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(54) **DRILLING SYSTEM AND METHOD OF OPERATION FOR SAME**

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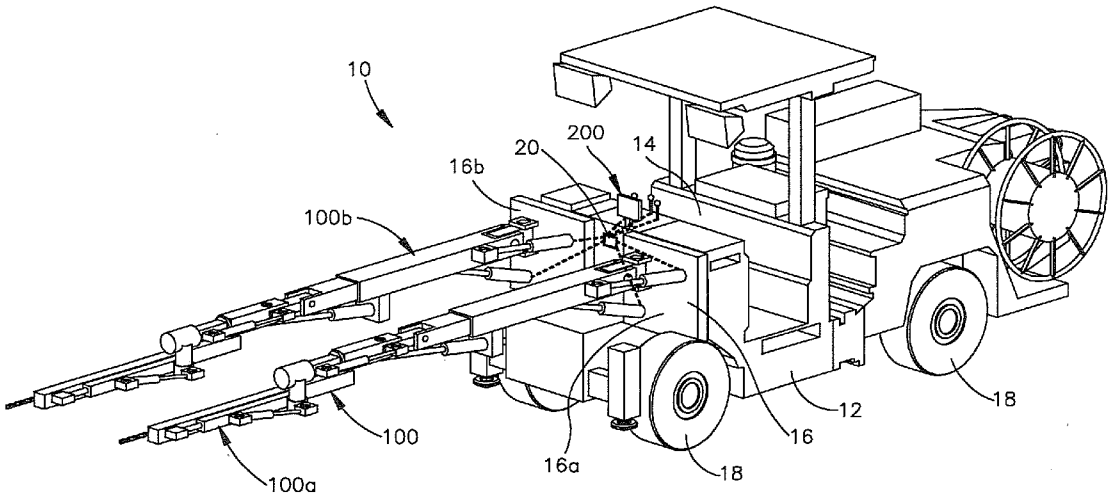
(57) **ABSTRACT**

A drilling system includes a drilling assembly and a control assembly. The control assembly is operably connected to the drilling assembly such that simultaneous movement of multiple portions of the drilling assembly is enabled.



