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(54) Title: SYSTEMS AND METHODS OF CONTROLLING OILFIELD EQUIPMENT VIA INDUCTIVE COUPLING

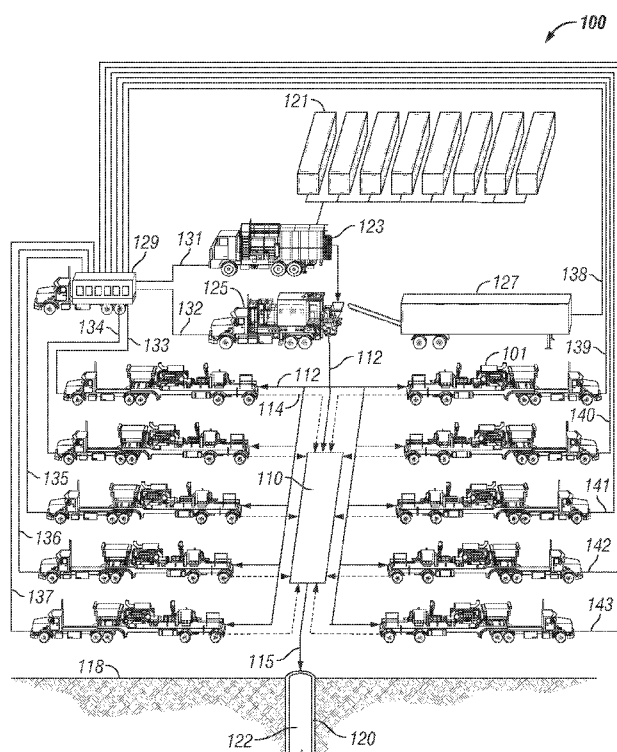


FIG. 1
(Prior Art)

(57) Abstract: [0057] The current application discloses methods and systems for controlling various pieces of equipment at a wellsite. The method comprises deploying a first piece of oilfield equipment at a wellsite; deploying a second piece of oilfield equipment at the wellsite; connecting the first piece of oilfield equipment and the second piece of oilfield equipment with a cable, where at least one of the connections between the cable and the first piece of oilfield equipment and between the cable and the second piece of oilfield equipment is via inductively coupling. Additional pieces of oilfield equipment can be deployed at the wellsite and inductively coupled by the cable in the similar manner.

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SYSTEMS AND METHODS OF CONTROLLING OILFIELD EQUIPMENT VIA INDUCTIVE COUPLING

RELATED APPLICATION DATA

[0001] None.

BACKGROUND

[0002] The statements in this section merely provide background information related to the present disclosure and may not constitute prior art. All references discussed in the current application are incorporated by reference in their entireties unless expressly indicated otherwise.

[0003] In large scale industrial operations, such as drilling, logging, cementing, or fracturing operations in the oil and gas industry, multiple pieces of equipment, such as machines, containers, pumps, mixers and so on, are often deployed at a work site to perform various tasks of the operation. Several, if not all, of these machines, containers, pumps and mixers are often connected together at the work site and controlled by a local computer unit for better coordination and execution of the operation. The connection between the local control unit and the multiple pieces of equipment is often via electrical wires, although in recent years people also tried to use local wireless network at the work site for equipment control.

[0004] However, due to the inclement environment and/or poor maintenance at the work site, electrical wires are often susceptible to mechanical wear, debris, corrosions, etc. As the number of pieces of equipment increases, the chance of connection failure will increase. Moreover, because the equipment can be set up and arranged in many different positions, each connecting electrical wire needs to be longer than the maximum possible distance between two pieces of equipment that need to be connected at the work site. This increases the total number and volume of electrical wires that need to be transported to the work site and maintained at the work site.

[0005] A local wireless network offers some benefits. However, a significant drawback associated with the use of the local wireless network is that the wireless signal

transmitted on the network is often unreliable. Interferences from internal and external sources cannot be fully eliminated, and an interrupted or unstable signal may cause serious damages to the equipment or personnel at the work site.

[0006] Accordingly, a need exists for an improved system and method of controlling multiple pieces of equipment at a work site.

SUMMARY

[0007] According to one aspect, there is provided a method of controlling various pieces of equipment at a wellsite. The method comprises deploying a first piece of oilfield equipment at a wellsite; deploying a second piece of oilfield equipment at the wellsite; connecting the first piece of oilfield equipment and the second piece of oilfield equipment with a cable; where at least one of the connections between the cable and the first piece of oilfield equipment and between the cable and the second piece of oilfield equipment is via inductively coupling. When needed, additional pieces of oilfield equipment can be deployed at the wellsite and inductively coupled by the cable.

[0008] A sensor such as an inductive sensor or a Hall-effect sensor may be provided in the oilfield equipment so that inductively coupling can be achieved between the cable and the sensor. Optionally, two sensors are provided in the oilfield equipment for inductively coupling with the cable. Optionally, more than two sensors are provided in the oilfield equipment for inductively coupling with the cable.

[0009] The cable may comprise one strand of conductive material surrounded by one or more layers of non-conductive material. Alternatively, the cable may comprise two strands of conductive material surrounded by one or more layers of non-conductive material. In some cases, the cable originates from the first piece of oilfield equipment and ends with the first pieces of oilfield equipment to form a closed loop at the wellsite. In some other cases, the cable originates from a first point and ends at a second point that differs from the first point, therefore does not form a closed loop at the wellsite. In one embodiment, a reel is provided at one or both of the first point and the second point so that any unused portion of the cable can be wound upon the reel(s) for improved tidiness and portability. In another embodiment, an emergency stop button is provided at one end or in the middle of the cable so that emergency shutdown action can be performed at the wellsite by activating the emergency stop button.

[0010] According to another aspect, there is provided a system comprising a first piece of oilfield equipment deployed at a wellsite; a second piece of oilfield equipment deployed at the wellsite; and a cable that connects the first piece of oilfield equipment and the second piece of oilfield equipment; wherein at least one of the connections between the cable and the first piece of oilfield equipment and between the cable and the second piece of oilfield equipment is via inductively coupling. In one embodiment, the first piece of oilfield equipment generates a signal that is transmitted on the cable to the second piece of oilfield equipment and can be inductively detected by the second piece of oilfield equipment. Alternatively or additionally, the second piece of oilfield equipment generates a signal that is transmitted on the cable to the first piece of oilfield equipment and can be inductively detected by the first piece of oilfield equipment. The system may further comprise a connector located on an external surface of the second piece of oilfield equipment, and the cable passes through the connector. The system may further comprise fastening device to secure the cable inside the connector.

