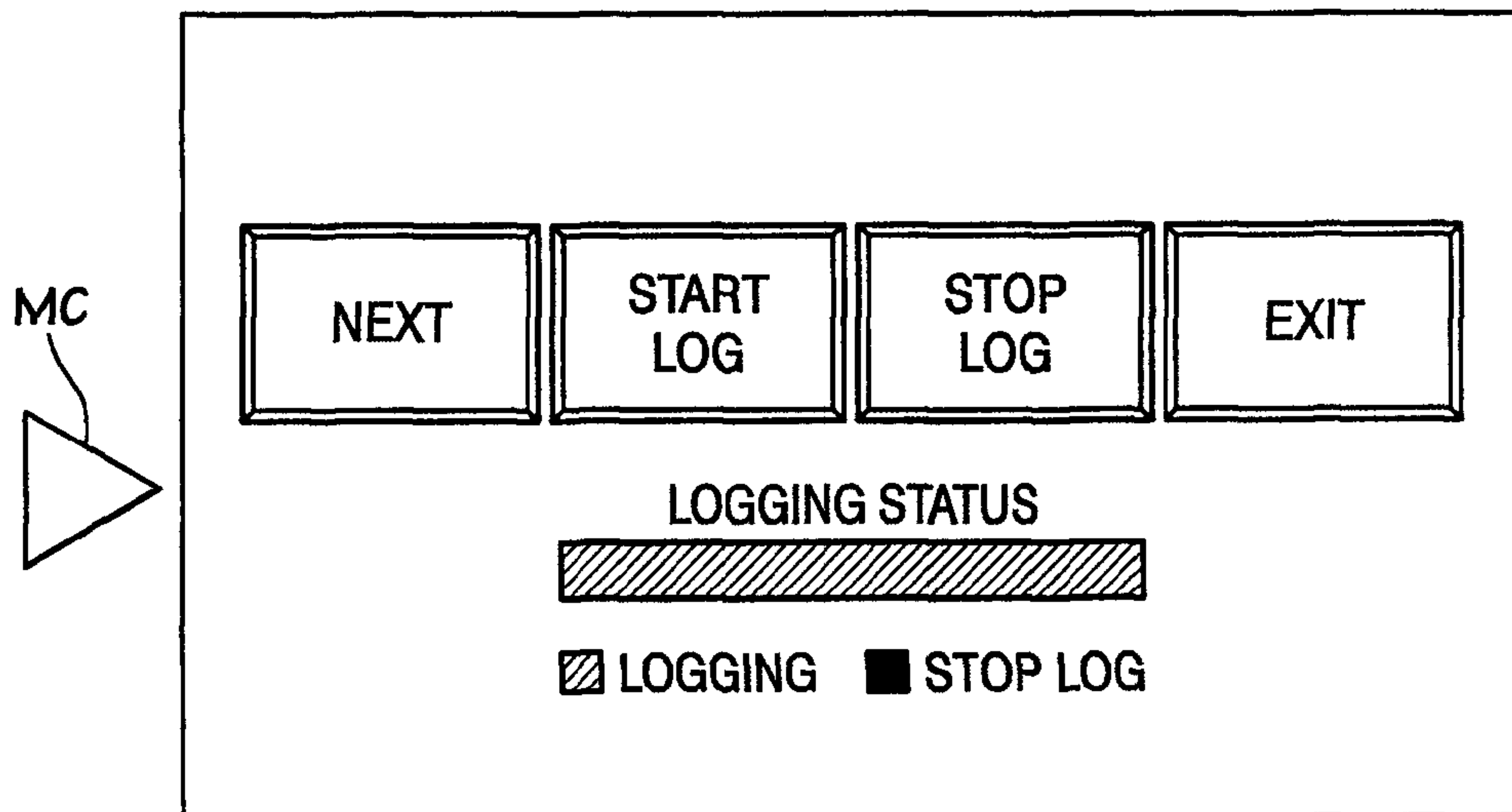




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(54) **Titre : PROCÉDE ET APPAREIL POUR LES OPERATIONS DE PUIITS**
(54) **Title: METHOD AND APPARATUS FOR WELL OPERATIONS**



(57) **Abrégé/Abstract:**

A method for well servicing operations, which method comprises the steps of : (a) monitoring a parameter related to a well servicing function; (b) displaying a value of the parameter; (c) based on said value determining in real-time if a fault exists related to said well servicing function; and (d) if a fault is determined to exist, correlating said value with a suggested remedial action for addressing said fault.

