

CEMENT HEAD REMOTE CONTROL AND TRACKING

BACKGROUND

5 [0001] The present disclosure is related to wellbore servicing tools used in the oil and gas industry and, more particularly, to remote control and tracking of cement head operations.

10 [0002] During completion of oil and gas wells, cement is often used to solidify a well casing within the newly drilled wellbore. To accomplish this, cement slurry is first pumped through the inner bore of the well casing and either out its distal end or through one or more ports defined in the well casing at predetermined locations. Cement slurry exits the well casing into the annulus formed between the well casing and the wellbore and is pumped back up toward the surface within the annulus. Once the cement hardens, it forms a seal between the well casing and the wellbore to protect oil producing zones and non-
15 oil producing zones from contamination. In addition, the cement bonds the casing to the surrounding rock formation, thereby providing support and strength to the casing and also preventing blowouts and protecting the casing from corrosion.

20 [0003] Prior to cementing, the wellbore and the well casing are typically filled with drilling fluid or mud. A cementing plug is then pumped ahead of the cement slurry in order to prevent mixing of the drilling mud already disposed within the wellbore with the cement slurry. When the cementing plug reaches a collar or shoulder stop arranged within the casing at a predetermined location, the hydraulic pressure of the cement slurry ruptures the plug and enables the
25 cement slurry to pass through the plug and then through either the distal end of the casing or the side ports and into the annulus. Subsequently, another cementing plug is pumped down the casing to prevent mixing of the cement slurry with additional drilling mud that will be pumped into the casing following the cement slurry. When the top cementing plug lands on the collar or stop
30 shoulder, the pumping of the cement slurry ceases.

35 [0004] To perform the aforementioned cementing operations, a cement head or cementing head is usually employed. The cement head is arranged at the surface of the wellbore and the cementing plugs are held within the cement head until the cementing operation requires their deployment. Various valves associated with the cement head are required to be manipulated in order to

perform the required tasks of the cement head. Such valves are typically manipulated manually, thereby requiring rig personnel to be in close proximity to the cement head and other wellbore equipment. In some cases, rig hands are required to be strapped and suspended in the air in order to operate the valves.

5 As can be appreciated, this presents a potential safety hazard.

SUMMARY

[0004a] According to an aspect of the present invention, there is provided a system, comprising:

10 a control device configured to transmit user command indicators in the form of *first command signals* and *second command signals*;
an onboard device operably connected to a mechanical device of a cement head and configured to receive the first command signals from the control device and operate the mechanical device in response thereto, the
15 onboard device being further configured to prepare and transmit a report signal, wherein the report signal encompasses a status indicator of the cement head;
and

a tracking device configured to receive the second command signals from the control device and the status indicator from the onboard device, the
20 tracking device being further configured to record the user command indicators and the status indicator.

[0004b] According to another aspect of the present invention, there is provided a method, comprising

25 transmitting a first command signal to an onboard device from a control device;
operating a mechanical device of a cement head with the onboard device in response to the first command signal;

transmitting a report signal to a tracking device, the report signal encompassing a status indicator of the cement head;

30 recording the status indicator from the onboard device with the tracking device;

transmitting the user command indicator from the control device to the tracking device via a *second command signal*; and

recording the user command indicator with the tracking device.

[0004c] According to another aspect of the present invention,
there is provided a method, comprising:

transmitting a first command signal to an onboard device with a control
device;

5 transmitting a second command signal to a tracking device with the
control device;

operating a mechanical device of a cement head with the onboard device
in response to the first command signal;

transmitting a status indicator of the cement head from the onboard
10 device to the tracking device via a report signal; and

recording the status indicator and the second command signal with the
tracking device.

BRIEF DESCRIPTION OF THE DRAWINGS

15 [0005] The following figures are included to illustrate certain aspects of
the present disclosure, and should not be viewed as exclusive embodiments.
The subject matter disclosed is capable of considerable modifications,
alterations, combinations, and equivalents in form and function, without
departing from the scope of this disclosure.

20 [0006] FIG. 1A is an isometric view of a cement head that embodies
principles of the present disclosure, according to one or more embodiments.

[0007] FIG. 1B is a cross-sectional view of a cement head that
embodies principles of the present disclosure, according to one or more
embodiments.

25 [0008] FIG. 1C is a cross-sectional view of a cement head that
embodies principles of the present disclosure, according to one or more
embodiments.

[0009] FIG. 1D is an isometric view of a cement head that embodies
principles of the present disclosure, according to one or more embodiments.

30 [0010] FIG. 2 is a front view of a cement head that embodies principles
of the present disclosure, according to one or more embodiments.

[0011] FIG. 3 is a side view of a cement head that embodies principles
of the present disclosure, according to one or more embodiments.

35 [0012] FIG. 4 is an isometric view of a cement head that embodies
principles of the present disclosure, according to one or more embodiments.

[0013] FIG. 5 is a schematic view of a communication system that embodies principles of the present disclosure, according to one or more embodiments.