[0011] According to a further aspect, there is provided a method comprising deploying a control unit at a wellsite; deploying a plurality of pieces of oilfield equipment at the wellsite; connecting a cable with the control unit and the plurality of pieces of oilfield equipment; effectuating a communication between the plurality of pieces of oilfield equipment and the control unit via the cable through inductive coupling. In one embodiment, said communication is to shut down one or more of the plurality of pieces of oilfield equipment at the same time. The control unit can be an emergency stop button or a computerized control system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and other features and advantages will be better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings.

[0013] FIG. 1 is a schematic representation of a system for controlling various pieces of equipment performing a hydraulic fracturing operation on a well site according to one embodiment of the prior art.

[0014] FIG. 2A is a schematic representation of a system for controlling various pieces of equipment performing a hydraulic fracturing operation on a well site according to one embodiment of the current application.

[0015] FIG. 2B is an exploded view of section “2B” in **FIG. 2A**, illustrating a schematic representation of an inductive coupling mechanism according to one embodiment of the current application.

[0016] FIG. 2C is a cross-sectional view of an inductive coupling mechanism according to one embodiment of the current application.

[0017] FIG. 2D is a cross-sectional view of an inductive coupling mechanism according to another embodiment of the current application.

[0018] FIG. 3A is a schematic representation of a system for controlling various pieces of equipment performing a hydraulic fracturing operation on a well according to another embodiment of the current application.

[0019] FIG. 3B is a schematic representation of a double-strand cable that can be used in the system illustrated in **FIG. 3A** according to one embodiment of the current application.

[0020] FIG. 3C is a cross-sectional view of an inductive coupling mechanism according to one embodiment of the current application.

[0021] FIG. 3D is a cross-sectional view of an inductive coupling mechanism according to another embodiment of the current application.

[0022] FIG. 4A is a schematic representation of an inductive coupling mechanism according to another embodiment of the current application.

[0023] FIG. 4B is a cross-sectional view of the inductive coupling mechanism of **FIG. 4A** along axis **4B-4B’**.

DETAILED DESCRIPTION OF SOME ILLUSTRATIVE EMBODIMENTS

[0024] FIG. 1 illustrates a prior art system and method for controlling multiple pieces of equipment in an exemplary oilfield operation such as a hydraulic fracturing operation. The system **100** delivers a fracturing fluid from a surface **118** of a well **120** to a wellbore **122** during the fracturing treatment operation. A plurality of water tanks **121** feed water to a gel maker **123**. The gel maker **123** combines water from the tanks **121** with a gelling agent to form a gel. The gel is then sent to a blender **125** where it is mixed with a proppant from a proppant feeder **127** to form a fracturing fluid. The gelling agent increases the viscosity of the fracturing fluid and allows the proppant to be suspended in

the fracturing fluid. It may also act as a friction reducing agent to allow higher pump rates with less frictional pressure.

[0025] The fracturing fluid is then pumped at low pressure (for example, around 60 to 120 psi) from the blender **125** to a plurality of plunger pumps **101** as shown by solid lines **112**. Each plunger pump **101** receives the fracturing fluid at a low pressure and discharges it to a common manifold **110** (sometimes called a missile trailer or missile) at a high pressure as shown by dashed lines **114**. The missile **110** then directs the fracturing fluid from the plunger pumps **101** to the wellbore **122** as shown by solid line **115**.

[0026] A local control unit **129**, which is illustrated in **FIG. 1** as a computerized control system mounted on a vehicle, may be deployed at the wellsite to coordinate the multiple pieces of equipment and control the operation of the entire system **100** for the duration of the fracturing operation.

[0027] In this prior art embodiment, each piece of equipment is connected to the local control unit **129** via an electrical wire, such as a computer network cable, a power cable, or a combination of same. For example, cable **131** connects the local control unit **129** to the gel maker **123** to control the speed or other parameters of the gel making. Cable **132** connects the local control unit **129** to the blender **125** to control the speed or other parameters of mixing the gel with the proppant. Cable **138** connects the local control unit **129** to the proppant feeder **127** to control the speed or other parameters of the proppant delivering. Finally, each of the cables **133**, **134**, **135**, **136**, **137**, **139**, **140**, **141**, **142**, **143** connects the local control unit **129** to a corresponding plunger pump **101** to control the speed or other parameters of the plunger pump **101** in pumping the fracturing fluid down to the wellbore **122**.

[0028] Typically, at least two electrical connections need to be established for each piece of equipment (also referred to as a "node"). One electrical connection is formed between the equipment and one end of the cable, for example by inserting the cable into an electrical connector or socket located on the body of the equipment. The other electrical connection is formed between the local control unit **129** and the other end of the cable, for example by inserting the other end of the cable into an electrical connector or socket located on the body of local control unit **129**.

[0029] Because these electrical connections rely greatly on the clean contact between two conductive materials, they are highly susceptible to inclement environment. For example, in an oilfield operation, the temperature can be extremely high (e.g. more than 40 °C if the well site is located around the equator or in a desert and the operation is during a summer sunny day) or extremely low (e.g. below -20 °C if the well site is located in Alaska, Alberta or Siberia and the operation is during the winter time). The oilfield can also be wet, salty, muddy and/or dusty. Corrosive chemicals may be present in the air and in the fluid, due to gas and oil erupted from the wellbore as well as materials introduced by the oilfield operators. All such conditions may impact on the integrity of the electrical connection. Therefore, the electrical connections in the prior art system must be routinely inspected and maintained. Non-compliance with the maintenance schedule may lead to failures of the electrical connection, which may cause delays or catastrophic consequences to the oilfield operation.

[0030] Moreover, because the equipment can be set up and arranged in many different positions, each connecting electrical wire needs to be longer than the maximum possible distance between two pieces of equipment that need to be connected at the work site. This increases the total number and volume of electrical wires that need to be transported to the work site and maintained at the work site.

[0031] Therefore, according to one embodiment of the current application, **FIG. 2A** illustrates a system and method for controlling multiple pieces of equipment in an industrial operation such as a hydraulic fracturing operation in the oilfield. Similar to the system **100** described in **FIG. 1** above, a system **200** as shown in **FIG. 2A** is provided which delivers a fracturing fluid from a surface **118** of a well **120** to a wellbore **122** during the fracturing treatment operation. A plurality of water tanks **221** feed water to a gel maker **223**, which combines water from the tanks **221** with a gelling agent to form a gel. The gel is then sent to a blender **225** where it is mixed with a proppant from a proppant feeder **227** to form a fracturing fluid. The fracturing fluid is then pumped from the blender **225** to a plurality of plunger pumps **201** as shown by solid lines **212**. Each plunger pump **201** receives the fracturing fluid at a low pressure and discharges it to a common manifold or missile **210** as shown by dashed lines **214**. The missile **210** then directs the fracturing fluid from the plunger pumps **201** to the wellbore **122** as shown by solid line **215**. A local control unit **229**, which is illustrated in **FIG. 2A** as a computerized control system mounted on a vehicle, may be deployed at the wellsite to coordinate the

multiple pieces of equipment and control the operation of the entire system **200** for the duration of the fracturing operation.