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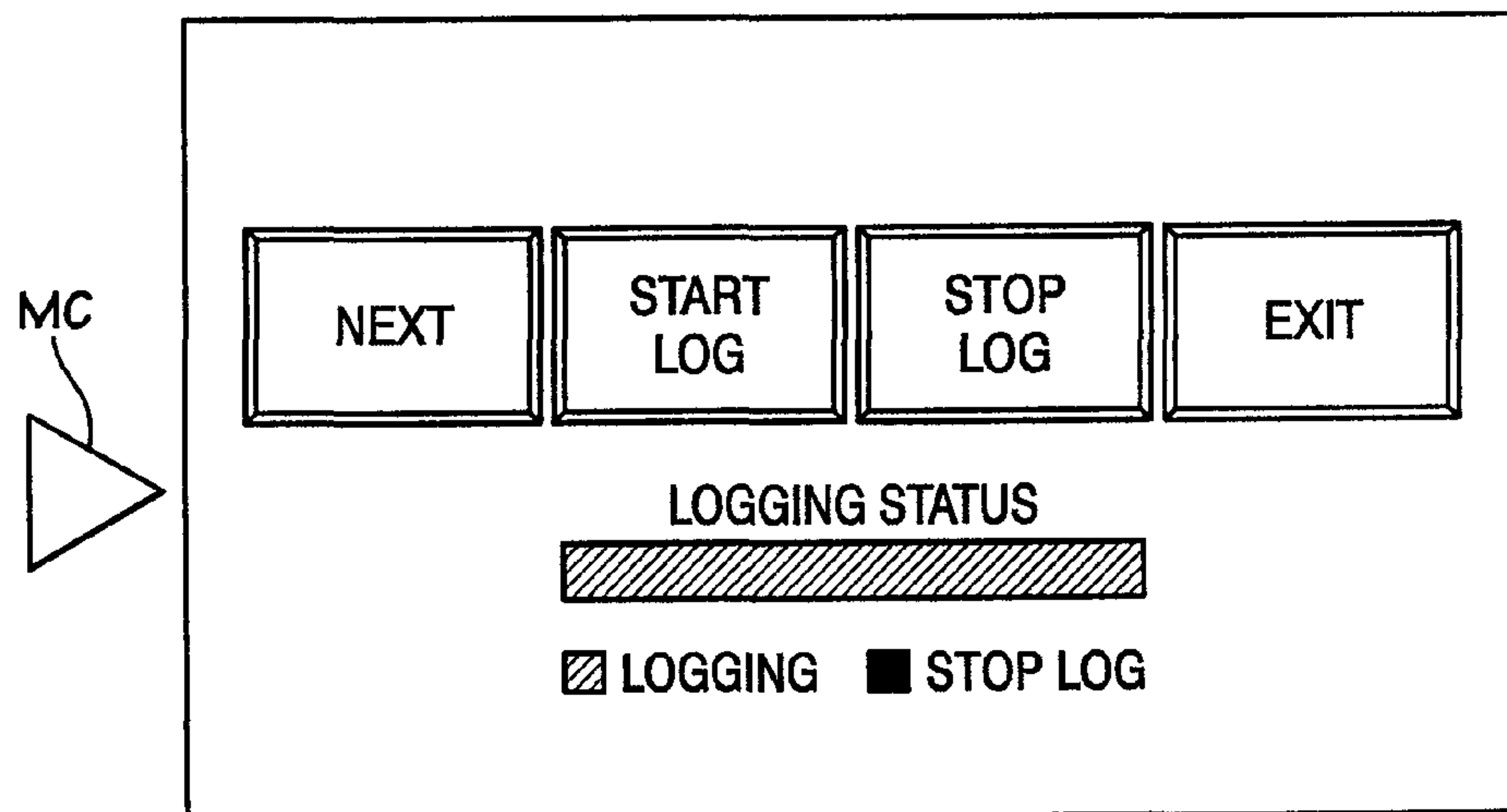
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(54) Title: METHOD AND APPARATUS FOR WELL OPERATIONS



(57) Abstract: A method for well servicing operations, which method comprises the steps of : (a) monitoring a parameter related to a well servicing function; (b) displaying a value of the parameter; (c) based on said value determining in real-time if a fault exists related to said well servicing function; and (d) if a fault is determined to exist, correlating said value with a suggested remedial action for addressing said fault.