[0014] FIG. 6 is a block diagram of a communication system that
5 embodies principles of the present disclosure, according to one or more embodiments.

[0015] FIG. 7 is a block diagram of a communication system that embodies principles of the present disclosure, according to one or more embodiments.

5 [0016] FIG. 8 is a flow chart showing steps performed by components of a communication system that embodies principles of the present disclosure, according to one or more embodiments.

DETAILED DESCRIPTION

10 [0017] The present disclosure is related to wellbore servicing tools used in the oil and gas industry and, more particularly, to remote control and tracking of components of a cement head.

15 [0018] The present disclosure provides an ability to operate valves of a cement head remotely. By reducing or eliminating the need for personnel to be physically present during operation of a cement head or other wellbore equipment, the exposure of such personnel to injury or harm that may occur during operation is reduced or eliminated. The present disclosure also describes an ability to sense parameters of a cement head or other wellbore equipment during operation. These parameters can be remotely recorded for further analysis. Signals may be received from both (1) a control device operated
20 remotely by a user and (2) an onboard device responsive to operation of the control device. These signals can be received by a tracking device remotely separated from both the remote control device and the onboard control device. As a result, various aspects of job performance with respect to multiple devices may be recorded. Performance, measured parameters, and status reported at
25 various stages of an operation allow a well operator to review and analyze such data after completion of a job. Such analysis may prove advantageous in yielding valuable information to well operators regarding performance characteristics and needed optimizations. Moreover, the present disclosure describes embodiments to operate valves of a cement head from a variety of
30 remote locations without requiring relocation of an associated tracking device. A mobile and portable control device may be operated from a variety of locations within a communication range of the cement head and the tracking device.

[0019] Referring to FIG. 1A, illustrated is a cement head 100 that may embody one or more principles of the present disclosure, according to one or
35 more embodiments. While the cement head 100 is shown as having a particular

configuration and design, those skilled in the art will readily recognize that other types and designs of cement heads may equally be used and otherwise employ the principles of the present disclosure. The cement head 100 is generally a multi-function device used inline with a work string associated with a wellbore in a hydrocarbon fluid production well. Most generally, the cement head 100 is used to deliver cement or other wellbore servicing fluids and/or mixtures to a wellbore through the work string to which the cement head 100 is attached. The cement head 100 is also capable of delivering darts and/or balls for activating or initiating some function of a tool or structure associated with the work string.

[0020] In one embodiment of the present disclosure, the cement head 100 includes an output module 102, two intermediate modules 104, and an input module 106. Each of the output module 102, intermediate modules 104, and input module 106 have a substantially cylindrical outer profile and each lie substantially coaxial with a central axis 128 that extends generally along the length of the cement head 100 and is generally located centrally within cross-sections of the cement head 100 that are taken orthogonal to the central axis 128. Each intermediate module 104 includes a launch valve 112 (discussed infra) while the output module 102 includes a launch port 114 and a launch indicator 116 (each discussed infra). The cement head 100 may further include safety modules 130, 134 with embedded safety valves 132, 136, discussed in more detail below.

[0021] Referring now to FIG. 1B, a cross-sectional view of the cement head 100 in a fully assembled state is shown. This view shows that the cement head 100 includes primary fluid flow bores 166 extending through each module 102, 104, 106 along the central axis 128. Also shown is that the cement head 100 includes bypass fluid flow bores 168 within each intermediate module 104. The input module 106 includes a conical header 170 into which fluid is passed and from which each of the primary fluid flow bores 166 and bypass fluid flow bores 168 are in fluid communication with, depending on the operational positions of the launch valves 112. The bypass fluid flow path 168 generally begins at the interface between the input module 106 and the adjacent intermediate module 104, so that fluid exiting the input module 106 and entering the adjacent intermediate module 104 is capable of passing through either the primary fluid flow bore 166 or the bypass fluid flow bore 168, depending on the operational orientation of launch valves 112.

[0022] The cement head 100 may be used to perform a variety of functions that are generally known in the art, some of which are described herein. Generally, flow through the cement head 100 would be from the left hand side of FIG. 1B to the right hand side of FIG. 1B. When the cement head 100 is installed in a work string, the input module 106 is located higher than the output module 102 so that flow through the cement head 100 would be generally from top to bottom from the input module 106 to the output module 102. Flow through the cement head 100 enters either through the upper work string interface 110 or mixture ports 176, which are fluidly coupled to the primary fluid flow bore 166 of the input module 106, and exits through the lower work string interface 108. Additionally, the cement head 100 is capable of retaining and launching darts.

[0023] The launch valves 112 operate in two positions. The first position is a bypass position where the launch valve prevents fluid flow directly through a primary fluid flow bore 166, but instead, allows fluid to flow from a bypass fluid flow bore 168 to a primary flow bore 166 on the downstream side of the launch valve 112. The second position is a primary position where the launch valve 112 allows fluid flow directly from a position upstream from the launch valve 112 in a primary fluid flow bore 166 to a position downstream from the launch valve 112 in a primary fluid flow bore 166.