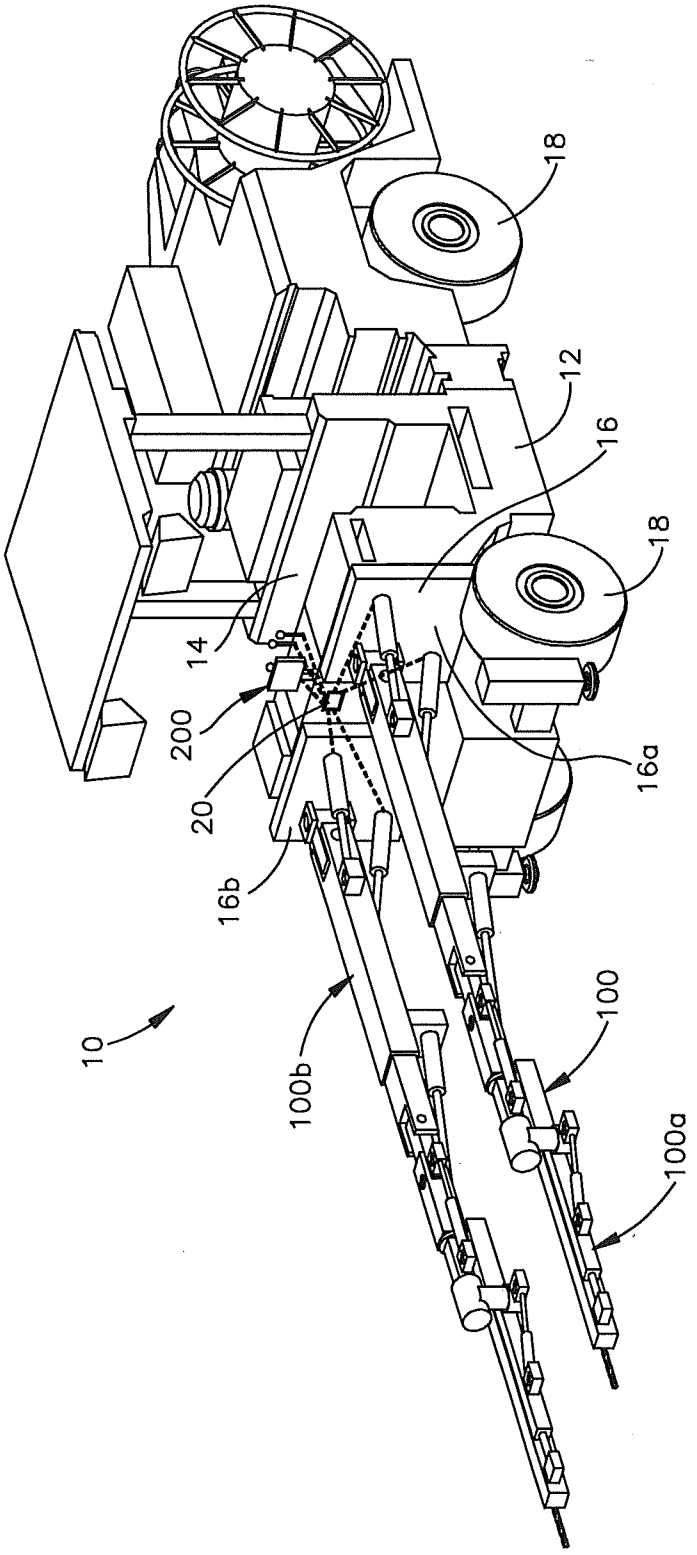


Fig. 1

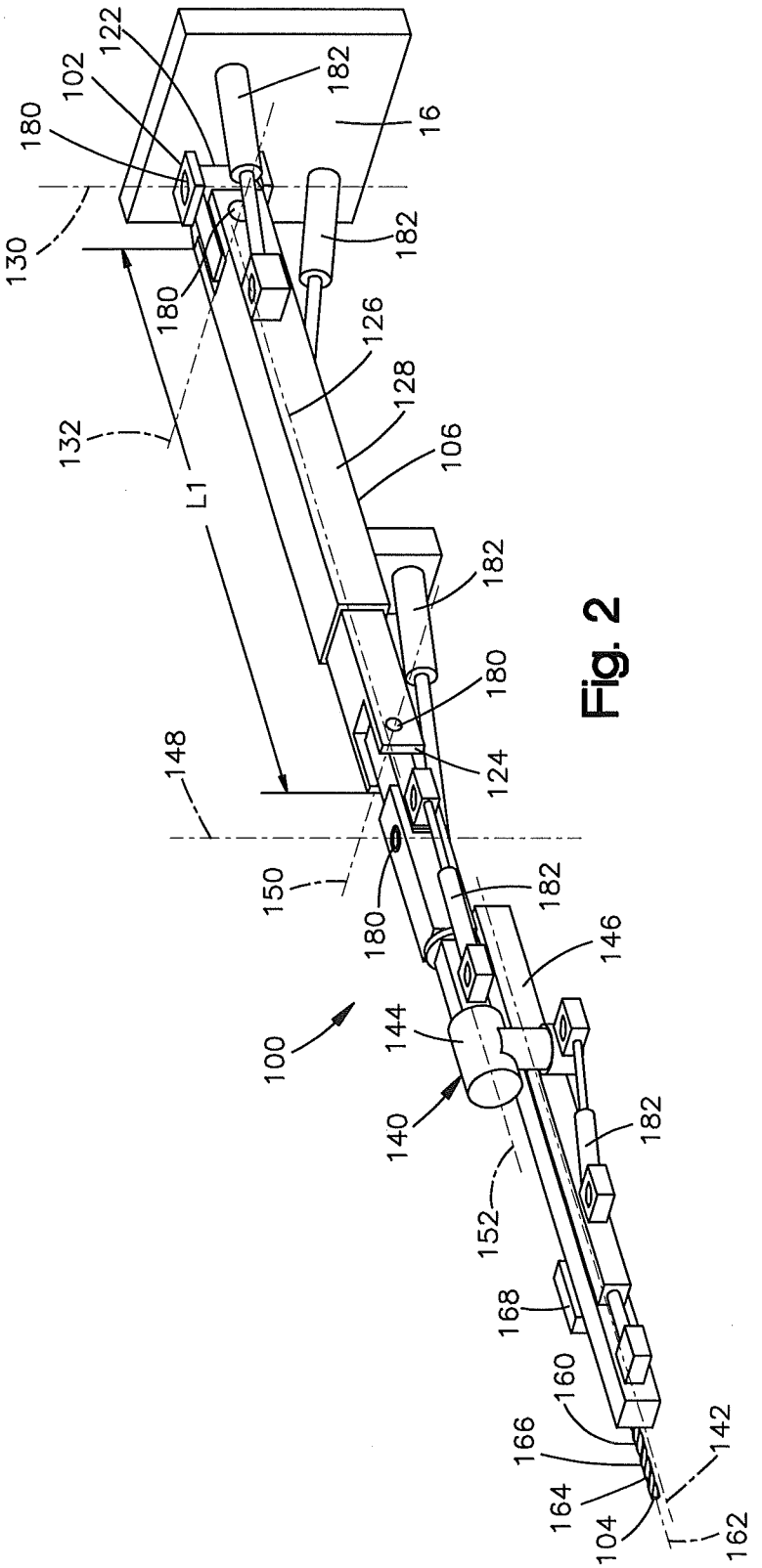

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Fig. 2

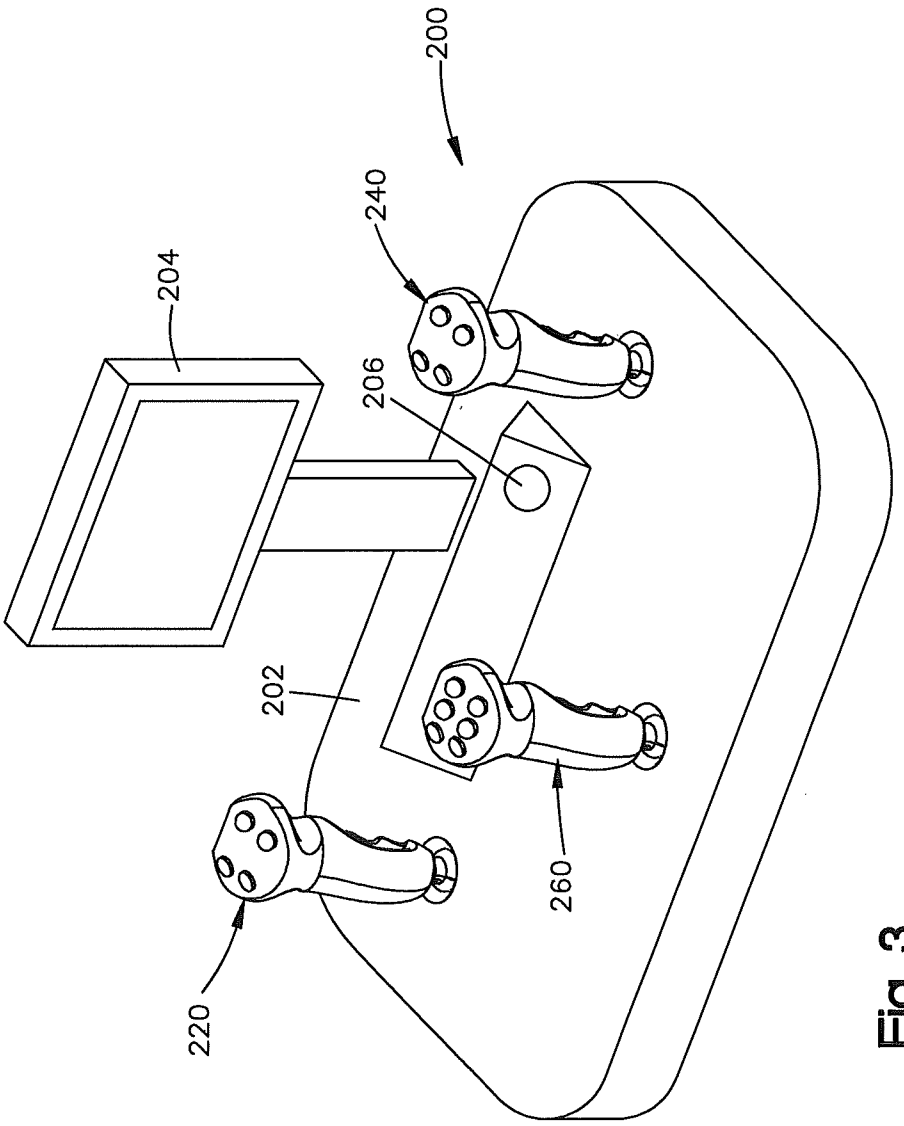

Fig. 3

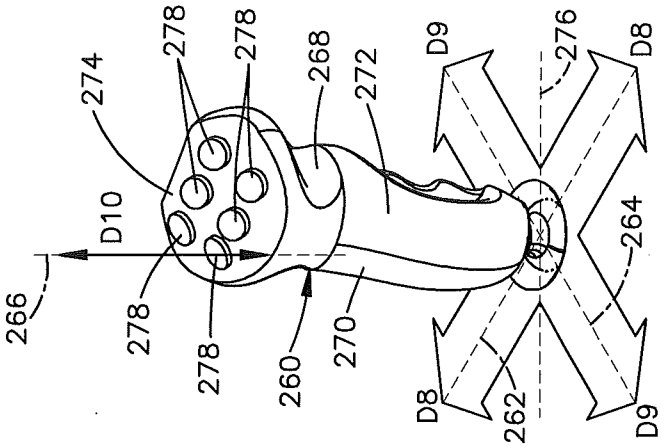

Fig. 6

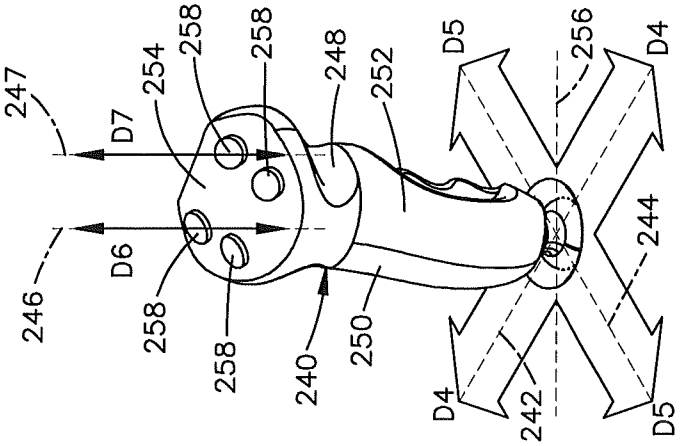

Fig. 5

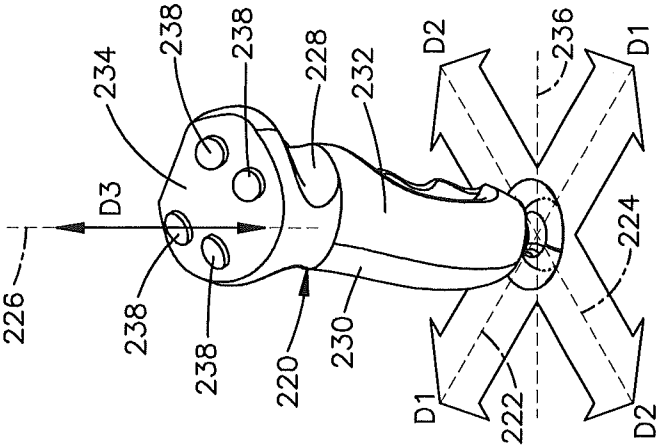

Fig. 4

DRILLING SYSTEM AND METHOD OF OPERATION FOR SAME

TECHNICAL FIELD

[0001] This patent disclosure relates generally to drilling systems and, more particularly, to a control assembly for a drilling system, and methods for operating the same.

BACKGROUND

[0002] Drilling systems with multiple component drilling assemblies are known. Known drilling systems include a control assembly wherein an input received through a control mechanism, for example moving or actuating a joystick in a lateral direction, moves a first component of the drilling assembly, and the same input, moving the joystick in the lateral direction, moves a second component of the drilling assembly when an auxiliary input, for example a button is pushed, on the control mechanism.

[0003] As a result, simultaneous movement of both the first component and the second component is not possible using conventional approaches. A drilling system including a control assembly operably connected to a drilling assembly such that simultaneous movement of multiple components of the drilling assembly is enabled could reduce the amount of time required to move the drilling assembly to a desired position which may result in more efficient use of the drilling system.

[0004] It will be appreciated that this background description has been created to aid the reader, and is not to be taken as an indication that any of the indicated problems were themselves known in the art.

SUMMARY

[0005] According to an aspect of the disclosure, a drilling system comprises a base, a drilling assembly, and a control assembly. The drilling assembly is coupled to the base and the drilling assembly includes a boom and a feed. The boom defines a first boom pivot axis and a second boom pivot axis offset with respect to the first boom pivot axis. The boom includes a boom body coupled to the base such that the boom body is pivotable relative to the base about the first boom pivot axis and the boom body is pivotable relative to the base about the second boom pivot axis. The feed defines a first feed pivot axis and a second feed pivot axis offset with respect to the first feed pivot axis. The feed includes a feed body coupled to the boom such that the feed body is pivotable relative to the boom about the first feed pivot axis and the feed body is pivotable relative to the boom about the second feed pivot axis.

[0006] The control assembly is operably connected to the drilling assembly, and the control assembly includes a first control mechanism and a second control mechanism. The first control mechanism is configured to be actuated in a first direction and a second direction, and the first control mechanism is operably connected to the boom such that actuation of the first control mechanism along the first direction pivots the boom body relative to the base about the first boom pivot axis and actuation of the first control mechanism along the second direction pivots the boom body relative to the base about the second boom pivot axis. The second control mechanism is configured to be actuated in a third direction and a fourth direction, and the second control mechanism is operably connected to the feed such that actuation of the second control mechanism along the third direction pivots the feed body relative to the boom about the first feed pivot axis and actuation of the second control mechanism along the fourth direction pivots the feed body relative to the boom about the second feed pivot axis. The control assembly is configured to simultaneously pivot the boom body about at least one of the first boom pivot axis and the second boom pivot axis in response to an input from the first control mechanism and pivot the feed body about at least one of the first feed pivot axis and the second feed pivot axis in response to an input from the second control mechanism.