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Method and Apparatus for Well Operations

The present invention relates to a method for well operations, to a method of servicing a well, to an apparatus for servicing a well and to a service vehicle
5 comprising the apparatus.

Once an oil or gas well has been completed and is operating to extract material from within the earth - e.g. petroleum, gas, hydrocarbons, water or other fluid various well service operations are periodically performed
10 to maintain the well. Such service operations may include e.g.: acidizing, fracturing, pumping sand, replacing worn parts such as a pump, sucker rods, inner tubing, and packer glands; pumping chemical treatments or hot oil down into the well bore; tubing services; workovers; plug and
15 abandonment operations; and pouring cement into the well bore to partially close off a portion of the well (or to shut it down entirely). Maintenance or service operations can be performed by a well servicing rig, mobile rig, or by a workover rig, swab rig, or a service vehicle having
20 special servicing equipment.

One particular prior art system useful in well servicing operations, provided by National Oilwell Varco is the KINETICS ENERGY CONTROL SYSTEM (described, e.g. in National Oilwell Varco Document No. SO 22277-0501-OPM-001;
25 pp. 4 - 31) ("KEC" is a trademark) that has PLC based instrumentation and controls that increase the functionality of a rig's engine, drawworks clutch and brakes. With such systems there is electric rather than hydraulic/pneumatic operation of the drawworks, engine,
30 and brakes which requires less physical exertion by an operator. The system provides alarms and monitoring of selected rig parameters to enable the operator to make more informed decisions. Stainless steel NEMA 4X

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enclosures are used which are suitable for hazardous area use (where necessary) and resilient mountings protect against shock and vibration.

One prior art version of the KECS system, the KECS -
5 0002 version, provides a fault finding procedure with two basic steps : (1) basic inspection and testing of components and wiring and (2) software interrogation which requires plugging in a laptop computer into a system's PLC ("programmable logic controller") and
10 interrogating the software. In certain aspects, the first step is done by a competent electrician. The second step is done, e.g., by a software engineer with knowledge of the system and the software code.

The present inventors have realised that it would be
15 beneficial to use such a system for diagnosis and fault finding without requiring an operator's knowledge of the software code and without actually accessing that code.

According to the present invention there is provided a method for well service operations, which method
20 comprises the steps of:

- (a) monitoring a parameter related to a well servicing function;
- (b) displaying a value of the parameter;
- (c) based on said value determining in real-time if
25 a fault exists related to said well servicing function; and

- (d) if a fault is determined to exist, correlating or associating said value with a suggested remedial action for addressing said fault. The method may be
30 performed at an oil or gas well for example. In step (c) the fault may be an equipment fault during well service operations for example. In one aspect the equipment fault relates to non-downhole apparatus such as equipment on a drilling rig or service vehicle that is used to perform
35 and/or control the well service operation.

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Further steps of the method are set out in claims 2 to 17 to which attention is hereby directed.

According to another aspect of the present invention there is provided a method of servicing a well, which
5 method comprises the steps of:

(a) moving well servicing equipment to a well site;
and

(b) employing a method as set out above during servicing of said well.

10 According to another aspect of the present invention there is provided an apparatus for servicing a well, which apparatus comprises a computer, such as a PLC, having a memory storing computer executable instructions for implementing a method as set out above.

15 There is also provided a well service vehicle comprising an apparatus as aforesaid.

The present invention, in at least certain aspects, provides a method for diagnosis of a well servicing system and of methods of its use which make it possible
20 to more readily find and diagnose faults in the system and to troubleshoot those faults. In certain aspects, the present invention provides such methods and systems to implement them that include continuous real-time monitoring and, in certain aspects, display of various
25 system and operational parameters so that problems can be recognized and more readily dealt with without knowledge of the software code used in computerized controllers and/or PLC's used with the system and without directly accessing the software code.

30 The present invention, in certain aspects, discloses systems and methods for well operations, in one aspect well servicing operations, the method in certain embodiments including: monitoring a parameter related to a well operations function or to a well servicing
35 function and/or monitoring multiple such parameters,

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displaying values of the parameter(s); based on said values determining in real-time if a fault exists related to said well operations function or to said well servicing function; and correlating said values with suggested remedial action to deal with said fault. In such systems and methods, wherein a control system with computer software controls an element of a well operations function or a well servicing apparatus which provides the function, an operator may determine if a fault exists without accessing the computer software and determines a possible remedial action without accessing the software. In certain aspects the displaying is done by a display system that has a screen for displaying information, the display system in communication with a control system, the display system for receiving data from the control system related to the parameter related to the well servicing function, and the display system for processing the data received from the control system to produce values of the parameter(s).