[0024] The primary position is a position in which a dart, ball, or other member to be launched is allowed to pass through the launch valve 112 from the upstream side of the launch valve 112 to the downstream side of the launch valve 112. The launch valves 112 of FIG. 1B are positioned so that a dart, ball, or other member to be launched is free to pass through the downstream launch valve 112 (on the right side of the drawing). To aid in pushing the dart or other object through the downstream launch valve 112 (on the right side of the drawing), the upstream launch valve 112 is positioned in the bypass position so that fluid can flow from the bypass fluid flow bore 168 into the primary fluid flow bore 166 located upstream from the downstream launch valve 112.

[0025] With the launch valves 112 in these positions, the upstream launch valve 112 could be holding a second dart or other object to be launched. With the downstream launch valve 112 in the primary position, the upstream launch valve 112 may be rotated one-quarter rotation from the bypass position to the primary position, thereby allowing passage of the dart and fluids through

the primary fluid flow bores 166. Launch port 114 offers convenient access to a primary fluid flow bore 166 for allowing the insertion of a ball to be dropped through the primary fluid flow bore 166. Launch indicator 116 uses lever arms to interfere with balls and/or darts that pass by the launch indicator 116, resulting in a rotation of an indicator portion of the launch indicator 116 to signify whether a dart, ball, or other object has passed by the launch indicator 116. In this embodiment, no part of the launch valves 112 extend radially beyond the full diameter sections 134, thereby reducing the chance of inadvertently breaking portions of the launch valves 112.

10 **[0026]** While not shown in this embodiment, alternative embodiments of a cement head may integrate a safety valve (*i.e.*, a ball valve having a full bore inside diameter, sometimes referred to as a TIW or Texas Iron Works valve) into one or more of the input module 106, intermediate modules 104, and/or output module 102.

15 **[0027]** An embodiment of a cement head including safety valves is shown in FIG. 1C. The cement head 100 may further include safety modules 130, 134. More particularly, a lower safety module 130 is connected to the output module 102, while an upper safety module 134 is connected to the input module 106 or the upper work string interface 110. The safety modules 130, 20 134 are also connected to the work string or other tools and selectively allow a fluid connection between the safety modules 130, 134. Specifically, each safety module 130, 134 includes a safety valve 132, 136, respectively, that operates to selectively restrict fluid flow through the safety modules 130, 134.

25 **[0028]** Referring now to FIG. 1D, the cement head 100 may also include an internal control line 162 that extends at least through adjacent intermediate modules 104. In this embodiment, the internal control line 162 is well suited for communicating pneumatic control pressure/signals to launch valves, such as the launch valves 112 of FIGS. 1A and 1B, thereby allowing remote control of the launch valves 112. While only one internal control line 162 is shown, it should be understood that in alternative embodiments, additional control lines may be used to control additional launch valves, with at least one internal control line being associated with the control of each launch valve. By placing the internal control line 162 inside the cement head 100 rather than external to the modules, the chances for inadvertent damage to the internal

control line 162 is minimized. Also shown in FIG. 1D are the primary fluid flow bore 166 and the bypass fluid flow bore 168.

[0029] FIG. 2 shows a front view of the cement head 100 in a fully assembled state. FIG. 3 shows a side view of the cement head 100 in a fully assembled state, including wrenches 190 provided for manual or mechanical actuation of each launch valve 112, the lower safety valve 132, the upper safety valve 136, and the mixture valves 178. Manual operation of such valves requires the presence of rig personnel to actuate or control one or more of these valves. An aspect of the present disclosure provides an ability to operate the valves of the cement head 100 remotely.

[0030] Referring now to FIG. 4, an isometric view of the cement head 100 in a fully assembled state is shown. Various onboard devices 200 (referred to as devices 200a, 200b, 200c, 200d, 200e, and 200f) are shown as being connected to the cement head 100. One or more of onboard devices 200a-f are operably connected to one or more mechanical devices of the cement head 100. Mechanical devices may include valves, levers, plungers, and the like. A first onboard device 200a may be operably connected to the upper safety valve 136 of the upper safety module 134. A second onboard device 200b may be operably connected to a mixture port 176 of the input module 106. Additional onboard devices (not shown) may be provided to one or more of the other mixture ports 176 shown in FIG. 4. A third onboard device 200c may be operably connected to the first launch valve 112 of the first intermediate module 104. Likewise, a fourth onboard device 200d may be operably connected to the second launch valve 112 of the second intermediate module 104. A fifth onboard device 200e may be operably connected to the launch port 114 of the output module 102. A sixth onboard device 200f may be operably connected to the lower safety valve 132 of the lower safety module 130.

[0031] As shown in FIG. 4, the first, second, and sixth onboard devices 200a, 200b, 200f may each be housed in independent enclosures. As further shown in FIG. 4, the third, fourth, and fifth onboard devices 200c, 200d, and 200e may be housed in a single enclosure. The enclosures may be attached to portions of the cement head 100. Alternatively, all or a portion of any of the onboard devices 200a-f may be integrated within the main body of the cement head 100.