[0007] According to another aspect of the disclosure, a drilling system comprises a base, a drilling assembly, and a control assembly. The drilling assembly is coupled to the base and the drilling assembly includes a boom and a feed. The boom defines a boom proximal end, a boom distal end, a boom pivot axis and a boom longitudinal axis offset with respect to the boom pivot axis, and the boom includes a boom body that extends from the boom proximal end to the boom distal end such that the boom body is elongate along the boom longitudinal axis. The boom is coupled to the base such that the boom body is pivotable relative to the base about the boom pivot axis and the distal end of the boom body is translatable relative to the base along the boom longitudinal axis. The feed defines a feed pivot axis and a feed longitudinal axis offset with respect to the feed pivot axis, and the feed includes a portion that is elongate along the feed longitudinal axis. The feed is coupled to the boom such that the feed body is pivotable relative to the boom about the feed pivot axis and the feed body is translatable relative to the boom along the feed longitudinal axis.

[0008] The control assembly is operably connected to the drilling assembly, and the control assembly includes a first control mechanism and a second control mechanism. The first control mechanism is configured to be actuated in a first direction and a second direction, and the first control mechanism is operably connected to the boom such that actuation of the first control mechanism along the first direction pivots the boom body relative to the base about the boom pivot axis and actuation of the first control mechanism along the second direction translates the boom body relative to the base along the boom longitudinal axis. The second control mechanism is configured to be actuated in a third direction and a fourth direction, and the second control mechanism is operably connected to the feed such that actuation of the second control mechanism along the third direction pivots the feed body relative to the boom about the feed pivot axis and actuation of the second control mechanism along the fourth direction translates the feed body relative to the boom along the feed longitudinal axis. The control assembly is configured to simultaneously pivot the boom body about the boom pivot axis or translate the boom body along the boom longitudinal axis in response to an input from the first control mechanism, and pivot the feed body about the feed pivot axis or translate the feed body along the feed longitudinal axis in response to an input from the second control mechanism.

[0009] According to another aspect of the disclosure, a method for operating a drilling system that comprises a base, a drilling assembly coupled to the base, and a control assembly operably connected to the drilling assembly, is disclosed. The drilling assembly includes a boom and a feed, the boom defines a first boom pivot axis and a second boom pivot axis offset from the first boom pivot axis. The boom includes a boom body, and the boom is coupled to the base such that the boom body is both pivotable relative to the base about the first

boom pivot axis and pivotable relative to the base about the second boom pivot axis. The feed defines a first feed pivot axis and a second feed pivot axis that is offset to the first feed pivot axis, and the feed includes a feed body. The feed is coupled to the boom such that the feed body is both pivotable relative to the boom about the first feed pivot axis and pivotable relative to the boom about the second feed pivot axis.