Such a system according to the present invention can provide continuous real-time monitoring and display of selected parameter values and control system data and can log chosen critical parameters. In certain aspects, a display provides a real time log of specific selected rig operating parameters to assist in dealing with intermittent system problems and also provides an historical record of system parameters and operation in the event of any incident. This information is, optionally, downloadable from a display system onto a memory device, e.g., a memory card or drive and/or into a computer, laptop computer, PC, desktop or other computer (on site or remote) for further analysis and long term storage if desired. Optionally, such methods include accessing and reviewing past parameter values and equipment conditions (e.g., but not limited to, with a

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display system screen "scroll back" OR "Previous" screen function).

In certain particular aspects, elements for the system (e.g. one or more PLC's; safety barriers; power supply; terminals; thermostat; switches; cables; connections; and/or heater) are installed inside a system PLC control cabinet fitted with mounting hardware to accommodate a display screen, e.g., a 5" Logging Display or a 10" Logging & Diagnostic Display. The display system has suitable power and communication interfaces and connections. In one aspect, the display system is in communication with the PLC, receives data from the PLC, processes the data with software within the display system, and displays (e.g., on screen and/or on strip chart) information related to measured parameter values in real-time. Upon review of parameter values, an operator correlates a value indicative of a fault or problem with suggested action to be taken to remedy the fault or problem (e.g. actions as listed in a list, matrix, or table in a manual or computerized list, etc.).

In certain aspects a system computer or PLC receives information about various rig apparatuses (on rig, off rig, adjacent to the rig, and/or ancillary rig equipment), etc. (e.g. operating parameters of a drawworks engine) via a network such as a PROFIBUS DP network or via a network such as a CanBus network. Diagnostic systems according to the present invention have, in certain aspects, a control system PLC which communicates with a rig operator's controls (e.g. at an operator console, e.g. a driller's controls), and the PLC and the operator's controls can communicate with each other via a network such as a PROFIBUS data processing protocol network or a CanBus protocol network. The PROFIBUS protocol network typically provides an interface between the drawworks engine/transmission and the control

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system's PLC. By utilizing an appropriate device, e.g. a CanBus J1939 gateway (a device that translates CanBus into Profibus) a logging and a diagnostics system according to the present invention records and utilizes
5 specific engine/transmission information received directly from the engine/transmission (via the gateway; without passing through the PLC) to assist in the fault finding procedure. Information from sensors, controls, engine and/or transmission in its raw form is processed
10 by the PLC and provided to the logging and diagnostic system. On many well service rigs the vehicle and the rig both use the same engine/transmission and can be interrogated with CanBus protocol technology while the rig control system often uses Profibus. The use of a
15 CanBus gateway allows for more system integration.

Systems according to the present invention are useful with mobile rigs, e.g. well servicing rigs, trailered rigs, workover rigs, swabbing rigs, and with small drilling rigs on wheels and rigs movable from one
20 site to another.

Accordingly, the present invention includes features and advantages which are believed to enable it to advance well servicing fault diagnosis and remedial action technology.

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For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings, in which:

Fig. 1A is a side view of a prior art well system;

5 Fig. 1 is a schematic side view of a well service vehicle using an apparatus and method according to the present invention;

Fig. 2 is a schematic end view of the vehicle of Fig. 1;

10 Fig. 3A is a schematic side view of the vehicle of Fig. 1 in a transportation mode;

Fig. 3B is a schematic side view of part of the vehicle of Fig. 1 at a first stage of use;

15 Fig. 3C is a schematic side view of part of the vehicle of Fig. 1 at a second stage of use;

Figs. 4 - 7F are illustrations of various different images that are displayed on a screen of a display system according to the present invention; and

20 Fig. 8A is a side view of a rig according to the present invention; and

Fig. 8B is an end view of the rig of Fig. 8A.

Fig. 1A illustrates a conventional prior art environment in which the system with a well 8 containing a well casing 12 having a well head 14 located at the earth surface. A tubing string 16 extends down the well through the well head and through tubing hanging slips 18 (e.g. power operated) positioned on the well head 14. The tubing string is held by means of an elevator 20 which is connected to traveling block 22 by means of elevator links 24 and 26. Hoist cables 28 and 30 connect the traveling block to a hoist 15 (shown schematically). Power tongs 21 and back up 23 are located above well head 14 to disconnect or to connect threaded tubing sections into the tubing string.

