupler 31. In particular, the machine control unit may also be operable to determine whether the intermediate element 30 comprises the at least one second coupling elements 39 of the second quick coupler 32. For example, the machine control unit may receive data from the element control unit verifying that the second quick coupler 32 is present. If it is not present, the machine control unit may exit the routine of Figure 3.

[0027] If it is determined at step 61 that the intermediate element 30 is not coupled and/or locked to the arm arrangement 14 by the first quick coupler 31 then, at step 62, the machine control unit may actuate the first quick coupler 31 to unlock the first coupling 33. In particular, the machine control unit may operate the necessary electric and/or hydraulic actuators to actuate the at least one first coupling element 35 of the first quick coupler 31 between its locked and unlocked configurations. Therefore, to couple the intermediate element 30 to the machine 10 via the first quick coupler 31, the operator may firstly provide an input to the input device to actuate the at least one first coupling element 35 of the first quick coupler 31 into the unlocked configuration. Subsequently the operator may couple the intermediate element 30 to the arm arrangement 14 by moving the at least one first coupling element 35 of the first quick coupler 31, for example by manipulating the arm arrangement 14, into the correct position relative to the at least one intermediate coupling element 37. The operator may subsequently provide another input to the input device to actuate the at least one first coupling element 35 of the first quick coupler 31 into the locked configuration, thereby locking the at least one first coupling element 35 of the first quick coupler 31 to the to the at least one intermediate coupling element 37 of the intermediate element 30. Therefore, the intermediate element 30 is locked to the arm arrangement 14 by the first quick couplers 31.

[0028] If it is determined at step 61 that the intermediate element 30 is coupled to the arm arrangement 14 then, at step 62, the machine control unit may actuate only the second coupling 38 via the at least one second coupling element 39 of the second quick coupler 32. The machine control unit may be programmed such that it is unable to actuate the first quick coupler 31 in response to an input to the input device if the intermediate element 30 is coupled to the arm arrangement 14. In particular, the machine control unit may operate the necessary electric and/or hydraulic actuators to move only the at least one second coupling element 39 of the second quick coupler 32 between locked and unlocked configurations.

[0029] Therefore, to couple and lock the tool 15 to the intermediate element 30 via the second quick coupler 32, the operator may provide an input to the input device to actuate the at least one second coupling element 39 of the second quick coupler 32 into the unlocked configuration. The operator may subsequently couple the intermediate element 30 to the tool 15 by moving the at least one second coupling element 39 of the second quick coupler 32, for example by manipulating the arm arrangement 14, into the correct position relative to the at least one tool coupling element 41. The operator may subsequently provide another input to the input device to actuate the at least one second coupling element 39 of the second quick coupler 32 into the locked configuration, thereby locking the intermediate element 30 to the tool 15 via the second quick coupler 32 and second coupling 38.

[0030] In order to uncouple the tool 15 from the intermediate element 30 the operator may provide an input to the input device, thereby actuating the second coupling 38 into the unlocked configuration by actuating the at least one second coupling element 39 of the second quick coupler 32. As a result, the at least one tool coupling element 41 and at least one second coupling element 39 of the second quick coupler 32 may be disengaged and the operator can separate the tool 15 from the intermediate element 30.

[0031] In order to uncouple the intermediate element 30 from the machine 10, the operator may have to manually unlock the first coupling 33 and/or manually uncouple the intermediate element 30 from the machine 10 by disengaging the at least one first coupling element 35 of the first quick coupler 31. Alternatively, the operator may need to provide a separate input to the machine control unit to override the determination that the intermediate element 30 is coupled to the machine 10 by the first quick coupler 31. For example, the operator may disconnect an electric connection between the element control unit and the machine control unit, such that the machine control unit no longer communicates with the element control unit. The machine control unit may therefore determine (intentionally but incorrectly) that the intermediate element 30 is unlocked from the machine 10. Therefore, in the routine of Figure 3, providing an input to the input device may result in the uncoupling of the intermediate element 30 from the machine 10. Alternatively, a separate override input device may be provided in a separate location to the input device. The separate override input device may be operable to control the locking and unlocking of only the at least one first coupling element 35 of the first quick coupler 31 or to provide an override signal to the machine control unit such that it determines (intentionally but incorrectly) that the intermediate ele-

ment 30 is unlocked from the machine 10.

[0032] In an alternative embodiment the element control unit may be operable to receive the input from the input device and control the first and second quick couplers 31, 32 as in the method described above. In yet a further embodiment a single control unit may comprise the element control unit and machine control unit. The single control unit, element control unit and machine control unit may be located remotely from the machine 10 and intermediate element 30 and configured to interact with the input device and first and second quick couplers 31, 32 wirelessly. Alternatively, the input device may be located on the intermediate element 30 or on a portable device external to the machine 10 and intermediate element 30 and configured to interact with the single control unit, element control unit and/or machine control unit wirelessly.