[0010] The method comprises the step of actuating a first control mechanism of the control assembly in a first direction, thereby pivoting the boom body about the first boom pivot axis. The method further comprises the step of actuating the first control mechanism in a second direction, thereby pivoting the boom body about the second boom pivot axis. The method further comprises the step of actuating a second control mechanism of the control assembly in a third direction, thereby pivoting the feed body relative to the boom body about the first feed pivot axis. The method further comprises the step of actuating the second control mechanism in a fourth direction, thereby pivoting the feed body relative to the boom body about the second feed pivot axis. According to the method, at least one of the steps of actuating the first control mechanism is performed simultaneously with at least one of the steps of actuating the second control mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is an isometric view of a machine, according to an aspect of the disclosure;

[0012] FIG. **2** is a an isometric view of a drilling assembly, according to an aspect of the disclosure;

[0013] FIG. **3** is an isometric view of a control assembly of the drilling system according to an aspect of the disclosure; and

[0014] FIG. **4** is an isometric view of a first control mechanism of the control assembly according to an aspect of the disclosure;

[0015] FIG. **5** is an isometric view of a second control mechanism of the control assembly according to an aspect of the disclosure; and

[0016] FIG. **6** is an isometric view of a third control mechanism of the control assembly according to an aspect of the disclosure.

DETAILED DESCRIPTION

[0017] Aspects of the disclosure will now be described in detail with reference to the drawings, wherein like reference numbers refer to like elements throughout, unless specified otherwise. Certain terminology is used in the following description for convenience only and is not limiting. The term "plurality", as used herein, means more than one. Certain features of the disclosure which are described herein in the context of separate embodiments may also be provided in combination in a single embodiment. Conversely, various features of the disclosure that are described in the context of a single embodiment may also be provided separately or in any subcombination.

[0018] Referring to FIG. **1**, a machine **10** may be a drilling system that includes a drilling assembly **100** and a control assembly **200**. The machine **10** may further include a frame **12** and a cab **14** mounted to the frame **12**. The cab **14** may be configured to at least partially, for example entirely, enclose the control assembly **200** and an operator of the machine **10**. The machine **10** may further include a base **16** coupled to the frame **12**, the drilling assembly **100** configured to be mounted to the base **16**.

[0019] In use, according to an aspect of the disclosure, the machine **10** is mobile and is configured to be positioned, for example driven, to a drilling site. As shown, the machine **10** may include a plurality of tires **18**. Once the machine **10** is positioned at the drilling site, input to the control assembly **200** moves the drilling assembly **100** as described in greater detail below.

[0020] The machine **10** may further include a controller **20**, such as a computer processor or electronic control module, configured to convert an input received by the control assembly **200** to an output that moves at least a portion of the drilling assembly **100**. The machine **10** may be configured such that any of the functions described herein can be controlled by the controller **20**.

[0021] According to one aspect of the disclosure the machine **10** includes a single drilling assembly **100**. According to another aspect of the disclosure, the machine **10** may include a plurality of drilling assemblies **100**, for example a first drilling assembly **100***a* and a second drilling assembly **100***b*. As shown, the first drilling assembly **100***a* is mounted to a first base **16***a* and the second drilling assembly **100***b* is mounted to a second base **16***b*. The description of the drilling assembly **100** throughout the disclosure is applicable to each of the one or more drilling assemblies **100** of the machine **10**.

[0022] According to one aspect of the disclosure, the machine **10** includes a single control assembly **200**. The single control assembly **200** may be configured to move the single drilling assembly **100**, one of the plurality of drilling assemblies **100**, or a plurality of the plurality of drilling assemblies **100**. According to another aspect of the disclosure, the machine **10** may include a plurality of control assemblies **200**. The plurality of control assemblies **200** may include, for example, a first control assembly and a second control assembly. Each of the plurality of control assemblies **200** may be configured to move the single drilling assembly **100**, one of the plurality of drilling assemblies **100**, or a plurality of the plurality of drilling assemblies **100**.

[0023] Referring to FIG. **2**, the drilling assembly **100**, according to an aspect of the disclosure, defines an assembly proximal end **102** coupled to the base **16**, an assembly distal end **104**, and an assembly body **106** extending from the assembly proximal end **102** to the assembly distal end **104**. The assembly body **106** includes a first portion, for example a boom **120**. The boom **120** defines a boom proximal end **122**, a boom distal end **124**, a boom longitudinal axis **126**, and a boom body **128**. As shown in the illustrated embodiment, the boom body **128** extends from the boom proximal end **122** to the boom distal end **124** such that the boom body **128** is elongate along the boom longitudinal axis **126**. According to one aspect of the disclosure, the boom body **128** is telescopic such that a length L**1** of the boom body **128** measured from the boom proximal end **122** to the boom distal end **124** along the boom longitudinal axis **126** may be increased or decreased.

[0024] The boom **120** may further define a first boom pivot axis **130** and a second boom pivot axis **132**. According to one aspect of the disclosure the first boom pivot axis **130** is offset with respect to the second boom pivot axis **132** such that the first boom pivot axis **130** is non-coincident with the second boom pivot axis **132**. According to one aspect of the disclosure the first boom pivot axis **130** is offset with respect to the

second boom pivot axis **132** such that the first boom pivot axis **130** is perpendicular to the second boom pivot axis **132**.

[0025] The boom **120** may be coupled to the base **16** such that the boom body **128** is pivotable relative to the base **16** about the first boom pivot axis **130**, the boom body **128** is pivotable relative to the base **16** about the second boom pivot axis **132**, the boom distal end **124** is translatable relative to the base **16** along the boom longitudinal axis **126**, or any combination thereof.

[0026] The assembly body **106** further includes a second portion, for example a feed **140**. The feed **140** defines a feed longitudinal axis **142** and a feed body **144**, the feed body **144** including a portion **146** that is elongate along the feed longitudinal axis **142**. The feed **140** may further define a first feed pivot axis **148**, a second feed pivot axis **150**, and a third feed pivot axis **152**.

[0027] According to one aspect of the disclosure, each of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152** is offset with respect to the others of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152** such that each of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152** is non-coincident with respect to the others of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152**. According to another aspect of the disclosure, each of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152** is offset with respect to the others of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152** such that each of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152** is perpendicular to the others of the first feed pivot axis **148**, the second feed pivot axis **150**, and the third feed pivot axis **152**.

[0028] The feed **140** may be coupled to the boom **120** such that the feed body **144** is pivotable relative to the boom **120** about the first feed pivot axis **148**, the feed body **144** is pivotable relative to the boom **120** about the second feed pivot axis **150**, the feed body is pivotable relative to the boom **120** about the third feed pivot axis **152**, the portion **146** is translatable relative to the boom **120** along the feed longitudinal axis **142**, or any combination thereof.

[0029] The assembly body **106** may further include a third portion, for example a drifter **160**. The drifter **160** defines a drifter axis **162** and a drifter body **164**. The drifter body **164** includes a drill bit **166** that is elongate along the drifter axis **162**. According to one aspect of the disclosure, the drifter **160** is coupled to the feed **140** such that the drill bit **166** is rotatable relative to the feed **140** about the drifter axis **162**, the drill bit **166** is translatable relative to the feed **140** along the drifter axis **162**, or both.

[0030] According to one aspect of the disclosure, the drifter body **164** includes a motor **168**, for example a hydraulic motor, that is configured to rotate the drill bit **166** about the drifter axis **162**. The motor **168** translationally secured relative to the drill bit **166** such that as the drill bit **166** translates relative to the feed **140** along the drifter axis **162**, the motor **168** also translates relative to the feed **140** along the drifter axis **162**.