[0032] Referring now to FIG. 5, with continued reference to FIG. 4, a schematic view of a communication system 500 is shown. It will be appreciated that items depicted in FIG. 5 are not necessarily shown to scale. The communication system 500 may include the cement head 100, a control device 300, and a tracking device 400. The control device 300 may be operable by a user, such as a well operator or rig hand. One or more inputs 314 are provided in the control device 300 for operation by the user, with each of the inputs 314 having an associated function. For example, one of the inputs 314 may be associated with a specific operation of a certain onboard device 200a-f; e.g., open, partially open, close, partially close, activate, deactivate, etc. Various operations and modes of the mechanical devices (e.g., valves) of the cement head 100 are disclosed herein.

[0033] The control device 300 further includes one or more displays 312 for providing information to the user. The display 312 may be associated with the current state of the control device 300, one of the inputs 314, and/or the onboard devices 200a-f. In operation, the control device 300 may be configured to transmit first command signals 390 to one or more of the onboard devices 200a-f. According to some embodiments, the control device 300 may be further configured to transmit second command signals 392 to the tracking device 400. The first and second command signals 390, 392 may be transmitted either wired or wirelessly. In embodiments where the signals are 390, 392 are transmitted wirelessly, the control device 300 may include a wireless transmitter, as described in more detail below.

[0034] The first and/or second command signals may encompass a user command (i.e., a user command indicator) provided by the user using one of the inputs 314. In some embodiments, the user command indicator may include a time that the control device 300 transmits the user command indicator. As used herein, an indicator including a time may have a timestamp corresponding to a time or span of time for an operation. The user command indicator may include instructions for an onboard device 200 to operate an associated mechanical device.

[0035] According to some embodiments, the onboard devices 200a-f may be configured to receive the first command signals 390 from the control device 300. In embodiments where the first command signals 390 are wireless signals, the onboard devices 200a-f may each include a wireless receiver or

transceiver configured to receive and process the first command signals 390, as described in more detail below. The onboard devices 200a-f may be configured to operate their corresponding mechanical devices in response to the first command signals 390 from the control device 300. In some embodiments, the
5 onboard devices 200a-f may be further configured to operate one or more sensors in response to the signals received from the control device 300.

[0036] According to some embodiments, the onboard devices 200a-f may be further configured to transmit report signals 290 to the tracking device 400 either wired or wirelessly. In embodiments where the report signals 290
10 signals are transmitted wirelessly, the onboard devices 200a-f may include wireless transmitters or transceivers, as described in more detail below. The report signals 290 may contain an indication of a state (*i.e.*, a status indicator) of the particular onboard device 200a-f, an associated mechanical devices, and/or the cement head 100. In some embodiments, the status indicator may
15 include a time that a command indicator was received by an onboard device 200, a time that an onboard device 200 commences operation, and/or a time that an onboard device 200 ceases operation. In some embodiments, the status indicator may include a parameter sensed by a sensor of the onboard device 200, and the status indicator may include a time that the onboard device 200
20 transmits the report signal 290.

[0037] According to some embodiments, the tracking device 400 may be configured to receive the second command signals 392 from the control device 300. According to some embodiments, the tracking device 400 may further be configured to receive report signals 290 from the onboard devices
25 200. The tracking device 400 may be configured to record and store the second command signals 392 and the report signals 290, along with any associated information or data.

[0038] Accordingly, the communication system 500 provides three communication pathways interconnecting the control device 300, the onboard
30 devices 200a-f, and the tracking device 400. As such, each component is communicatively linked to the others while potentially being disposed at separate and remote locations. For instance, the onboard devices 200a-f may be located at a wellbore site for operation of the cement head 100 in conjunction with other wellbore equipment. The control device 300 may be operated
35 remotely and at a distance away from the cement head 100 and the onboard

devices 200a-f. Accordingly, the user of the control device 300 may operate to control device 300 from a safe distance away from the cement head 100 and other wellbore equipment.

5 **[0039]** Similarly, the tracking device 400 may operate at a location that is remote relative to the onboard devices 200a-f and the control device 300. The location of the tracking device 400 may include any equipment useful for the operation of the tracking device 400, such as components for storing, uploading, or analyzing data collected by the tracking device 400. Because the control device 300 and the tracking device 400 are separate components, they may be
10 located separately and remotely away from each other while maintaining a communication link. Accordingly, a user operating the control device 300 may be able to position or move the control device 300 to a variety of locations without correspondingly moving the tracking device 400. Thus, the mobility and portability of the control device 300 is enhanced by separation thereof from the
15 tracking device 400. As mentioned above, signals between the control device 300, the onboard devices 200a-f, and the tracking device 400 may be transmitted wirelessly to further enhance mobility.