[0032] Unlike the prior art embodiment in **FIG. 1** where each piece of equipment is connected to the local control unit **129** via an electrical wire, in the exemplary embodiment as shown in **FIG. 2A**, a single cable **250** is provided to connect multiple pieces of equipment to the local control unit **229**. In the illustrated embodiment, cable **250** starts from the local control unit **229** and connects first to the gel maker **223**, then the blender **225**, the plurality of plunger pumps **201**, the proppant feeder **227**, and finally returns back to the local control unit **129** to form a closed loop.

[0033] In one embodiment, no electrical connection is formed between the cable and each piece of equipment. Instead, an inductive coupling is formed between the cable and each piece of equipment. In another embodiment, an electrical connection is formed only between the cable **250** and the local control unit **229**. In yet another embodiment, an electrical connection is formed between the cable **250** and one or more pieces of equipment deployed at the wellsite, including for example the local control unit **229**, but at least one an inductive coupling is formed between the cable and a piece of equipment deployed at the wellsite.

[0034] **FIG. 2B** shows an exploded view of one example of the inductive coupling mechanism that can be used in the current application, where a hook-shaped connector **255** is provided on the front bumper of a vehicle and the cable **250** is placed inside the cavity of the hook-shaped connector **255**. It should be understood that although the connector **255** is illustrated in the shape of a hook in **FIG. 2B**, people skilled in the art can readily amend the connector **255** into any shape that is suitable for receiving cable **250**. All such variations should be considered within the scope of the current application. Moreover, additional structures can be added to the connector **250** to improve the integrity and/or functionality of the coupling between connector **255** and connector **250**. For example, a lock (not shown) can be provided at the opening of the connector **255** which can open or close the cavity of the connector **255**. Other variations are possible.

[0035] **FIG. 2C** shows a cross-sectional view of the inductive coupling mechanism in **FIG. 2B** where the cable **250** rests in the cavity of the hook-shaped connector **255**. In the illustrated embodiment, cable **250** comprises a conductive core **251** (such as a

strand of copper wire) and an insulation layer surrounding the conductive core **251**. In one embodiment, the cable can be secured to a predetermined position inside the cavity of the connector **255** by a set of fasteners **252**, **253**. For example, as shown in **FIG. 2C**, a pair of protrusions **253** may be provided on the internal surface of the cavity of the connector **255**, which can matingly engage (e.g. “snap in”) a pair of recesses **252** formed on the external surface of the cable **250**. In such an embodiment, the cable can be secured at a location inside the cavity of connector **255** and its relative position with respect to the sensor **254** (see below) will not change during the course of an industrial operation.

[0036] For each sensor, the magnitude of the signal that is induced in the sensor and detected by the sensor typically varies depending on the proximity of the cable **250** to the sensor. If the cable **250** moves closer to the sensor, a stronger signal will be induced in the sensor and detected by the sensor. Conversely, if the cable **250** moves further away from the sensor, a weaker signal will be induced in the sensor and detected by the sensor. Therefore, when a single sensor **254** is used in the system **200**, such as illustrated in **FIG. 2C**, it is often desirable to fasten the cable **250** to a fixed location inside the cavity of the connector **255** so that the position of the cable **250** with respect to the position of the sensor **254** does not change significantly during an operation at the work site.

[0037] The sensor **254** can be embedded in the connector **255** or be deployed at any location that is capable of detecting signals carried on the cable **250**. The sensor **254** can be any type of sensor that is capable of being inductively coupled to the cable **250** without forming an electrical connection with the cable **250**. The external surface of the sensor **254** can be in physical contact with the external surface of the cable **250**, however, no electrical contact should be formed between the sensor **254** and the conductive core **251** of the cable **250**. Stated in other words, the sensor **254** of the current application only forms inductive coupling with the cable **250**; the sensor **254** does not form electrical connection or electrical coupling with the cable **250**. Accordingly, the communication between the sensor **254** and the cable **250** is much more tolerant of inclement environment at an industrial work site.

[0038] In one embodiment, the sensor **254** is an inductive sensor comprising a highly permeable core, such as a ferrite core in a rod or “C” shape, surrounded by a series of

conductive coils wound on the core. In another embodiment, the sensor **254** is a Hall effect sensor which is capable of detecting the current flowing through a transmitter wire such as the cable **250**. Other forms and types of sensors can also be used in the current application, such as the ones disclosed in U.S. Patent Application Publication No. 2008/0007253, U.S. Patent No. 4438394, U.S. Patent No. 4709205, U.S. Patent No. 6437555, U.S. Patent No. 5416407, U.S. Patent No. 5874848, and the like, the entire contents of which are incorporated by reference into the current application.

[0039] The sensor **254** can be further connected to an electrical circuit (not shown) located in the equipment (e.g. truck) where the detected signal can be amplified and analyzed. In one embodiment, a capacitor is connected in parallel to the inductor to create a parallel resonance tank circuit which resonates at a predetermined frequency transmitted on the cable **250**. In such an embodiment, the parallel resonance circuit can effectively attenuate out undesired band frequencies. The output signal from the tank circuit can be fed to a high impedance amplifier and then digitized to detect the desired signature transmitted on the cable **250**. Other forms of electrical circuits can also be used in the current application, such as the ones disclosed in U.S. Patent No. 5608318, U.S. Patent No. 5796232, U.S. Patent No. 5559454, and the like, the entire contents of which are incorporated by reference into the current application.

[0040] In operation, the local control unit **229** causes a signal to be transmitted along the cable **250** from the local control unit **229** to the multiple pieces of equipment located at the work site. The signal can be in the form of a single predetermined frequency, a combination of multiple predetermined frequencies, a single digital code, or a combination of multiple digital codes. Depending on the particular setting and design of the system **200**, the signal can be picked up by one predetermined sensor **254** located on one predetermined piece of equipment, i.e. a “one-to-one type of communication”. Alternatively, the signal can be picked up by a plurality of sensors **254** located on a plurality of pieces of equipment, i.e. a “one-to-more type of communication”. Moreover, the signal transmitted on cable **250** can be designed to be picked up by all sensors **254** located on all equipment that is deployed at the work site, i.e. a “one-to-all type of communication”. A mixture of one-to-one, one-to-more and one-to-all types of communication can also be designed depending on the need at the work site.