Industrial Applicability

[0033] In the present disclosure disengagement of the first quick coupler 31 and first coupling 33 may be restricted when an intermediate element 30 is attached to the machine 10. In particular, if an input is received at the input device then only the second coupling 38, via the at least one second coupling element 39 of the second quick coupler 32, may be actuated. As a result, it is not possible for an operator to erroneously disengage the intermediate element 30 and tool 15 simultaneously. In particular, the control unit may be operable to prevent the unlocking of the first quick coupler 31 when the tool 15 is connected to the intermediate element 30 by the second quick coupler 32.

[0034] Furthermore, in the present disclosure a single input device may be operable to control both the first and second quick couplers 31, 32. This ensures that the operator cannot provide an erroneous input relating to which of the first and second couplings 33, 38 and first and second quick couplers 31, 32 they want to engage or disengage.

Claims

1. An apparatus comprising:

a coupling arrangement comprising an intermediate element and a first quick coupler operable to selectively couple the intermediate element to a machine, the intermediate element comprising a second quick coupler operable to selectively couple a tool to the intermediate element, the first and second quick couplers each being selectively actuatable to lock the intermediate element to the machine or tool respectively;
an input device; and
a control unit configured to determine whether the intermediate element is coupled to the machine, receive an input signal from the input device and, in response to the input signal, restrict the unlocking of the first quick coupler when the intermediate element is coupled to the machine.

2. An apparatus as claimed in claim 1 wherein the control unit is configured to determine whether to lock or unlock either the first quick coupler or the second quick coupler by determining whether the intermediate element is coupled to the machine by the first quick coupler.

3. An apparatus as claimed in claim 2 wherein the control unit is a machine control unit and further comprising an element control unit, the machine control unit being configured to determine whether the intermediate element is coupled to the machine by the first quick coupler by communication with the element control unit.

4. An apparatus as claimed in any one of the preceding claims wherein the control unit is configured to cause:

the locking or unlocking of the first quick coupler if the intermediate element is uncoupled from the machine; and
the locking or unlocking of the second quick coupler if the intermediate element is coupled to the machine.

5. An apparatus as claimed in any one of the preceding claims wherein the control unit is configured such that, in response to the input signal, the control unit is prevented from unlocking the first quick coupler if the intermediate element is coupled to the machine.

6. An apparatus as claimed in any one of the preceding claims wherein the first quick coupler comprises at least one first coupling element and at least one second coupling element.

7. An apparatus as claimed in claim 6 wherein the at least one first coupling element of the first quick coupler is configured to selectively engage at least one intermediate coupling element to selectively couple the intermediate element to the first quick coupler.

8. An apparatus as claimed in claim 6 or claim 7 wherein the at least one second coupling element of the first quick coupler is configured to selectively engage with at least one arm coupling element of the machine to selectively couple the first quick coupler to the machine.

9. An apparatus as claimed in any one of claims 6 to 8 wherein the second quick coupler comprises at least one second coupling element, the at least one sec-

ond coupling element of the second quick coupler being configured to selectively engage with at least one tool coupling element of the tool to selectively couple the intermediate element to the tool.

10. An apparatus as claimed in any one of the preceding claims wherein the intermediate element comprises a tool orientation device.

11. A method of operating an apparatus, the apparatus comprising an input device and a coupling arrangement comprising an intermediate element and a first quick coupler operable to selectively couple the intermediate element to a machine, the intermediate element comprising a second quick coupler operable to selectively couple a tool to the intermediate element, the first and second quick couplers each being selectively actuatable to lock the intermediate element to the machine or tool respectively, the method comprising:

receiving an input to the input device;
determining at a control unit whether the intermediate element is coupled to the machine; and
in response to the input signal, restrict the unlocking of the first quick coupler when the intermediate element is coupled to the machine.

12. A method as claimed in claim 11 further comprising, in response to the input, disabling unlocking of the first quick coupler when the intermediate element is coupled by the first quick coupler to the machine.

13. A method as claimed in claim 11 or claim 12 wherein determining whether to lock or unlock the first quick coupler or the second quick coupler is based upon determining whether the intermediate element is coupled to the machine by the first quick coupler.

14. A method as claimed in any one of claims 11 to 13 further comprising, in response to determining that the intermediate element is coupled to the machine:

maintaining the first quick coupler in a locked configuration to keep the intermediate element coupled to the machine; and
locking or unlocking the second quick coupler.