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In certain aspects, systems and methods according to the present invention are intended for use in the environment shown in Fig. 1A. As illustrated in Figs. 1 and 2, a system 10 according to the present invention includes a wheeled vehicle 31 having sets of wheels 32 and 33 at the front and rear of the vehicle, respectively. Power systems are provided on the vehicle including an operator's cab at 34 and a power drive system 35 with an engine 35a for operating the vehicle and a winching system 36 all of which may be driven from a single power driven system.

The system 10 includes pipe rack arms 37, a jib crane 38, pipe conveyors 39, transfer arms 41, a hoist cables 42, a derrick 43, a crown block 44, a pipe manipulator 45, a traveling block 46, power tongs 21, back up tongs 23, a centralizer 47, and an elevator 48. The foregoing equipment is supported on and provided with operating apparatus that is also supported on the vehicle 31. When in operating position, the vehicle is leveled by a set of levelers 49 which engage the earth surface.

A control system 60 according to the present invention includes a login/diagnostic display system 70 which provides on screen real-time indications of system parameter levels and/or values, changes in them over a specified time period, a "scroll back" ability for viewing past (and recent past) parameter levels and/or values, and gives an operator a visual display of parameter levels and/or values in real-time. The system 60 may use any suitable computer(s) and/or PLC(s). Optionally, the control system 60 and/or display system 70 are in/on a PLC cabinet 33' (and any system according to the present invention herein may have such a PLC cabinet).

A system 100 according to the present invention is illustrated in Fig. 3A. The system 100 includes a wheeled

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vehicle 110, having a cab 134 and a bed 114 for mounting operating equipment. The operating equipment includes a winch or hoisting system 116 and a power drive system 118. The system 100 includes a hydraulically operated
5 derrick 120, having a hoist block 122 and elevator 124, that are shown in a stored position for transport to a well head 126. A racking platform 128 is folded against the side of the derrick 120 for transportation.

Tong assemblies 130 are pivotally mounted on the
10 frame of derrick 120, and when not in use, are folded against the forward end of vehicle 110. A control system 132 (like the control system of Fig. 1) for controlling operation of elements of the system 100 including the tong assemblies 130 also has a system 170 (like the
15 system 70, Fig. 1). Optionally, a PLC cabinet 133 (like the PLC cabinet 33, Fig. 1) is used with the display system 170.

The system 100 is driven to a site and positioned adjacent to the well head 126. The derrick 120 is then
20 raised into a vertical position by the hydraulic cylinders 112 and stabilized in the position illustrated in Fig. 3B. The racking platform 128 is then lowered to the position shown in Fig. 3B for receiving and racking tubulars, e.g. pipes, tubing, and/or rods.

The system 100 as shown in Fig. 3B, is set up for
25 handling rods. A rod string is set in position in rod slips 198 to hold a rod string 138. Rod slips 198 prevent the string from falling back into the well. The hoist 122 and elevator 124 are then lowered close to rod slips 198
30 and the collar of rod string 138 placed in the elevator 124. The hoist 122 is then lifted to the position shown in Fig. 3B. An operator 140 then presses a momentary switch on the control system 132 to activate the tong assembly 144. Once activated, the tong assembly 144 moves
35 forward to grip the junction between adjacent rods in the

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rod string 138, disconnects or connects adjacent rods, and then retracts.

Once an upper rod 139 is detached from the rod string 138, the elevator and blocks are lowered and a
5 floor man 141 can manipulate a robotic rod and pipe handler 146 by a waist mounted control (optionally in communication with the control system 132) or joy stick 158 connected by cable 153. The floor man 141 advances the handler 146 and grips the detached rod 139 after the
10 hoist 122 has been lowered below the racking board 128. The hoist block 122 is lowered below the free end of the rod 139 allowing the floor man 141 to manipulate the handler 146 to place the rod in the racking board 128 as shown in Fig. 3C. The free end of rod 139 is allowed to
15 rest on a base 160.

Fig. 4 shows display system's screen according to the present invention (e.g. for a system 70 or a system 170), a start up screen for one embodiment of the present invention (which may be a touch screen). Touch screens
20 with touch screen buttons may be used to navigate through the available screens. In one particular aspect this display screen for a system according to the present invention is a 10" STN touch screen (e.g. Siemens Simatic TP 270). The display includes a removable Secure Digital
25 (SD) memory device or equivalent flash memory card MC (shown schematically) to allow data to be downloaded from a PLC onto the flash memory card MC and transferred onto a computer for further analysis and storage. The system in one aspect logs approximately seven to ten signals. In
30 one aspect, this data is sampled every second and stored for a period of twenty hours or longer before being overwritten.