[0040] According to some embodiments, the tracking device 400 includes one or more interfaces 416 for communicating stored data to other
20 devices. Data received, collected, and stored on the tracking device 400 may be accessible to a user during or after a procedure involving the cement head 100. Information collected from the control device 300 via command signals 392, and from the onboard devices 200 via the report signals 290, may be correlated and compared in a meaningful way. For example, a user may analyze timing of
25 commands and actuation of valves, levers, and/or plungers. The time span between the transmission of a user command from a control device 300 and the completion of an associated operation by the onboard device 200a-f may be determined and analyzed. For instance, a user may be able to compare the period of time from when a wellbore projectile (*i.e.*, dart, ball, plug, etc.) is
30 released from the cement head 100 to a pressure spike once the wellbore projectile lands on a downhole tool, shoulder, or obstruction. Commands and operations may also be compared with sensed parameters, such as pressure or temperature at or near one or more valves, levers, and/or plungers. The analysis may identify proper or improper operation, as well as any needed
35 optimizations to improve performance of the cement head 100.

[0041] Referring now to FIG. 6, with continued reference to FIG. 5, a conceptual block diagram of the communication system 500 is shown. The control device 300 is configured to transmit the first command signals 390, shown as command signals 390a, 390b, 390c, 390d, 390e, and 390f. Each of the command signals 390a-f may be associated with a respective onboard device 200a-f. For example, the first command signal 390a carries a user command indicator relating to operation of the first onboard device 200a. Data carried on a given command signal 390 may contain a reference identifier indicating which of the onboard devices 200 is intended to respond to the given command signal 390. Data carried on a given command signal 390 may contain an instruction that the intended onboard device 200 is to execute.

[0042] The control device 300 is also configured to transmit the second command signals 392, shown as command signals 392a, 392b, 392c, 392d, 392e, and 392f. Each of the command signals 392a-f may be associated with a respective onboard device 200a-f. Moreover, each of the command signals 392a-f may be transmitted for reception by the tracking device 400. In some embodiments, a given pair of command signals 390 and 392 may carry the same user command indicator. For example, the given pair of command signals 390 and 392 are transmitted at or about the same time. In some embodiments, a pair of command signals 390 and 392 may be separate propagations of a single signal. For example, the pair of command signals 390 and 392 may be different directional components of a multi-directional broadcast.

[0043] The onboard devices 200a-f may be configured to transmit the report signals 290a-f, respectively. Each of the report signals 290a-f may carry information associated with the corresponding onboard device 200a-f. Moreover, each of the report signals 290a-f may be received by the tracking device 400. A given report signal (e.g., report signal 290a) may be correlated with a corresponding command signal (e.g., command signal 392a).

[0044] Referring now to FIG. 7, with continued reference to FIGS. 5 and 6, a conceptual block diagram of the communication system 500 is shown. The control device 300 may include a processing system 302. The processing system 302 is capable of communication with a transmitter 309 through a bus 304 or other structures or devices. The processing system 302 can generate commands and/or other types of data to be provided to the transmitter 309 for communication by command signals 390, 392. In some embodiments, the

control device 300 may also include a receiver (not shown) and a power source (not shown).

[0045] The processing system 302 may include a processor for executing instructions and may further include a non-transitory machine-readable medium 319, such as a volatile or non-volatile memory, for storing data and/or instructions for software programs. The instructions may be executed by the processing system 302 to control and manage access to the various networks, as well as provide other communication and processing functions. The instructions may also include instructions executed by the processing system 302 for various components of the control device 300, such as a display 312, an input 314, and an interface 316.

[0046] The onboard device 200 shown in FIG. 7 is representative of any one of the onboard devices 200a-f of FIGS. 4-6. The onboard device 200 may include a processing system 202 capable of communication with a receiver 206 and a transmitter 209 through a bus 204 or other structures or devices. The processing system 202 can acquire, record, and generate data to be provided to the transmitter 209 for communication as the report signal 290. In addition, commands and/or other types of data, communicated as the command signal 390, can be received at the receiver 206 and processed by the processing system 202. A transceiver block 207 may represent one or more transceivers, and each transceiver may include a receiver 206 and a transmitter 209.

[0047] The processing system 202 may include a processor for executing instructions and may further include a non-transitory machine-readable medium 219, such as a volatile or non-volatile memory, for storing data and/or instructions for software programs. The instructions, which may be stored in the machine-readable medium 219, may be executed by the processing system 202 to control and manage access to the various networks, as well as provide other communication and processing functions. The instructions may also include instructions executed by the processing system 202 for various components of the onboard device 200, such as an onboard control 214 and one or more sensors 216.

[0048] According to some embodiments, the onboard device 200 may be configured to operate a corresponding mechanical device to which it is operably connected. For example, each onboard device 200 includes an onboard control 214 configured to open, partially open, close, partially close, activate,

and/or deactivate a corresponding valve. Such actions may be achieved by rotating or moving the valve. For example, the onboard device 200 may include a pneumatic actuator that operates a cell, canister, or tank of a compressible fluid for operation of a valve. The compressible fluid may include nitrogen, oxygen, air, or any compressible gas. At least a portion of the pneumatic actuator may connect to a chamber of the cement head 100, such as the internal control line 162 shown in FIG. 1D. In other embodiments, the onboard device 200 may include any other type of actuating device capable of manipulating a corresponding valve including, but not limited to, mechanical actuators, electromechanical actuators, hydraulic actuators, piston and solenoid assemblies, combinations thereof, and the like. By further example, such actions may be applied to other mechanical devices of the cement head 100, such as levers and/or plungers.