[0041] The one-to-one type of communication can be useful when a command needs to be transmitted to a single piece of equipment that is connected by the cable **250**. The one-to-more type of communication can be useful when a plurality of pieces of equipment need to carry out a same action at the same time. The one-to-all type of communication can be useful in situations when all equipment deployed at the work site needs to carry out a same action at the same time, such as a “switch on” action at the beginning of a project, a “shut down” action at the end of a project, or an “emergency shutdown” action when a hazardous event occurred at the work site and the entire system needs to be urgently turned off to protect the personnel or equipment at the work site.

[0042] It should be noted that the local control station **229** does not have to be the only location where the commanding signal can be introduced into the system **200**. One or more intermediate control units **260** can be positioned along the cable **250**. Therefore, when situation justifies, an operator at the work site can enter commands at the intermediate control unit **260**, have the commanding signal transmitted along the cable **250** and picked up by the sensors **254** located on the desired equipment, and control the activity of the desired equipment. In one embodiment, the intermediate control unit **260** is an emergency stop button so that once the emergency stop button is pressed, the cable **250** is severed or otherwise electrically disconnected so that no further signal can be transmitted on the cable **250**. The sensors **254** and the circuits on the equipment can be designed in such a way that a sudden disappearing of a constant baseline signal transmitted on the cable **250** indicates a command of an emergency shutdown (or idling), and the equipment will shut down (or idle) accordingly. Alternatively, the emergency stop button can be designed in such a way that once it is pressed, a distinct frequency or digital code will be transmitted along the cable **250** to command all equipment to perform an immediate shut down or idling. Variations to these embodiments are possible and can be readily perceived by people skilled in the art upon reviewing the current application. All such variations should be considered within the scope of the current application.

[0043] **FIG. 2D** illustrates an alternative embodiment where multiple sensors are used in the system **200**. In some cases, two sensors **254&254'**, or **254&254''**, or **254'&254''** are used. In some other cases, more than two sensors **254**, **254'**, **254''** are used. The multiple sensors can be spaced from each other at a predetermined angle. For

example, in the illustrated example, the first sensor **254** is spaced approximately 90 degrees apart from the second sensor **254'**, and the second sensor **254'** is spaced approximately 90 degrees apart from the third sensor **254''**. Other variations are possible.

[0044] When two or more sensors **254**, **254'**, **254''** are used in the system, the exact position of the cable **250** in the connector **255** becomes less important. The cable **250** may vibrate, turn, slide, or otherwise change positions inside the cavity of the connector **255**. Each sensor will pick up a signal from the cable **250**. When the cable **250** moves closer to one sensor, the cable **250** often moves away from another sensor. Therefore, under most circumstances, the combination of signals from all sensors does not change significant so long as the cable **250** remains inside the cavity of the connector **255**. Thus, a system **200** with two or more sensors is more tolerant of position changes of the cable **250**. Accordingly, the fastening devices **252**, **253** as shown in **FIG. 2C** can be eliminated when two or more sensors **254**, **254'**, **254''** are used in the system.

[0045] It should be noted that even only a single sensor **254** is used in the system **200**, it is not absolutely necessary to have fastening devices **252**, **253** to secure the cable **250** in the connector **255**. For example, when the sensor **254** has an effective detection range that is equal to or greater than the maximum possible distance from the sensor **254** to the conductive core **251** of the cable **250**, a single sensor **254** without any fastening devices **252**, **253** can reliably detect the signal carried on the cable **250**. In another example, if the signal transmitted on the cable **250** is sufficiently strong and/or unique that any position change of the cable **250** inside the cavity of the **255** will produce a relatively small variant in terms of the signal detected by the sensor **254**, there would be no jeopardy to the proper interpretation of the signal transmitted on the cable **250**. Accordingly, there would be no need to secure the cable **250** to the connector **255**. One example of such scenario is where the system **200** is used primarily for the purpose of effectuating an emergency shutdown to the system **200** when an incidence occurs at the work site. In such a situation, the cable **250** may constantly deliver a very strong baseline signal to all equipment connected by the cable **250**. When the emergency stop button **260** is pressed by the operator who has observed a hazardous situation at the well site, the strong baseline signal on the cable **250** will be terminated. The sudden disappearance of the baseline signal will be picked up by the sensor **254** no matter where the cable **250** is located inside the cavity of the connector **255**. In this case, no

fastening device is needed. Other variations are also possible and can be readily perceived by people skilled in the art upon reviewing the current application. All such variations should be considered within the scope of the current application..

[0046] **FIG. 3A** to **FIG. 3D** illustrate a further improved system and method of the current application. Similar to the system **200** as in **FIG. 2A** above, a system **300** is provided in **FIG. 3A** which delivers a fracturing fluid from a surface **118** of a well **120** to a wellbore **122** during a fracturing treatment operation. A plurality of water tanks **321** feed water to a gel maker **323**, which combines water from the tanks **321** with a gelling agent to form a gel. The gel is then sent to a blender **325** where it is mixed with a proppant from a proppant feeder **327** to form a fracturing fluid. The fracturing fluid is then pumped from the blender **325** to a plurality of plunger pumps **301** as shown by solid lines **312**. Each plunger pump **301** receives the fracturing fluid at a low pressure and discharges it to a common manifold or missile **310** as shown by dashed lines **314**. The missile **310** then directs the fracturing fluid from the plunger pumps **301** to the wellbore **122** as shown by solid line **315**. A local control unit **329**, which is illustrated in **FIG. 3A** as a computerized control system mounted on a vehicle, may be deployed at the wellsite to coordinate the multiple pieces of equipment and control the operation of the entire system **300** for the duration of the fracturing operation.

[0047] Unlike the embodiment in **FIG. 2A** where multiple pieces of equipment are connected by a single cable **250** which originates from the local control unit **129** and returns back to the local control unit **129** to form a closed loop, in the embodiment as shown in **FIG. 3A**, the cable **350** originates from a first point and ends at a second point that differs from the first point so that no closed loop is formed by the cable **350**. In one case, as shown in **FIG. 3A**, the first point is a reel of cable **356'** and the second point is another reel of cable **356**. In another case (not shown), the first point is the local control unit **129** and the second point is a reel of cable **356**. In a further case (not shown), the first point is a reel of cable **356'** and the second point is the proppant feeder **327**. In yet another case (not shown), the second point is an emergency stop button similar to the one discussed above. Other variations are possible.

[0048] The cable **350** may comprise two strands of conductive materials **351**, **351'** as shown in **FIG. 3B**. At one end of the cable **350**, the two strands of conductive materials **351**, **351'** can be connected to a power source, such as an electrical connector or socket

(not shown). At the other end of the cable **350**, the two strands of conductive materials **351**, **351'** can be connected to a resistor (not shown) or other electrical component so that the two strands **351**, **351'** can form a closed circuit within the cable **350**. Other variations are possible.