As shown in Fig. 4, when it is desired to view levels or values of other operation parameters, pushing
35 the "Next" button reveals the next screen. Pushing the

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"Start Log" button instructs the display system to begin logging (recording) data from the PLC and processing it (the display system includes its own data processor, computer, and/or PLC). Pushing the "Stop Log" button
 5 instructs the display system to cease logging (recording) data from the PLC. Pushing the "Exit" button exits the display system program. The "Logging Status" bar indicates whether the system is receiving data ("logging") or has ceased doing this ("Stop Log").

10 In certain embodiments there are a minimum of seven screens available on the display, including approximately four diagnostic screens. Digital values are shown as 0 or 1; analogue values are shown as numeric values on the diagnostic screens. One, two, or more logging screens
 15 show information in line graph format.

The logging screen(s) may, e.g., show selected values from the following parameter list:

Joystick Position
 Joystick Dead Man Switch Position
 20 PLC Brake Output value
 Brake System Pressure
 PLC Drawworks Clutch Output
 Rig Engine RPM (e.g. engine 35, Fig. 1)
 Block Height
 25 Block Speed
 Hook Load
 Over Ride Push Button Position
 Mode Switch Position (e.g. modes of a KECS ((TM))
 system)

30 Fig. 5 shows a typical logging screen which, illustrates graph lines in real-time for three system parameters. The lower horizontal axis is a time axis. For example, one graph line indicates the height of the rig's travelling block ("BlockHeight"); one graph line
 35 indicates the position of an operator's joystick

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("J/Stick"); and one graph line indicates hook load ("HookLoad").

As shown in Fig. 5, when it is desired to view historical levels or values of operational parameters, pushing the "Return" button scrolls the display backwards chronologically. Pushing the "Next" button scrolls the display forwards chronologically. The "Real Data" indicator at the top of the screen indicates when real time levels or values are being displayed.

10 The data represented on the logging screen(s) is obtained from sensors (e.g. sensors S, Figs 1A, shown schematically) on each element of a rig which are in communication with the control system computer or PLC. In certain aspects, these screens show selected parameter values grouped by functionality. For example, parameters associated with raising the block or engine only (auxiliary equipment operation) are shown on the same screen. These diagnostic screens are used in conjunction with a fault finding manual or screen display to simplify the fault finding procedure. Examples of these screens can be seen in Figs. 7A - 7C.

Suitable communication cables for interface with a drawworks control PLC ("PL", Fig. 1) and other system sensors and elements provide communication with the control system. In certain aspects the display system operating ambient temperature is 0 C to +40 C and system operating ambient humidity is 90% (non condensing).

The fault finding protocols and procedures are available in hard copy and/or physical papers or manuals which contain criteria, tables and steps for fault finding and trouble shooting procedures, e.g. procedures related to rig functionality such as "raising the blocks" and "engine only" (tong/utility winch) operation, etc.; or these are presented on screen. These procedures, the manual, and its lists, matrices, tables, etc. and the

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diagnostic display screens assist with fault finding of specific recurring problems. This can be done following a study of historical rig problem data. In certain aspects the manual (or screen display) contains descriptions of each functionality based test; a matrix of possible test results with remedial actions; and examples of screen displays (screen shots) seen during each specific test.

In one particular aspect, in a fault finding format according to the present invention, a test is performed of auxiliary equipment, an engine only test. With the engine idling, the control system switched on, and the joystick at rest, a basic engine control diagnostic screen looks like screenshot 1 (Fig. 7A). As the joystick is moved, e.g. left or right, a joystick signal starts to rise and both the engine throttle and RPM values increase as shown in Screenshot 2 (Fig 7B). The engine speed is heard increasing. With the joystick fully to the left or right, all signals should be at or near maximum as shown in Screenshot 3 (Fig 7C) and the engine noise should indicate high RPM. When moving the joystick slowly left or right, all signals should increase and decrease (track) together. If any signal is missing or not tracking, a fault finding chart (e.g. see Fig. 5A or Fig 6) is used to determine the existence of a fault. This chart can be in a printed paper manual (Fig. 6) or presented in a screen of the display system (e.g. by pushing or touching the "Chart" button, Fig. 5, producing a screen as in Fig. 5A). Absence of the joystick or engine throttle signals may stop the engine from running. For example, if the value for "Joystick Output" in Screenshot 3 is zero, an operator goes to the Result Matrix (Fig 5A or Fig. 6) and looks in the box which indicates a "0" in the Joystick column. This is box "BX" in Fig. 6. The operator then checks the corresponding "Action" column to determine what action is to be taken -

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in this case "Check joystick". Similarly for any box indicating a zero value (a "Missing or problem signal" box), an operator locates the correct box and then sees what action is indicated in a corresponding "Action" box.