[0049] According to some embodiments, the onboard device 200 may further be configured to sense, detect, and/or measure one or more parameters of a corresponding mechanical device to which it is operably connected or one or more parameters of the cement head 100. For example, the sensors 216 may be sensitive to a state of the mechanical device (e.g., open, partially open, closed, partially closed, present, absent, and the like). For example, the sensors 216 may detect a time at which a mechanical device changes from one state (e.g., open) to another state (e.g., closed). The sensors 216 may detect the presence, absence, or motion of a plunger and an associated time. For example, one or more sensors 216 may detect a time at which a plunger is released and a time that the plunger arrives at a given location after release. The sensors 216 may further be sensitive to conditions within the cement head 100 (e.g., pressure, flow rate, temperature, proximity sensors, and the like). As will be appreciated, multiple sensors may be provided in or otherwise associated with each onboard device 200, each having a distinct sensitivity and function. In at least one embodiment, one or more sensors may also be installed in wellbore projectiles to be launched from the cement head 100.

[0050] According to some embodiments, the onboard device 200 may include a power source 212 for operation. For example, the power source 212 powers operation of the onboard control 214, the sensors 216, the receiver 206, the transmitter 209, and/or the processing system 202. The power source 212 may include a battery (e.g., a rechargeable battery), a generator, a solar panel,

and/or combinations thereof. As will be appreciated, a single power source 212 may be configured to provide power to more than one onboard device 200.

[0051] The tracking device 400 may include a processing system 402. The processing system 402 is capable of communication with a receiver 406
5 through a bus 404 or other structures or devices. Reports and/or other types of data, communicated as the report signal 290, can be received at the receiver 406 and processed by the processing system 402. The tracking device 400 may also include a transmitter (not shown). The tracking device 400 may also include a power source (not shown).

10 **[0052]** The processing system 402 may include a processor for executing instructions and may further include a non-transitory machine-readable medium 419, such as a volatile or non-volatile memory, for storing data and/or instructions for software programs. The instructions, which may be stored in a non-transitory machine-readable medium 410 and/or 419, may be
15 executed by the processing system 402 to control and manage access to the various networks, as well as provide other communication and processing functions. The instructions may also include instructions executed by the processing system 402 for various components of the tracking device 400, such as an interface 416 and the machine-readable medium 419. The machine-
20 readable medium 419 provides storage of data apart from the processing system 402. For example, data communicated as the report signal 290 may be recorded or otherwise stored in the machine-readable medium 419. The data may be further communicated between the tracking device 400 and another device, such as a computer, a server, or a hand-held device, for display, review,
25 analysis, or manipulation.

[0053] The processing systems 202, 302, 402 may be implemented using software, hardware, or a combination of both. By way of example, the processing systems 202, 302, 402 may each be implemented with one or more processors. A processor may be a general-purpose microprocessor, a
30 microcontroller, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA), a Programmable Logic Device (PLD), a controller, a state machine, gated logic, discrete hardware components, or any other suitable device that can perform calculations or other manipulations of information.

[0054] A machine-readable medium can be one or more machine-readable media. Software shall be construed broadly to mean instructions, data, or any combination thereof, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

5 Instructions may include code (e.g., in source code format, binary code format, executable code format, or any other suitable format of code).

[0055] Machine-readable media (e.g., 219, 319, 419) may include storage integrated into a processing system, such as might be the case with an ASIC. Machine-readable media (e.g., 410) may also include storage external to
10 a processing system, such as a Random Access Memory (RAM), a flash memory, a Read Only Memory (ROM), a Programmable Read-Only Memory (PROM), an Erasable PROM (EPROM), registers, a hard disk, a removable disk, a CD-ROM, a DVD, or any other suitable storage device. Those skilled in the art will recognize how best to implement the described functionality for the processing systems
15 202, 302, 402. According to one aspect of the disclosure, a machine-readable medium is a computer-readable medium encoded or stored with instructions and is a computing element, which defines structural and functional interrelationships between the instructions and the rest of the system, which permit the instructions' functionality to be realized. In one aspect, a machine-
20 readable medium is a non-transitory machine-readable medium, a machine-readable storage medium, or a non-transitory machine-readable storage medium. In one aspect, a computer-readable medium is a non-transitory computer-readable medium, a computer-readable storage medium, or a non-transitory computer-readable storage medium. Instructions may be executable,
25 for example, by a client device or server or by a processing system of a client device or server. Instructions can be, for example, a computer program including code.