[0049] Referring now to **FIG. 3C** and **FIG. 3D**, when the cable **350** is placed inside the cavity of the connector **355**, the signal carried on the cable **350** can be picked up by sensor **354** (**FIG. 3C**), or two or more sensors **354**, **354'**, **354''** (**FIG. 3D**). Fastening devices **352**, **353** can be optionally included, as described above. However, in the current embodiment where two strands of conductive materials **351**, **351'** are included in the cable **350**, fastening devices **352**, **353** are even less necessary because the sensor(s) **354**, **354'**, **354''** will pick up the signals from both strands of conductive materials **351**, **351'**. Therefore, movements such as vibrating, sliding, and twisting of cable **350** inside the cavity of the connector **355** will produce less variations to the sum of the signals induced by both strands of conductive materials **351**, **351'**.

[0050] The system **300** may also optionally include one or more emergency stop buttons (not shown) as described above.

[0051] It should be noted that although the above description is set forth in the context of a hook-shaped connector **255**, **355** with a cable **250**, **350** passing through the connector **255**, **355**, variations are possible without departing from the general principle of the current application. For example, instead of having the cable **250**, **350** passing straightly through the connector **255**, **355**, the cable **250**, **350** can be looped around the body of the connector **255**, **355** for one or more turns. Moreover, instead of using a hook-shaped connector **255**, **355** to host the cable **250**, **350**, a "snap in" type of cable holder **455** can be placed on an external surface of a piece of equipment, such as the bumper **470** of a truck, as shown in **FIGs. 4A** and **4B**. In one embodiment, the diameter of the cable **450** is larger than the opening of the connector **455** defined by the tips of the two arms **455a**, **455b** of the connector **455**. In such an event, the cable **450** can be lodged into the cavity of the connector **455** by pressing the cable **450** against the tips of the two arms **455a**, **455b**, which temporarily widens the distance between the tips of the two arms **455a**, **455b** and allows the cable **450** to enter the cavity of the connector **455**. Once the cable **450** passes the opening of the connector **455**, the two arms **455a**, **455b**

resume their initial positions and secure the cable **450** inside the cavity of the connector **455**.

[0052] Moreover, in the illustrated embodiment in **FIGs. 4A** and **4B**, the sensor **454** is embedded in the bumper **470**. However, the sensor **454** can also be embedded in the connector **455** in a fashion similar to that illustrated in **FIGs. 2C, 2D, 3C, and 3D**. In some cases, one sensor is used; in some other cases, two or more sensors are used. Other variations are also possible.

[0053] Furthermore, it should also be noted that although the above description is set forth in the context of transmitting signals from a control station to one or more pieces of equipment, the reverse can be applicable as well. That is, the equipment emits signals that can be inductively detected by the cable and transmitted along the cable to a desired location, such as the local control unit and/or another piece of equipment. In some cases, the “sensor” as described in **FIGs. 2-4** above is also capable of emitting electromagnetic signals. In some other cases, the “sensor” as described in **FIGs. 2-4** is further connected to a piece of hardware that is capable of emitting electromagnetic signals. In some further cases, a separate, stand alone component is used to emit electromagnetic signals that can be picked up by the cable. In any event, the system and method of the current application can be used to effectuate a two-way communication via inductive coupling.

[0054] It should also be noted that although the above description is set forth in the context of conducting a hydraulic fracturing operation in an oilfield, embodiments of the current application are also applicable to other oilfield operations including, but not limited to, drilling, cementing, logging, working over, stimulating, producing, and so on. Moreover, embodiments of the current application may also be applicable to other industries as well, such as construction, manufacture, transportation, just to name a few.

[0055] The preceding description has been presented with reference to some illustrative embodiments of the Inventors’ concept. Persons skilled in the art and technology to which this application pertains will appreciate that alterations and changes in the described structures and methods of operation can be practiced without meaningfully departing from the principle, and scope of this application. Accordingly, the foregoing description should not be read as pertaining only to the precise structures described and

shown in the accompanying drawings, but rather should be read as consistent with and as support for the following claims, which are to have their fullest and fairest scope.

[0056] Furthermore, none of the description in the present application should be read as implying that any particular element, step, or function is an essential element which must be included in the claim scope: THE SCOPE OF PATENTED SUBJECT MATTER IS DEFINED ONLY BY THE ALLOWED CLAIMS. Moreover, none of these claims are intended to invoke paragraph six of 35 USC §112 unless the exact words “means for” are followed by a participle. The claims as filed are intended to be as comprehensive as possible, and NO subject matter is intentionally relinquished, dedicated, or abandoned

We claim:

1. A method, comprising:
 - deploying a first piece of oilfield equipment at a wellsite;
 - deploying a second piece of oilfield equipment at the wellsite;
 - connecting the first piece of oilfield equipment and the second piece of oilfield equipment with a cable;
 - effectuating a communication between the first piece of oilfield equipment and the second piece of oilfield equipment;
 - wherein at least one of the connections between the cable and the first piece of oilfield equipment and between the cable and the second piece of oilfield equipment is via inductively coupling.
2. The method of claim 1, further comprising:
 - deploying a third piece of oilfield equipment at a wellsite;
 - connecting the cable with the third piece of oilfield equipment via inductively coupling.
3. The method of claim 1, wherein the connection between the cable and the first piece of oilfield equipment is an electrical connection, and the connection between the cable and the second piece of oilfield equipment is via inductively coupling, the method further comprising:
 - transmitting a signal from the first piece of oilfield equipment to the second piece of oilfield equipment via inductively coupling.
4. The method of claim 3, further comprising:
 - providing a sensor in the second piece of oilfield equipment, wherein said inductively coupling is achieved between the cable and the sensor.
5. The method of claim 4, wherein the sensor is an inductive sensor or a Hall-effect sensor.
6. The method of claim 1, further comprising:

providing two or more sensors in the second piece of oilfield equipment, wherein said inductively coupling is achieved between the cable and the two sensors.

7. The method of claim 1, wherein the cable has a first end and a second end, both connected to the first piece of oilfield equipment.

8. The method of claim 1, wherein the cable has a first end and a second end and wherein only the first end is connected to the first piece of oilfield equipment.

9. The method of claim 8, wherein at least one of the first end and the second end of the cable is wound on a reel.

10. The method of claim 1, wherein both the connection between the cable and the first piece of oilfield equipment and the connection between the cable and the second piece of oilfield equipment are via inductively coupling, and the method further comprising:

transmitting a signal from the second piece of oilfield equipment to the first piece of oilfield equipment via inductively coupling.

11. A system, comprising:

a first piece of oilfield equipment deployed at a wellsite;

a second piece of oilfield equipment deployed at the wellsite;

a cable that connects the first piece of oilfield equipment and the second piece of oilfield equipment;

wherein at least one of the connections between the cable and the first piece of oilfield equipment and between the cable and the second piece of oilfield equipment is via inductively coupling.