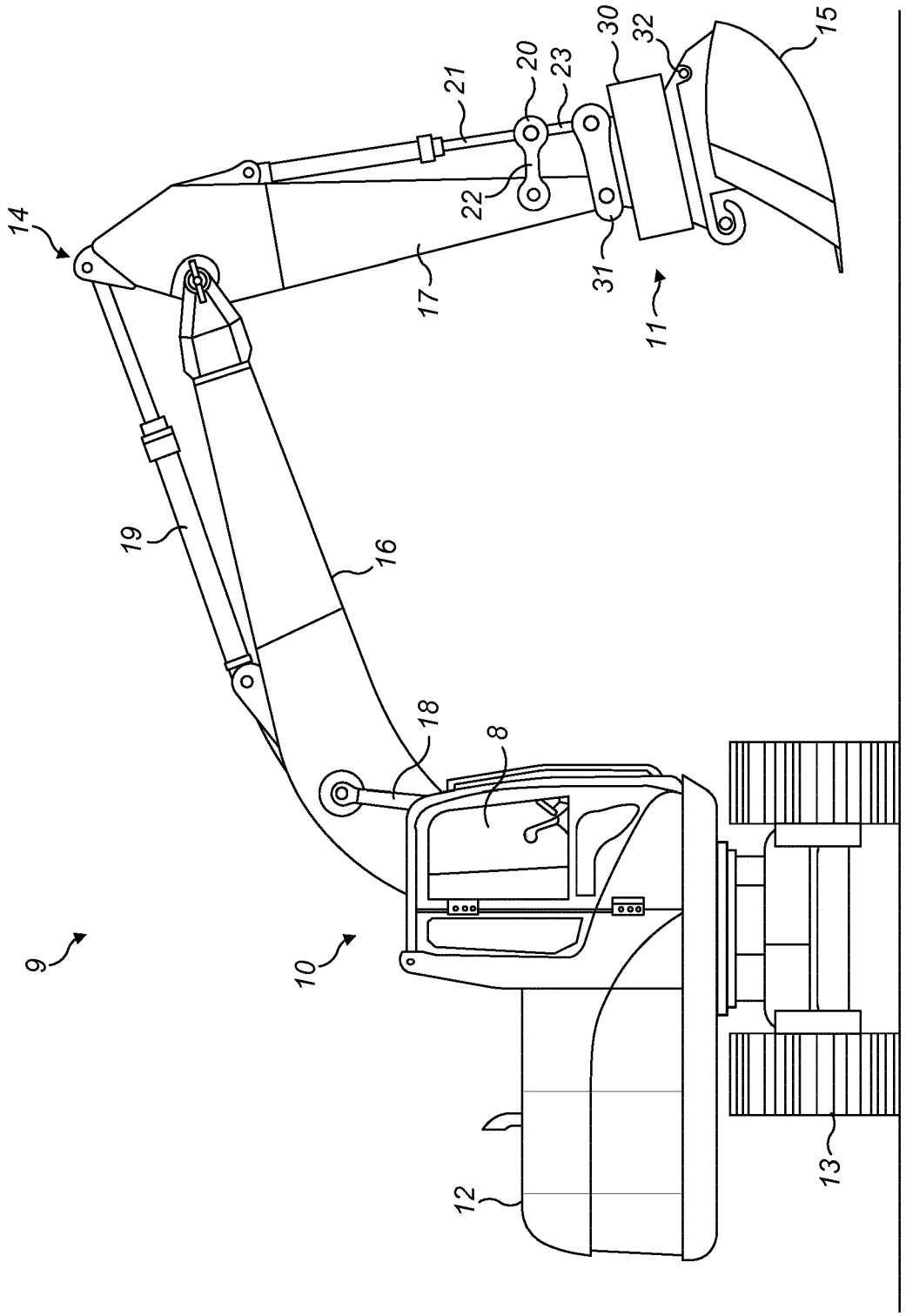

FIG. 1

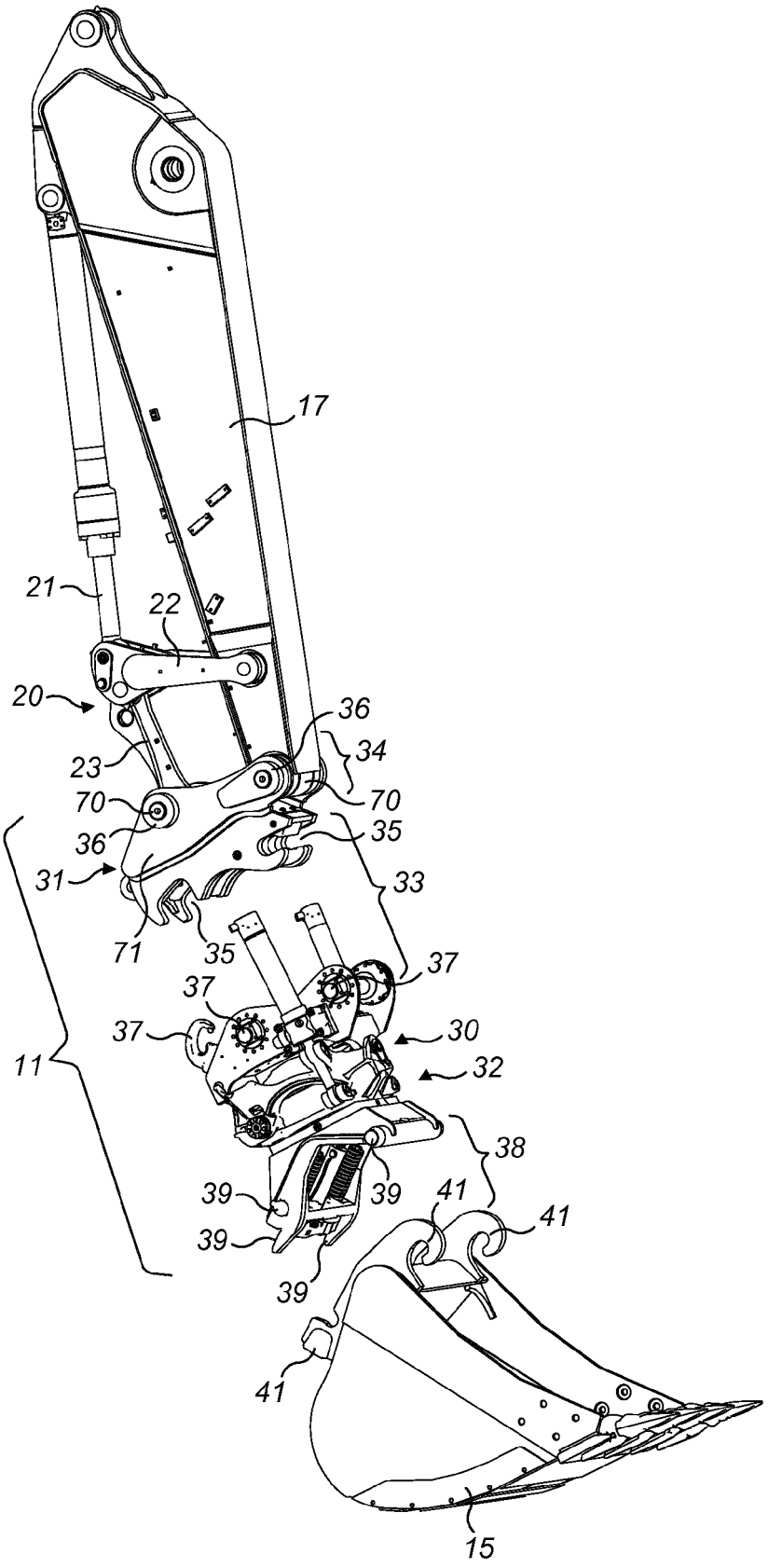
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FIG. 2