- 5 The "Engine Status" boxes indicate a variety of possible statuses for the rig engine.

It is within the scope of the present invention, in particular aspects, to automatically provide an indication of a possible remedial action to be taken when
10 the display system displays a parameter value indicating a fault or possible fault in an operational function. In one aspect, for example, on a tubular screen (e.g. the screen of Fig. 7A) the operator pushes (touches) a line (e.g. "Joystick Output 0") and the next screen display is
15 the "Action" box or boxes from a list or test results matrix (e.g. as in Fig. 6) (e.g. the operator touches "Joystick Output 0") and the next screen displays the top and the bottom boxes from the "Action" column of Fig. 6. The operator knows the engine is either idling or silent
20 and chooses the action listed corresponding to this Engine Sound.

In another aspect, the operator touches a line indicating a potential fault (e.g. the line "Joystick Output 0" in Fig. 7D) and then touches the "Additional
25 Input" button. The next screen asks for additional information before the system automatically displays the remedial action to be taken. For example, after touching the "Joystick Output 0" line of Fig. 7D, the operator views the next screen as shown in Fig. 7E and touches
30 "Idling" in the "Engine Status" column and "Idling" in the "Engine Noise" column. Either automatically or upon touching the "Auto" button, the display system displays screen 7F which shows the suggested remedial action.

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Automatic suggested action display can be done with respect to any of the fault-indicating values for any parameter.

Each PLC, computer, control system, and display system herein includes computer readable media containing appropriate executable instructions that when executed by the PLC, computer, control system or display system implement a method to accomplish the desired function or effect and computer programs used in said PLC, etc. 10 comprise logic for accomplishing said function or effect.

With such systems according to the present invention, an operator need only access displayed data and use the fault finding protocols to determine that a fault exists and to determine possible remedial action. 15 This operator does not need to have any intimate knowledge of the control system's software code nor does the operator need to actually access this code to find a fault and to learn actions to take to remedy the fault.

Figs. 8A and 8B show a rig 800 according to the present invention comprising a wheeled vehicle 202 and a derrick system 220 (e.g. like the derrick 120). The rig 200 has a logging and diagnostic system 210 according to the present invention which receives data from a PLC 230 (e.g. like the PLC's in the systems of Fig. 1 and Fig. 25 3A). The PLC 230 receives data from the various on-rig, adjacent-to-the-rig, and/or ancillary equipment which it processes and sends to the system 210. An operator communicates with the system 210 via a console 240 (e.g. a driller's control console).

30 Fig. 8A shows a mast 222 of the derrick system 220 in both a lowered position ("mast lowered") and a raised position ("mast raised").

The present invention, therefore, provides in at least some embodiments, a method for well servicing operations, the method including: monitoring a parameter 35

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related to a well servicing function; displaying a value of the parameter; based on said value determining in real-time if a fault exists related to said well servicing function; and correlating said value with suggested remedial action to deal with said fault. Such a method may include one or some - in any possible combination - of the following: wherein a control system with computer software controls an element of a well servicing apparatus which provides the well servicing function, and an operator determines if a fault exists without accessing the computer software; wherein said correlating includes correlating said displayed value with a suggested remedial action; wherein said suggested remedial action is listed in a hard copy printed item; wherein said suggested remedial action is displayed on a screen; wherein said displaying is done by a display system that has a screen for displaying information; wherein a control system with computer software controls an element of a well servicing apparatus which provides the well servicing function, wherein said displaying is done by a display system that has a screen for displaying information, the display system in communication with the control system, the display system for receiving data from the control system related to the parameter related to the well servicing function, and the method further including the display system processing the data received from the control system to produce the value of the parameter; removably installing a memory device in the display system, and transferring information related to the value of the parameter to the memory device; removing the memory device from the display system, and transferring information from the memory device to another apparatus, e.g. a computer, PLC, laptop, or desktop; wherein a control system controls an element of a well servicing apparatus which provides the well