12. The system of claim 11, wherein the connection between the cable and the first piece of oilfield equipment is an electrical connection, and the connection between the cable and the second piece of oilfield equipment is via inductively coupling; and wherein at least one sensor is provided in the second piece of oilfield equipment and said sensor is inductively coupled to the cable.

13. The system of claim 12, wherein two or more sensors are provided in the second piece of oilfield equipment.
14. The system of claim 13, wherein the sensor is an inductive sensor or a Hall-effect sensor.
15. The system of claim 11, further comprising a connector located on an external surface of the second piece of oilfield equipment, wherein the cable passes through the connector.
16. The system of claim 11, wherein both the connection between the cable and the first piece of oilfield equipment and the connection between the cable and the second piece of oilfield equipment are via inductively coupling, and at least one sensor is provided in the first piece of oilfield equipment so that the first piece of oilfield equipment is inductively coupled to the cable.
17. A method, comprising:
 - deploying a control unit at a wellsite;
 - deploying a plurality of pieces of oilfield equipment at the wellsite;
 - connecting the control unit and the plurality of pieces of oilfield equipment with a cable;
 - effectuating a communication between the control unit and the plurality of pieces of oilfield equipment via inductive coupling.
18. The method of claim 17, wherein said communication is a signal generated by the control unit, transmitted along the cable, and inductively detected by the plurality of pieces of oilfield equipment.
19. The method of claim 17, wherein said communication is a signal generated by one or more of the plurality of pieces of oilfield equipment, transmitted along the cable, and inductively detected by the control unit.
20. The method of claim 17, wherein said communication is a shutting down signal that switches off one or more of the plurality of pieces of oilfield equipment.

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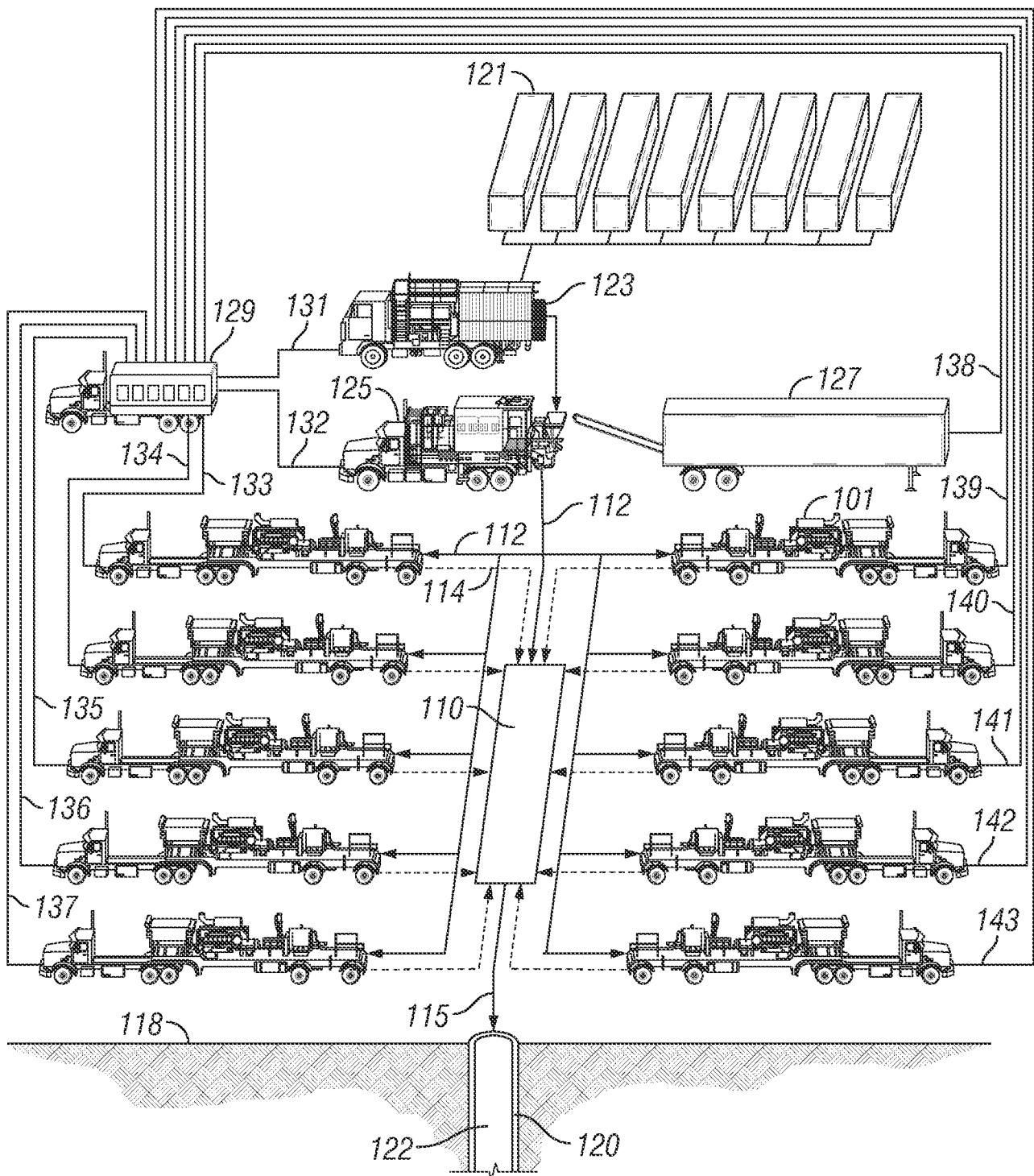


FIG. 1
(Prior Art)