[0056] The interfaces 316, 416 may be any type of interface and may reside between any of the components shown in FIG. 7. The interfaces 316, 416
30 may also be, for example, an interface to the outside world (e.g., an Internet network interface). A functionality implemented in a processing system may be implemented in a portion of a receiver, a portion of a transmitter, a portion of a machine-readable medium, a portion of a display, a portion of a keypad, or a portion of an interface, and vice versa.

[0057] As mentioned above, components (*i.e.*, transmitters, receivers) of the onboard device 200, the control device 300, and the tracking device 400 may be configured to perform wired or wireless communication. The transmitters and receivers may send and receive radio frequency (RF) signals, infrared (IR) frequency signals, or other electromagnetic signals. Any of a variety of modulation techniques may be used to modulate data on a respective electromagnetic carrier wave. Alternatively, wired communications may also be performed. Communications protocols for managing communication are known, and may include IEEE 802.11, IEEE 802.3, USB-compatible, Bluetooth, etc.

[0058] Referring now to FIG. 8, a flow chart illustrating a method 800 is shown. Various steps performed by the control device 300, the onboard device 200, and the tracking device 400 are illustrated.

[0059] As shown in FIG. 8, a user may provide a user command to the control device 300, as at 802. In response, the control device 300 transmits a user command indicator via a first command signal 390 and a second command signal 392, as at 804. In response to the first command signal 390, the onboard device 200 may operate a mechanical device, such as a valve, a lever, or a plunger, as at 806, and/or sense a parameter, as at 808. Furthermore, the onboard device 200, in response to the first command signal 390 or an additional command signal, may cease operation of the mechanical device, as at 810, and/or sense an additional parameter, as at 812. Each operation performed or parameter sensed by the onboard device 200 may generate a status indicator transmitted via a report signal 290, as at 814. Multiple report signals 290 may be transmitted or a single report signal 290 containing multiple data values may be transmitted.

[0060] As further shown in FIG. 8, the tracking device 400 receives the second command signal 392 and its associated user command indicator. In response, the tracking device 400 records the user command indicator, as at 816. Further, the tracking device 400 receives the report signal 290 and its associated status indicator from the onboard device 200. In response, the tracking device 400 records the status indicator, as at 818.

[0061] Additional user commands may be provided to the control device 300 at any time during the operation described and illustrated in FIG. 8. The additional user commands may the control device 300, the onboard device 200,

and/or the tracking device 400 to perform additional operations subsequent to or simultaneous with previously initiated operations.

[0062] The steps illustrated, a subset of the steps illustrated, or additional steps may be performed in any order. Any two or more steps may be performed in series or in parallel (e.g., simultaneously). Furthermore, operations associated with the control device 300, the onboard device 200, or the tracking device 400 as illustrated in FIG. 8 may be performed by a device other than the device as shown in FIG. 8. Multiple methods 800 may be performed in series or in parallel. For example, a method 800, or portions thereof, may be performed for each of a plurality of onboard devices 200.

[0063] Embodiments disclosed herein include:

[0064] A. A system that includes a control device configured to transmit user command indicators in the form of first command signals and second command signals, an onboard device operably connected to a mechanical device of a cement head and configured to receive the first command signals from the control device and operate the mechanical device in response thereto, the onboard device being further configured to prepare and transmit a report signal, wherein the report signal encompasses a status indicator of the cement head, and a tracking device configured to receive the second command signals from the control device and the status indicator from the onboard device, the tracking device being further configured to record the user command indicators and the status indicator.

[0065] B. A method that includes transmitting a first command signal to an onboard device from a control device, operating a mechanical device of a cement head with the onboard device in response to the first command signal, transmitting a report signal to a tracking device, the report signal encompassing a status indicator of the cement head, recording the status indicator from the onboard device with the tracking device, transmitting the user command indicator from the control device to the tracking device via a second command signal, and recording the user command indicator with the tracking device.

[0066] C. A method that includes transmitting a first command signal to an onboard device with a control device, transmitting a second command signal to a tracking device with the control device, operating a mechanical device of a cement head with the onboard device in response to the first command signal, transmitting a status indicator of the cement head from the onboard

device to the tracking device via a report signal, and recording the status indicator and the second command signal with the tracking device.

[0067] Each of embodiments A, B, and C may have one or more of the following additional elements in any combination: Element 1: wherein the user
5 command indicator comprises a time that the control device transmits the user command indicator. Element 2: wherein the status indicator comprises a time that the onboard device receives the first command signals, a parameter sensed by a sensor of the onboard device, a time that the onboard device commences
10 an operation of the mechanical device, or a time that the onboard device ceases an operation of the mechanical device. Element 3: further comprising a report signal wherein the first command signal, the second command signal, and the report signal are wireless signals. Element 4: wherein the control device comprises a wireless transmitter, the onboard device comprises a wireless receiver and a wireless transmitter, and the tracking device comprises a wireless
15 receiver. Element 5: wherein the onboard device comprises a sensor configured to sense one or more parameters of the cement head. Element 6: wherein the mechanical device is a valve, a lever, or a plunger.