[0031] The drilling assembly **100**, according to one aspect of the disclosure, may further include a plurality of hinges **180** and a plurality of actuators **182**, each of the plurality of hinges **180** defines one of the axes, for example one of the pivot or longitudinal axes, and each of the plurality of actuators **182** is configured to move, for example pivot or translate, a portion of the drilling assembly **100**.

[0032] Referring to FIGS. **1** and **2**, movement of the drilling assembly **100** is controlled by the controller **20**. The controller **20** may be configured to receive a command signal from the control assembly **200**, convert the command signal into an output signal that is received by the drilling assembly **100**, for example an actuator **182** of the drilling assembly. The output signal may direct a desired operating state of a component (not shown) of a hydraulic circuit, such as a valve, a pump, or other component, to allow the flow of hydraulics, typically from a pump, within the machine **10** to extend or contract the actuator **182**, which results in the desired movement of at least a portion of the drilling assembly **100**, for example pivoting the boom body **128** relative to the base **16** about the first boom pivot axis **130**.

[0033] Referring to FIG. **3**, the control assembly **200** includes a control assembly body **202** that includes a plurality of control mechanisms. According to one aspect of the disclosure, the control assembly **200** includes a first control mechanism **220**, a second control mechanism **240**, a third control mechanism **260**, or any combination thereof. The control assembly body **202** may further include one or more video monitors **204** configured to display portions of the machine **10** and an emergency shut off switch **206** configured to cut power to portions of the machine **10**, for example the drilling assembly **100**.

[0034] Referring to FIG. **4**, the first control mechanism **220** is configured to be actuated along a first direction D**1**, a second direction D**2**, a third direction D**3**, or any combination thereof. According to one aspect of the disclosure, the first direction D**1** is defined by a first axis **222** and the second direction D**2** is defined by a second axis **224**. According to another aspect of the disclosure the third direction D**3** may be defined by a third axis **226**. The first direction D**1**, the second direction D**2**, the third direction D**3**, and any combination thereof may be a linear direction. The first direction D**1**, the second direction D**2**, the third direction D**3**, and any combination thereof may be a rotational direction, for example twisting the first control mechanism **220** about an axis of elongation of the first control mechanism **220**. The first direction D**1**, the second direction D**2**, and the third direction D**3**, may include a combination of one or more linear directions and one or more rotational directions.

[0035] Each of the first direction D**1**, the second direction D**2**, and the third direction D**3**, according to one aspect of the disclosure, is offset with respect to the others of the first direction D**1**, the second direction D**2**, and the third direction D**3** such that each of the first direction D**1**, the second direction D**2**, and the third direction D**3** is non-coincident with the others of the first direction D**1**, the second direction D**2**, and the third direction D**3**. According to one aspect of the disclosure the first direction D**1** is offset with respect to at least one of the second direction D**2** and the third direction D**3** such that the first direction D**1** is perpendicular to at least one of the second direction D**2** and the third direction D**3**.

[0036] As shown in the illustrated embodiment, the first control mechanism **220** may be, for example, a first two axis joystick **228** including a first joystick body **230** including a first shaft **232** and a first head **234**. The first control mechanism **220** is secured to the control assembly **200** such that the first shaft **232** is movable along the first direction D**1**, for example along the first axis **222**, movable along the second direction D**2**, for example along the second axis **224**, and

movable in both the first direction D1 and the second direction D2 simultaneously, for example along an axis **236** that includes components of both the first direction D1 and the second direction D2.

[0037] The first control mechanism **220** may further include at least one input device **238**, for example one or more buttons, levers, switches, sliders, combinations thereof, or any other input device known in the art that is movable, for example along the third direction D3. According to one aspect of the disclosure, the at least one input device **238** is carried by the first head **234** of the first control mechanism **220**. The first control mechanism **220** may further be configured such that an operator is able to grip and actuate the first shaft **232** with one hand and actuate the at least one input device **238** with a finger, for example a thumb, of the hand gripping the first shaft **232**.

[0038] Referring to FIG. **5**, the second control mechanism **240** is configured to be actuated along a fourth direction D4, a fifth direction D5, a sixth direction D6, a seventh direction D7, or any combination thereof. According to one aspect of the disclosure, the fourth direction D4 is defined by a fourth axis **242** and the fifth direction D5 is defined by a fifth axis **244**. According to another aspect of the disclosure the sixth direction D6 may be defined by a sixth axis **246** and the seventh direction D7 may be defined by a seventh axis **247**.

[0039] According to one aspect of the disclosure the second control mechanism **240** is configured such that each of the fourth direction D4, the fifth direction D5, and the sixth direction D6, is offset with respect to the others of the fourth direction D4, the fifth direction D5, and the sixth direction D6 such that each of the fourth direction D4, the fifth direction D5, and the sixth direction D6 is non-coincident with the others of the fourth direction D4, the fifth direction D5, and the sixth direction D6. According to one aspect of the disclosure, the second control mechanism is further configured such that the fourth direction D5 is offset with respect to at least one of the fifth direction D5 and the sixth direction D6 such that the fourth direction D4 is perpendicular to at least one of the fifth direction D5 and the sixth direction D6.

[0040] According to one aspect of the disclosure the second control mechanism **240** is further configured such that the seventh direction D7 is offset with respect to each of the fourth direction D4, the fifth direction D5, and the sixth direction D6 such that the seventh direction D7 is non-coincident with each of the fourth direction D4, the fifth direction D5, and the sixth direction D6.

[0041] As shown in the illustrated embodiment, the second control mechanism **240** may be, for example, a second two axis joystick **248** including a second joystick body **250** including a second shaft **252** and a second head **254**. The second control mechanism **240** is secured to the control assembly **200** such that the second shaft **252** is movable along the fourth direction D4, for example along the fourth axis **242**, movable along the fifth direction D5, for example along the fifth axis **244**, and movable in both the fourth direction D5 and the fifth direction D5 simultaneously, for example along an axis **256** that includes components of both the fourth direction D4 and the fifth direction D5.

[0042] The second control mechanism **240** may further include at least one input device **258**, for example one or more buttons, levers, switches, sliders, combinations thereof, or any other input device known in the art that each is movable, for example along one of the sixth direction D6 and the seventh direction D7. According to one aspect of the disclosure, the at least one input device **258** is carried by the second head **254** of the second control mechanism **240**. The second control mechanism **240** may further be configured such that an operator is able to grip and actuate the second shaft **252** with one hand and actuate the at least one input device **258** with a finger, for example a thumb, of the hand gripping the second shaft **252**.

[0043] Referring to FIG. **6**, the third control mechanism **260** is configured to be actuated along an eighth direction D8, a ninth direction D9, a tenth direction D10, or any combination thereof. According to one aspect of the disclosure, the eighth direction D8 is defined by an eighth axis **262** and the ninth direction D9 is defined by a ninth axis **264**. According to another aspect of the disclosure the tenth direction D10 may be defined by a tenth axis **266**.

[0044] Each of the eighth direction D8, the ninth direction D9, and the tenth direction D10, according to one aspect of the disclosure, is offset with respect to the others of the eighth direction D8, the ninth direction D9, and the tenth direction D10 such that each of the eighth direction D8, the ninth direction D9, and the tenth direction D10 is non-coincident with the others of the eighth direction D8, the ninth direction D9, and the tenth direction D10. According to one aspect of the disclosure the eighth direction D8 is offset with respect to at least one of the ninth direction D9 and the tenth direction D10 such that the eighth direction D8 is perpendicular to at least one of the ninth direction D9 and the tenth direction D10.