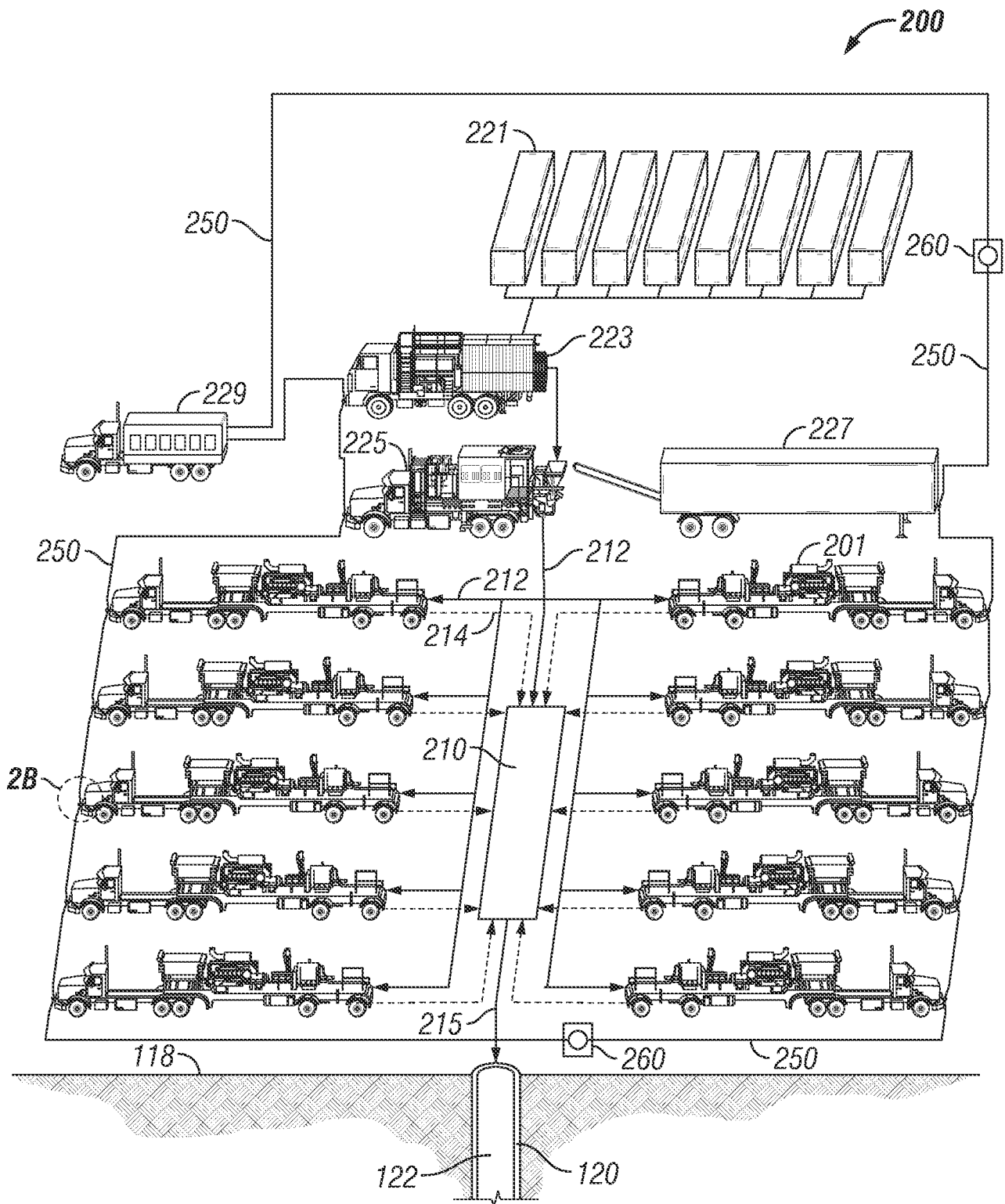


FIG. 2A

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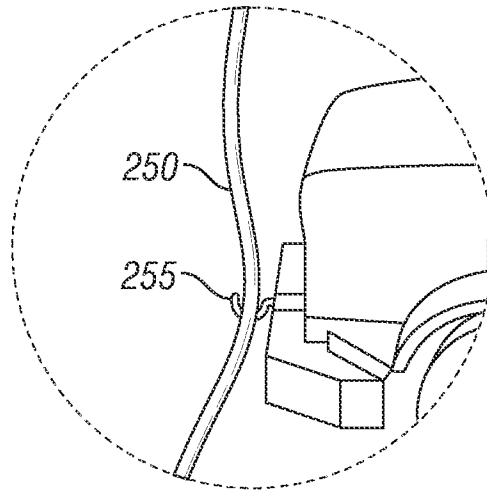