[0068] Therefore, the disclosed systems and methods are well adapted to attain the ends and advantages mentioned as well as those that are inherent
20 therein. The particular embodiments disclosed above are illustrative only, as the teachings of the present disclosure may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims
25 below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered, combined, or modified and all such variations are considered within the scope of the present disclosure. The systems and methods illustratively disclosed herein may suitably be practiced in the absence of any element that is not specifically disclosed herein and/or any optional element disclosed herein. While compositions and methods are described in
30 terms of "comprising," "containing," or "including" various components or steps, the compositions and methods can also "consist essentially of" or "consist of" the various components and steps. All numbers and ranges disclosed above may vary by some amount. Whenever a numerical range with a lower limit and an
35 upper limit is disclosed, any number and any included range falling within the

range is specifically disclosed. In particular, every range of values (of the form, "from about a to about b," or, equivalently, "from approximately a to b," or, equivalently, "from approximately a-b") disclosed herein is to be understood to set forth every number and range encompassed within the broader range of values. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. Moreover, the indefinite articles "a" or "an," as used in the claims, are defined herein to mean one or more than one of the element that it introduces. If there is any conflict in the usages of a word or term in this specification and one or more patent or other documents that may be incorporated herein by reference, the definitions that are consistent with this specification should be adopted.

CLAIMS

What is claimed is:

1. A system, comprising:
 - a control device configured to transmit user command indicators in the form of first command signals and second command signals;
 - an onboard device operably connected to a mechanical device of a cement head and configured to receive the first command signals from the control device and operate the mechanical device in response thereto, the onboard device being further configured to prepare and transmit a report signal, wherein the report signal encompasses a status indicator of the cement head; and
 - a tracking device configured to receive the second command signals from the control device and the status indicator from the onboard device, the tracking device being further configured to record the user command indicators and the status indicator.
2. The system of claim 1, wherein the user command indicator comprises a time that the control device transmits the user command indicator.
3. The system of claim 1, wherein the status indicator comprises a time that the onboard device receives the first command signals, a parameter sensed by a sensor of the onboard device, a time that the onboard device commences an operation of the mechanical device, or a time that the onboard device ceases an operation of the mechanical device.
4. The system of claim 1, further comprising a report signal wherein the first command signal, the second command signal, and the report signal are wireless signals.
5. The system of claim 1, wherein the control device comprises a wireless transmitter, the onboard device comprises a wireless receiver and a wireless transmitter, and the tracking device comprises a wireless receiver.
6. The system of claim 1, wherein the onboard device comprises a sensor configured to sense one or more parameters of the cement head.
7. The system of claim 1, wherein the mechanical device is a valve, a lever, or a plunger.
8. A method, comprising
 - transmitting a first command signal to an onboard device from a control device;

operating a mechanical device of a cement head with the onboard device
in response to the first command signal;
transmitting a report signal to a tracking device, the report signal
encompassing a status indicator of the cement head;
recording the status indicator from the onboard device with the tracking
device;
transmitting the user command indicator from the control device to the
tracking device via a second command signal; and
recording the user command indicator with the tracking device.

9. The method of claim 8, wherein the user command indicator
comprises a time that the control device transmits the user command indicator.

10. The method of claim 8, wherein the status indicator comprises a
time that the onboard device receives the user command indicator.

11. The method of claim 8, wherein the status indicator comprises a
parameter sensed by a sensor of the onboard device.

12. The method of claim 8, wherein the status indicator comprises a
time that the onboard device commences an operation of the mechanical device.

13. The method of claim 8, wherein the status indicator comprises a
time that the onboard device ceases an operation of the mechanical device.

14. The method of claim 8, further comprising wirelessly transmitting
and receiving the first command signal, the second command signal, and the
report signal.

15. The method of claim 8, wherein the first command signal comprises
a time that the control device transmits the first command signal.

16. The method of claim 8, wherein the mechanical device is a valve, a
lever, or a plunger.

17. A method, comprising:

transmitting a first command signal to an onboard device with a control
device;

transmitting a second command signal to a tracking device with the
control device;

operating a mechanical device of a cement head with the onboard device
in response to the first command signal;

transmitting a status indicator of the cement head from the onboard
device to the tracking device via a report signal; and

recording the status indicator and the second command signal with the tracking device.

18. The method of claim 17, wherein one or both of the first and second command signals comprises a time that the control device transmits the first or second command signals.

19. The method of claim 17, wherein the status indicator comprises a time that the onboard device receives the first command signal.

20. The method of claim 17, wherein the status indicator comprises a parameter sensed by a sensor of the onboard device.

21. The method of claim 17, wherein the status indicator comprises a time that the onboard device commences an operation of the mechanical device.

22. The method of claim 17, wherein the status indicator comprises a time that the onboard device ceases an operation of the mechanical device.

23. The method of claim 17, further comprising wirelessly transmitting and receiving the first command signal, the second command signal, and the report signal.

24. The method of claim 17, wherein the mechanical device is a valve, a lever, or a plunger.