[0045] As shown in the illustrated embodiment, the third control mechanism **260** may be, for example, a third two axis joystick **268** including a third joystick body **270** including a third shaft **272** and a third head **274**. The third control mechanism **260** is secured to the control assembly **200** such that the third shaft **272** is movable along the eighth direction D8, for example along the eighth axis **262**, movable along the ninth direction D9, for example along the ninth axis **264**, and movable in both the eighth direction D8 and the ninth direction D9 simultaneously, for example along an axis **276** that includes components of both the eighth direction D8 and the ninth direction D9.

[0046] The third control mechanism **260** may further include at least one input device **278**, for example one or more buttons, levers, switches, sliders, combinations thereof, or any other input device known in the art, that is movable, for example along the tenth direction D10. According to one aspect of the disclosure, the at least one input device **278** is carried by the third head **274** of the third control mechanism **260**. The third control mechanism **260** may further be configured such that an operator is able to grip and actuate the third shaft **272** with one hand and actuate the at least one input device **278** with a finger, for example a thumb, of the hand gripping the third shaft **272**.

[0047] According to one aspect of the disclosure, the control assembly **200** is configured to initiate or terminate additional functions of the machine **10** that do not relate to movement of the drilling assembly **100**. For example, the control assembly **200** may be configured to initiate and terminate an air exhaust, a water jet, or a mist spray, for example in proximity to the drill bit **166**. The additional functions of the machine **10** may be initiated and terminated, for example, by pressing one or more of the at least one input devices **278** carried by the third control mechanism **260**.

[0048] Referring to FIGS. **2** and **3**, according to one aspect of the disclosure, the control assembly **200** is operably con-

nected to the drilling assembly **100** such that the first control mechanism **220** is operably connected to the boom **120**, the second control mechanism **240** is operably connected to the feed **140**, the third control mechanism **260** is operably connected to the drifter **160**, or any combination thereof.

[0049] Referring to FIGS. **2** and **4**, the first control mechanism **220** may be operably connected to the boom **120** such that actuation of the first control mechanism **220** along the first direction D**1** pivots the boom body **128** relative to the base **16** about the first boom pivot axis **130**, actuation of the first control mechanism **220** along the second direction D**2** pivots the boom body **128** relative to the base **16** about the second boom pivot axis **132**, actuation of the first control mechanism **220** along the third direction D**3** translates the boom distal end **124** relative to the base **16** along the boom longitudinal axis **126**, or any combination thereof.

[0050] According to one aspect of the disclosure, actuating the first control mechanism **220** along the first direction D**1** includes tilting the first shaft **232** at least partially along the first axis **222**, actuating the first control mechanism **220** along the second direction D**2** includes titling the first shaft **232** at least partially along the second axis **224**, actuating the first control mechanism **220** along the third direction D**3** includes pushing one of the at least one input devices **238**, or any combination thereof.

[0051] Referring to FIGS. **2** and **5**, the second control mechanism **240** may be operably connected to the feed **140** such that actuation of the second control mechanism **240** along the fourth direction D**4** pivots the feed body **144** relative to the boom **120** about the first feed pivot axis **148**, actuation of the second control mechanism **240** along the fifth direction D**5** pivots the feed body **144** relative to the boom **120** about the second feed pivot axis **150**, actuation of the second control mechanism **240** along the sixth direction D**6** pivots the feed body **144** relative to the boom **120** about the third feed pivot axis **152**, actuation of the second control mechanism **240** along the seventh direction D**7** translates at least a portion of the feed body **144**, for example the portion **146**, relative to the boom **120** along the feed longitudinal axis **142**, or any combination thereof.

[0052] According to one aspect of the disclosure, actuating the second control mechanism **240** along the fourth direction D**4** includes tilting the second shaft **252** at least partially along the fourth axis **242**, actuating the second control mechanism **240** along the fifth direction D**5** includes titling the second shaft **252** at least partially along the fifth axis **244**, actuating the second control mechanism **240** along the sixth direction D**6** includes pushing one of the at least one input devices **258**, actuating the second control mechanism **240** along the seventh direction D**7** includes pushing another of the at least one input devices **258**, or any combination thereof.

[0053] Referring to FIGS. **2** and **6**, the third control mechanism **260** may be operably connected to the drifter **160** such that actuation of the third control mechanism **260** along the eighth direction D**8** rotates the drill bit **166** relative to the feed **140** about the drifter axis **162**, actuation of the third control mechanism **260** along the ninth direction D**9** translates the drill bit **166** relative to the feed **140** along the drifter axis **162**, or both.

[0054] According to one aspect of the disclosure, actuating the third control mechanism **260** along the eighth direction D**8** includes tilting the third shaft **272** at least partially along the eighth axis **262**, actuating the third control mechanism **260** along the ninth direction D**9** includes titling the third shaft **272** at least partially along the ninth axis **264**, actuating the third control mechanism **260** along the tenth direction D**10** includes pushing one of the at least one input devices **278**, or any combination thereof.

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[0055] Referring to FIGS. **1-6**, according to one aspect of the disclosure, the control assembly **200** is configured to pivot the boom body **128** about the first boom pivot axis **130**, pivot the boom body **128** about the second boom pivot axis **132**, translate the boom body **128** along the boom longitudinal axis **126**, or any combination thereof in response to an input from the first control mechanism **220**, and the control assembly **200** is further configured to simultaneously pivot the feed body **144** about the first feed pivot axis **148**, pivot the feed body **144** about the second feed pivot axis **150**, pivot the feed body **144** about the third feed pivot axis **152**, translate a portion of the feed body **144**, for example the portion **146**, along the feed longitudinal axis **142**, or any combination thereof in response to an input from the second control mechanism **240**. The input from the first control mechanism **220** may include, for example, actuation of the first control mechanism **220** in the first direction D**1**, the second direction D**2**, the third direction D**3**, or any combination thereof. The input from the second control mechanism **240** may include, for example, actuation of the second control mechanism **240** in the fourth direction D**4**, the fifth direction D**5**, the sixth direction D**6**, the seventh direction D**7**, or any combination thereof.

[0056] According to one aspect of the disclosure, the control assembly **200** is configured such that the first control mechanism **220** is devoid of a direction that the first control mechanism **220** may be actuated in to move, for example pivot or translate, the feed body **144** relative to the boom **120**. According to one aspect of the disclosure, the control assembly **200** is configured such that the second control mechanism **240** is devoid of a direction that the second control mechanism **240** may be actuated in to move, for example pivot or translate, the boom body **128** relative to the base **16**.

[0057] According to one aspect of the disclosure, a method for operating the machine **10** includes the steps of: actuating the first control mechanism **220** of the control assembly **200** in a first direction D**1**, thereby pivoting the boom body **128** about the first boom pivot axis **130**, actuating the first control mechanism **220** in a second direction D**2**, thereby pivoting the boom body **128** about the second boom pivot axis **132**, actuating the second control mechanism **240** of the control assembly **200** in the fourth direction D**4**, thereby pivoting the feed body **144** relative to the boom body **128** about the first feed pivot axis **148**, actuating the second control mechanism **240** in the fifth direction D**5**, thereby pivoting the feed body **144** relative to the boom body **128** about the second feed pivot axis **150**, wherein at least one of the actuating the first control mechanism **220** steps is performed simultaneously with at least one of the actuating the second control mechanism **240** steps.