FIG. 2B

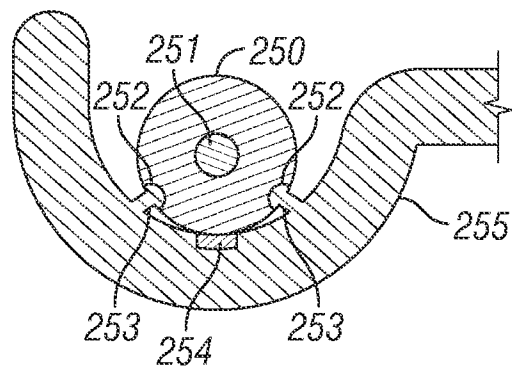


FIG. 2C

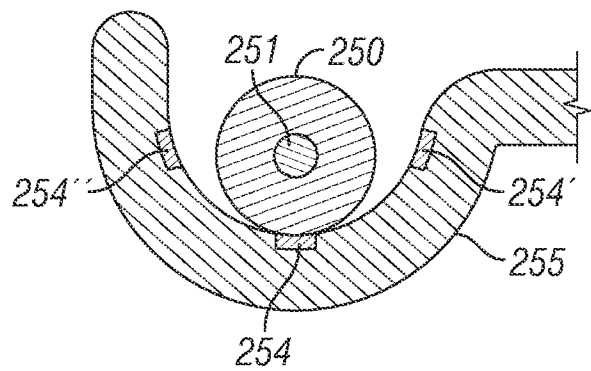


FIG. 2D

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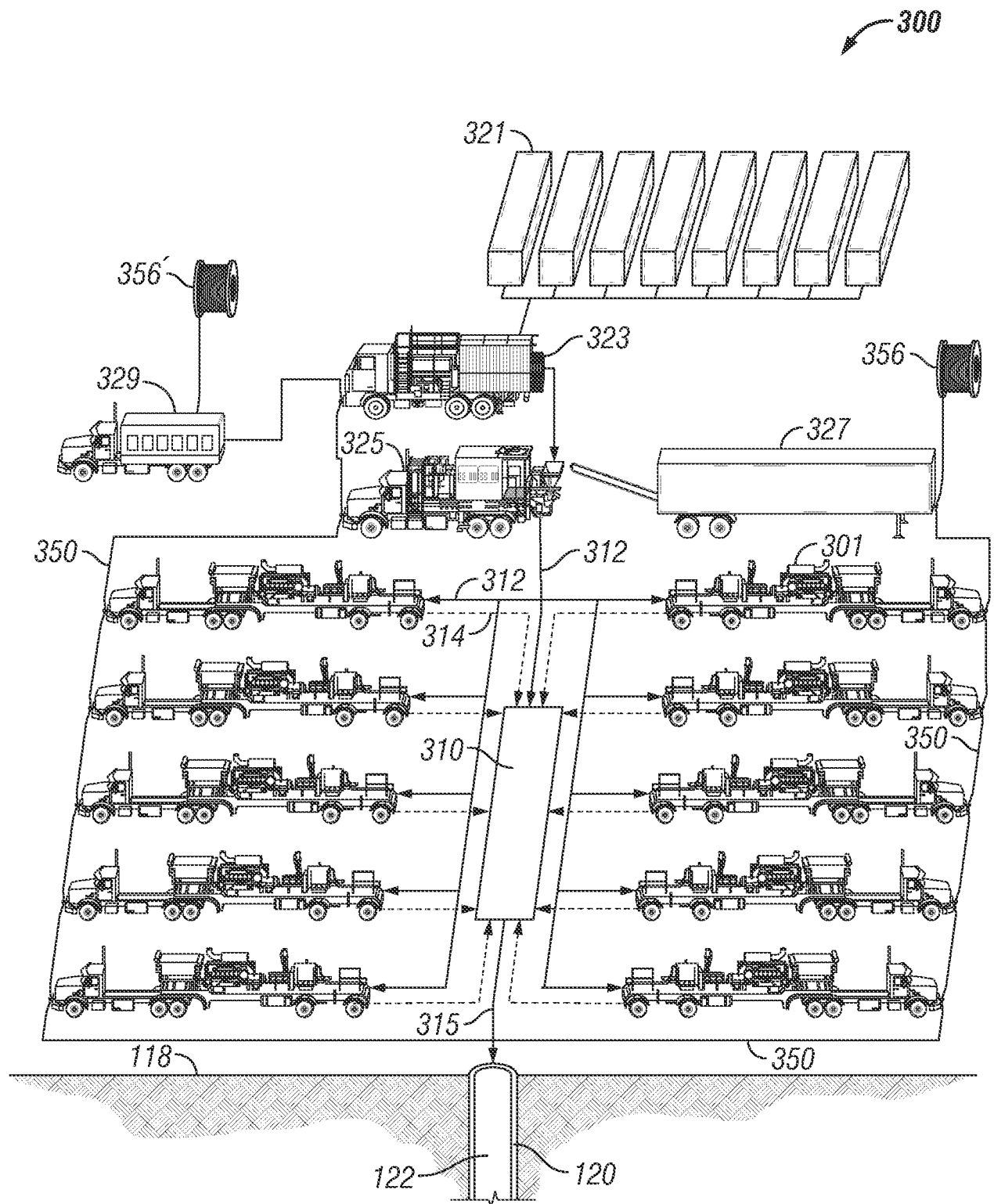


FIG. 3A

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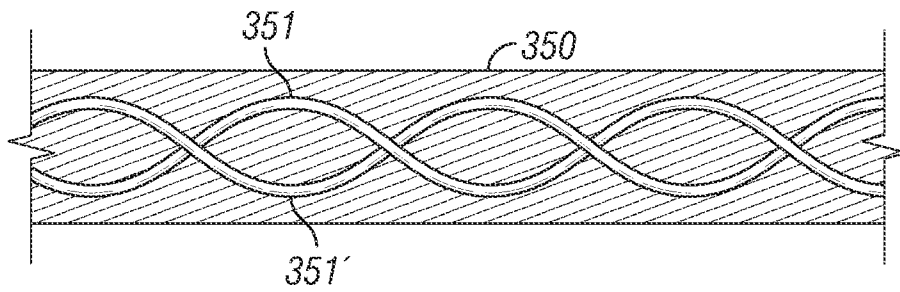


FIG. 3B

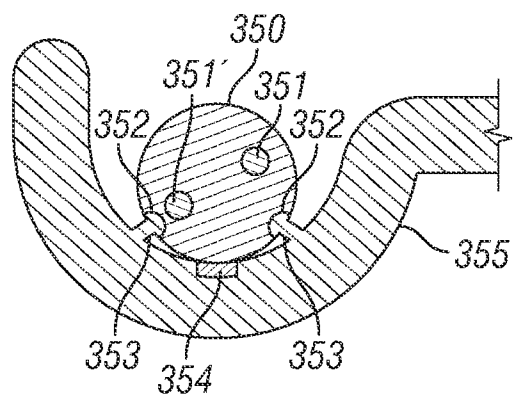


FIG. 3C

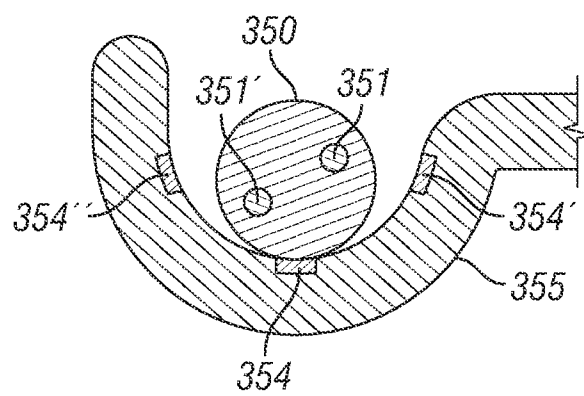


FIG. 3D

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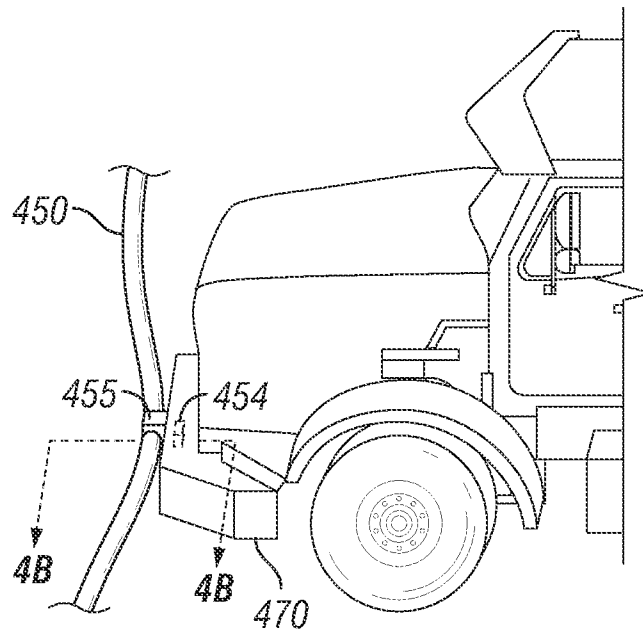


FIG. 4A

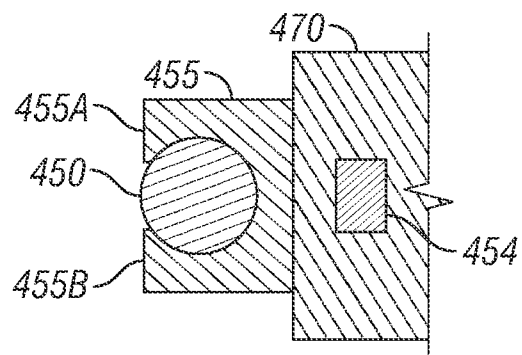


FIG. 4B