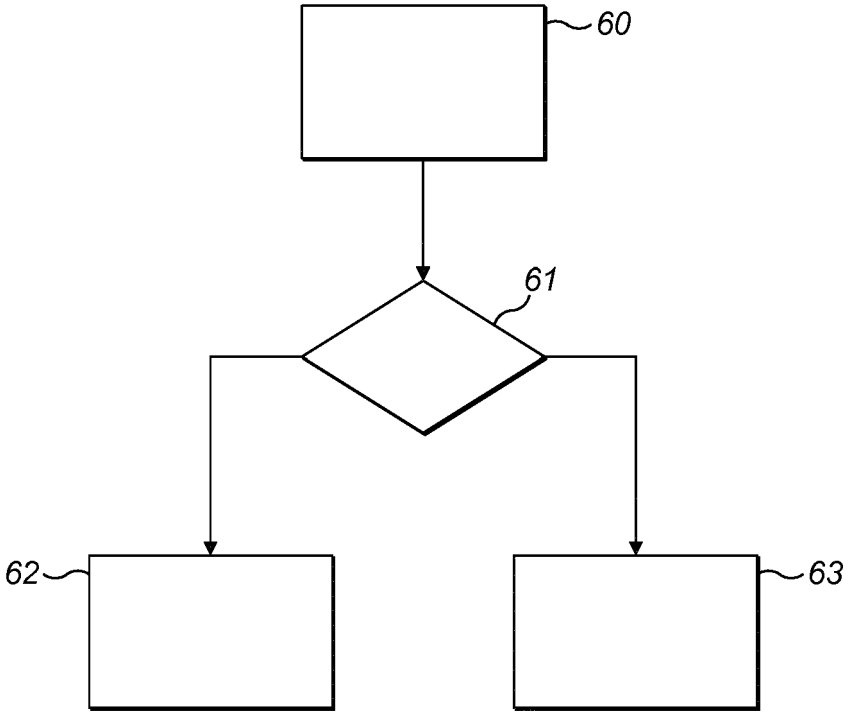

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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