[0058] According to one aspect of the disclosure, the method may further include the step of actuating the first control mechanism **220** in the third direction D**3**, thereby translating the boom body **128** along the boom longitudinal axis **126**. The step of actuating the first control mechanism **220** in the third direction D**3** may be performed separate from each of the other steps of the method, or may be performed simultaneously with at least one of the other steps of the method.

[0059] According to one aspect of the disclosure, the method may further include the step of actuating the second control mechanism **240** in the sixth direction D**6**, thereby pivoting the feed body **144** relative to the boom body **128** along the third feed pivot axis **152**. The step of actuating the second control mechanism **240** in the sixth direction D**6** may be performed separate from each of the other steps of the method, or may be performed simultaneously with at least one of the other steps of the method.

[0060] According to one aspect of the disclosure, the method may further include the step of actuating the second control mechanism **240** in the seventh direction D**7**, thereby translating the feed body **144** relative to the boom body **128** along the feed longitudinal axis **142**. The step of actuating the second control mechanism **240** in the seventh direction D**7** may be performed separate from each of the other steps of the method, or may be performed simultaneously with at least one of the other steps of the method.

[0061] The machine **10** may be configured for use at a drilling site and to be operated by an operator to drill one or more holes in a surface, such as a rock wall. The assembly distal end **104** of the drilling assembly **100** may be defined by the drill bit **166** which is configured to drill one or more holes in the surface. Through inputs into the control assembly **200** the drilling assembly **100**, specifically the drill bit **166** can be moved from an initial position to a drilling position. Previous machines are not configured to allow the simultaneous movement in multiple directions, or multiple degrees of freedom. For example, an operator of a previous machine moving a drill bit from an initial position to a drilling position would require moving a first portion of the machine, and then as a separate step, moving a second portion of the machine. The machine **10** is configured such that the both the boom body **128** and the feed body **144** are movable simultaneously through simultaneous inputs into both the first control mechanism **220** and the second control mechanism **240**.

[0062] According to one aspect of the disclosure, the drilling assembly **100** is configured such that the drifter **160**, including the drill bit **166**, is carried by the feed **140** such that movement of the feed body **144** also moves the drill bit **166**. For example when the feed body **144** pivots about the first feed pivot axis **148**, the drill bit **166** also pivots about the first feed pivot axis **148**. The drilling assembly may further be configured such that the feed **140** is carried by the boom **120** such that movement of the boom body **128** also moves both the feed body **144** and the drill bit **166**. For example, when the boom body **128** pivots about the first boom pivot axis **130**, the drill bit **166** also pivots about the first boom pivot axis **130**.

[0063] Thus, to move the drill bit **166** from the initial position to the drilling position, an operator may actuate the first control mechanism **220**, for example in the first direction D**1** thereby pivoting the boom body **128** about the first boom pivot axis **130**, and may simultaneously actuate the second control mechanism **240**, for example in the fourth direction D**4** thereby pivoting the feed body **144** about the first feed pivot axis **148**. This simultaneous actuating of the first control mechanism **220** and the second control mechanism **240** results in the drill bit **166** simultaneously pivoting about the first boom pivot axis **130** and the first feed pivot axis **148**.

[0064] The simultaneous movement of the drill bit **166** described above may lead to faster movement of the drill bit **166** from the initial position to the drilling position than first moving a first portion of a drilling assembly, and then after moving the first portion, separately moving a second portion of the drilling assembly.

[0065] According to one aspect of the disclosure, the machine **10** may include an electrohydraulic system that includes electric signals sent by, for example, the controller **20**, and the electric signals drive electrohydraulic valves, the output of which is directed to components of the drilling assembly **100**, for example one or more of the plurality of actuators **182** or the motor **168**.

[0066] It will be appreciated that the foregoing description provides examples of the disclosed system and technique. However, it is contemplated that other implementations of the disclosure may differ in detail from the foregoing examples. All references to the disclosure or examples thereof are intended to reference the particular example being discussed at that point and are not intended to imply any limitation as to the scope of the disclosure more generally. All language of distinction and disparagement with respect to certain features is intended to indicate a lack of preference for those features, but not to exclude such from the scope of the disclosure entirely unless otherwise indicated.

[0067] Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context.

We claim:

1. A drilling system comprising:

a base;

a drilling assembly coupled to the base, the drilling assembly including:

a boom defining a first boom pivot axis and a second boom pivot axis offset with respect to the first boom pivot axis, the boom including a boom body, and the boom being coupled to the base such that: 1) the boom body is pivotable relative to the base about the first boom pivot axis and 2) the boom body is pivotable relative to the base about the second boom pivot axis; and

a feed defining a first feed pivot axis and a second feed pivot axis offset with respect to the first feed pivot axis, the feed including a feed body, the feed being coupled to the boom such that: 1) the feed body is pivotable relative to the boom about the first feed pivot axis and 2) the feed body is pivotable relative to the boom about the second feed pivot axis; and

a control assembly operably connected to the drilling assembly, the control assembly including:

a first control mechanism configured to be actuated in a first direction and a second direction, the first control mechanism operably connected to the boom such that: 1) actuation of the first control mechanism along the first direction pivots the boom body relative to the base about the first boom pivot axis and 2) actuation of the first control mechanism along the second direction pivots the boom body relative to the base about the second boom pivot axis; and

a second control mechanism configured to be actuated in a third direction and a fourth direction, the second control mechanism operably connected to the feed

such that: 1) actuation of the second control mechanism along the third direction pivots the feed body relative to the boom about the first feed pivot axis and 2) actuation of the second control mechanism along the fourth direction pivots the feed body relative to the boom about the second feed pivot axis,

wherein the control assembly is configured to simultaneously 1) pivot the boom body about at least one of the first boom pivot axis and the second boom pivot axis in response to an input from the first control mechanism, and 2) pivot the feed body about at least one of the first feed pivot axis and the second feed pivot axis in response to an input from the second control mechanism.

2. The drilling system of claim **1**, wherein:

the boom defines a boom proximal end, a boom distal end, and a boom longitudinal axis, the boom body extends from the boom proximal end to the boom distal end such that the boom body is elongate along the boom longitudinal axis, the boom distal end is translatable relative to the base along the boom longitudinal axis; and

the first control mechanism is configured to be actuated in a fifth direction such that actuation of the first control mechanism in the fifth direction translates the boom body relative to the base along the boom longitudinal axis.

3. The drilling system of claim **2**, wherein:

the feed defines a third feed pivot axis offset to both the first feed pivot axis and the second feed pivot axis, and the feed further defines a feed longitudinal axis, the feed body includes a portion that is elongate along the feed longitudinal axis; and

the second control mechanism is configured to be actuated in a sixth direction such that actuation of the second control mechanism in the sixth direction pivots the feed body relative to the boom about the third feed pivot axis, and the second control mechanism is further configured to be actuated in a seventh direction such that actuation of the second control mechanism in the seventh direction translates the portion relative to the boom along the feed longitudinal axis.

4. The drilling system of claim **3**, wherein:

the drilling assembly further includes a drifter that defines a drifter axis, the drifter includes a drifter body that has a drill bit elongate along the drifter axis, the drifter being coupled to the feed such that: 1) the drill bit is rotatable relative to the feed about the drifter axis and 2) the drill bit is translatable relative to the feed along the drifter axis; and

the control assembly further includes a third control mechanism configured to be actuated in an eighth direction and a ninth direction, the third control operably connected to the drifter such that: 1) actuation of the third control mechanism along the eighth direction rotates the drifter body relative to the feed about the drifter axis and 2) actuation of the third control mechanism along the ninth direction translates the drifter body relative to the feed along the drifter axis.

5. The drilling system of claim **4**, wherein the first control mechanism is devoid of a direction that the first control mechanism may be actuated in to pivot the feed body relative to the boom.

6. The drilling system of claim **5**, wherein the second control mechanism is devoid of a direction that the second control mechanism may be actuated in to pivot the boom body relative to the base.

7. The drilling system of claim **6**, wherein the first control mechanism is a first two axis joystick, and the second control mechanism is a second two axis joystick.

8. The drilling system of claim **7**, wherein the third control mechanism is a third two axis joystick, and the third two axis joystick is devoid of both: 1) a direction that the third control mechanism may be actuated in to pivot the boom body relative to the base and 2) a direction that the third control mechanism may be actuated in to pivot the feed body relative to the boom.

9. A drilling system comprising:

a base;

a drilling assembly coupled to the base, the drilling assembly including:

a boom defining a boom proximal end, a boom distal end, a boom pivot axis and a boom longitudinal axis offset with respect to the boom pivot axis, the boom including a boom body extending from the boom proximal end to the boom distal end such that the boom body is elongate along the boom longitudinal axis, the boom being coupled to the base such that: 1) the boom body is pivotable relative to the base about the boom pivot axis and 2) the distal end of the boom body is translatable relative to the base along the boom longitudinal axis; and

a feed defining a feed pivot axis and a feed longitudinal axis offset with respect to the feed pivot axis, the feed including a feed body including a portion that is elongate along the feed longitudinal axis, the feed being coupled to the boom such that: 1) the feed body is pivotable relative to the boom about the feed pivot axis and 2) the feed body is translatable relative to the boom along the feed longitudinal axis; and

a control assembly operably connected to the drilling assembly, the control assembly including:

a first control mechanism configured to be actuated in a first direction and a second direction, the first control mechanism operably connected to the boom such that: 1) actuation of the first control mechanism along the first direction pivots the boom body relative to the base about the boom pivot axis and 2) actuation of the first control mechanism along the second direction translates the boom body relative to the base along the boom longitudinal axis; and

a second control mechanism configured to be actuated in a third direction and a fourth direction, the second control mechanism operably connected to the feed such that: 1) actuation of the second control mechanism along the third direction pivots the feed body relative to the boom about the feed pivot axis and 2) actuation of the second control mechanism along the fourth direction translates the feed body relative to the boom along the feed longitudinal axis,

wherein the control assembly is configured to simultaneously 1) pivot the boom body about the boom pivot axis or translate the boom body along the boom longitudinal axis in response to an input from the first control mechanism, and 2) pivot the feed body about the feed

pivot axis or translate the feed body along the feed longitudinal axis in response to an input from the second control mechanism.

10. The drilling system of claim **9**, wherein the boom pivot axis is a first boom pivot axis, the boom defines a second boom pivot axis offset with respect to the first boom pivot axis, and the first control mechanism is configured to be actuated in a fifth direction such that actuation of the first control mechanism in the fifth direction pivots the boom body relative to the base about the second boom pivot axis.

11. The drilling system of claim **10**, wherein the feed pivot axis is a first feed pivot axis, the feed defines a second feed pivot axis offset with respect to the first feed pivot axis, the feed further defines a third feed pivot axis offset with respect to both the first feed pivot axis and the second feed pivot axis, the second control mechanism is configured to be actuated in a sixth direction such that actuation of the second control mechanism in the sixth direction pivots the feed body relative to the boom about the second feed pivot axis, and the second control mechanism is further configured to be actuated in a seventh direction such that actuation of the second control mechanism in the seventh direction pivots the feed body relative to the boom about the third feed pivot axis.

12. The drilling system of claim **11**, wherein:

the drilling assembly further includes a drifter that defines a drifter axis, the drifter includes a drifter body that has a drill bit elongate along the drifter axis, the drifter being coupled to the feed such that: 1) the drill bit is rotatable relative to the feed about the drifter axis and 2) the drill bit is translatable relative to the feed along the drifter axis; and

the control assembly further includes a third control mechanism configured to be actuated in an eighth direction and a ninth direction, the third control operably connected to the drifter such that: 1) actuation of the third control mechanism along the eighth direction rotates the drifter body relative to the feed about the drifter axis and 2) actuation of the third control mechanism along the ninth direction translates the drifter body relative to the feed along the drifter axis.

13. The drilling system of claim **12**, wherein the first control mechanism is devoid of a direction that the first control mechanism may be actuated in to pivot the feed body relative to the boom.

14. The drilling system of claim **13**, wherein the second control mechanism is devoid of a direction that the second control mechanism may be actuated in to pivot the boom body relative to the base.

15. A method for operating a drilling system, the drilling system comprising a base, drilling assembly coupled to the base, and a control assembly operably connected to the drilling assembly, the drilling assembly including a boom and a feed, the boom defining a first boom pivot axis and a second boom pivot axis offset from the first boom pivot axis, the boom including a boom body, and the boom being coupled to the base such that the boom body is both pivotable relative to the base about the first boom pivot axis and pivotable relative to the base about the second boom pivot axis, the feed defining a first feed pivot axis and a second feed pivot axis that is offset to the first feed pivot axis, the feed including a feed body, the feed being coupled to the boom such that the feed body is both pivotable relative to the boom about the first feed pivot axis and pivotable relative to the boom about the second feed pivot axis, the method comprising the steps of:

(a) actuating a first control mechanism of the control assembly in a first direction, thereby pivoting the boom body about the first boom pivot axis;

(b) actuating the first control mechanism in a second direction, thereby pivoting the boom body about the second boom pivot axis;

(c) actuating a second control mechanism of the control assembly in a third direction, thereby pivoting the feed body relative to the boom body about the first feed pivot axis; and

(d) actuating the second control mechanism in a fourth direction, thereby pivoting the feed body relative to the boom body about the second feed pivot axis;

wherein at least one of steps (a) and (c), steps (a) and (d), steps (b) and (c), and steps (b) and (d) are performed simultaneously.

16. The method of claim **15**, further comprising the step of:

(e) actuating the first control mechanism in a fifth direction, thereby translating the boom body along a boom longitudinal axis that is offset from both the first boom pivot axis and the second boom pivot axis.

17. The method of claim **16**, further comprising the step of:

(f) actuating the second control mechanism in a sixth direction, thereby pivoting the feed body relative to the boom body along a third pivot axis that is offset from both the first feed pivot axis and the second feed pivot axis.

18. The method of claim **17**, wherein steps (a), (b), (c), (d), (e), and (f) are performed simultaneously.

19. The method of claim **16**, further comprising the step of:

(f) actuating the second control mechanism in a sixth direction, thereby translating the feed body relative to the boom body along a feed longitudinal axis that is offset from both the first feed pivot axis and the second feed pivot axis.

20. The method of claim **19**, wherein steps (a), (b), (c), (d), (e), and (f) are performed simultaneously.

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