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servicing function, wherein said displaying is done by a display system that has a screen for displaying information, the display system in communication with the control system, the display system for receiving data
5 from the control system related to the parameter related to the well servicing function, wherein when a value of a parameter is selected indicative of a fault, the display system automatically displays a suggested remedial action for dealing with the fault; wherein the control system
10 has programmable media with computer software to facilitate control of the element of the well servicing apparatus which provides the well servicing function, and an operator determines if a fault exists without accessing the computer software; wherein a control system
15 controls an element of a well servicing apparatus which provides the well servicing function, wherein said displaying is done by a display system that has a screen for displaying information, the display system in communication with the control system, the display system
20 for receiving data from the control system related to the parameter related to the well servicing function, wherein when a value of a parameter is selected indicative of a fault and additional information about the well servicing operations is entered into the display system, the
25 display system automatically displays a suggested remedial action for dealing with the fault; wherein the control system has programmable media with computer software to facilitate control of the element of the well servicing apparatus which provides the well servicing
30 function, and an operator determines if a fault exists without accessing the computer software;; wherein multiple values of the parameter are displayed; wherein multiple parameters are displayed; wherein steps are performed by an operator using a touch screen; wherein
35 the screen is a touch screen; wherein selected parameter

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values are displayed grouped by functionality; the display includes means for going back to at least one or multiple previous screen displays; and/or in which computers or PLC's used in the method have programmable media programmed to accomplish the appropriate function or functions.

The present invention, therefore, provides in at least some embodiments, a method for well operations, the method including monitoring at least one parameter related to a well operation function, displaying a value of the at least one parameter, based on said value determining in real-time if a fault exists related to said well operation function, and correlating said value with suggested remedial action to deal with said fault.

The embodiments of the present invention for which an exclusive property or privilege is claimed are defined as follows:

1. A computer-implemented method of determining a remedial action for a fault in an uphole rig apparatus, which uphole rig apparatus is for performing a well servicing function, which method comprises the steps of:

(a) performing the well servicing function with said uphole rig apparatus by controlling the uphole rig apparatus with an electronic control system and displaying multiple parameters related to said uphole rig apparatus, which multiple parameters are grouped by functionality;

(b) monitoring a parameter of said multiple parameters during step (a);

(c) displaying a value of the parameter;

(d) determining in real-time if a fault exists in said uphole rig apparatus by comparing said value with a remainder of the multiple parameters; and

(e) if a fault is determined to exist, using said value and the comparison in step (d) to determine a suggested remedial action for addressing said fault, and displaying said remedial action on a screen of a display system.

2. The method according to claim 1, wherein said electronic control system comprises computer software for controlling an element of said rig apparatus which provides said well servicing function, and wherein step (d) is performed by computer apparatus in communication with said electronic control system whereby an operator may determine if said fault exists without accessing said computer software.

3. The method according to claim 2, wherein said computer software comprises software code, the method further comprising the step of said computer apparatus interpreting outputs from said software code when said software code is executed, whereby said fault may be discovered by said computer apparatus without an operator of said well servicing operation having to access and interpret said software code.

4. The method according to any one of claims 1 to 3, wherein said display system is in communication with said electronic control system, the display system for receiving from said electronic control system data related to the multiple parameters related to the uphole rig apparatus, the method further comprising the step of said display system processing the data received from the control system to generate said value.

5. The method according to any one of claims 1 to 4, further comprising the steps of removably installing a memory device in said display system, and transferring information related to the value of the parameter to the memory device.

6. The method according to claim 5, further comprising the steps of removing said memory device from the display system, and transferring information from said memory device to another apparatus.

7. The method according to any one of claims 1 to 6, further comprising the step of automatically displaying on said screen said suggested remedial action for dealing with said fault.

8. The method according to any one of claims 1 to 7, further comprising the steps of:

(i) receiving in said display system additional information about said well servicing function;

(ii) processing said additional information so as to generate said suggested remedial action; and

(iii) displaying said suggested remedial action on said screen.

9. The method according to claim 8, wherein before step (i) said display system displays a list of potential faults on said screen and following selection of at least one of said potential faults, said display system displays said additional information on said screen, which additional information is related to said selected potential fault, and said display system awaits selection of at least one part of said additional information before proceeding to step (ii).

10. The method according to any one of claims 1 to 9, wherein step (c) comprises displaying multiple values related to said parameter.

11. The method according to any one of claims 1 to 10, wherein said screen comprises a touch screen.

12. The method according to any one of claims 1 to 11, performed in real-time with real-time displays.

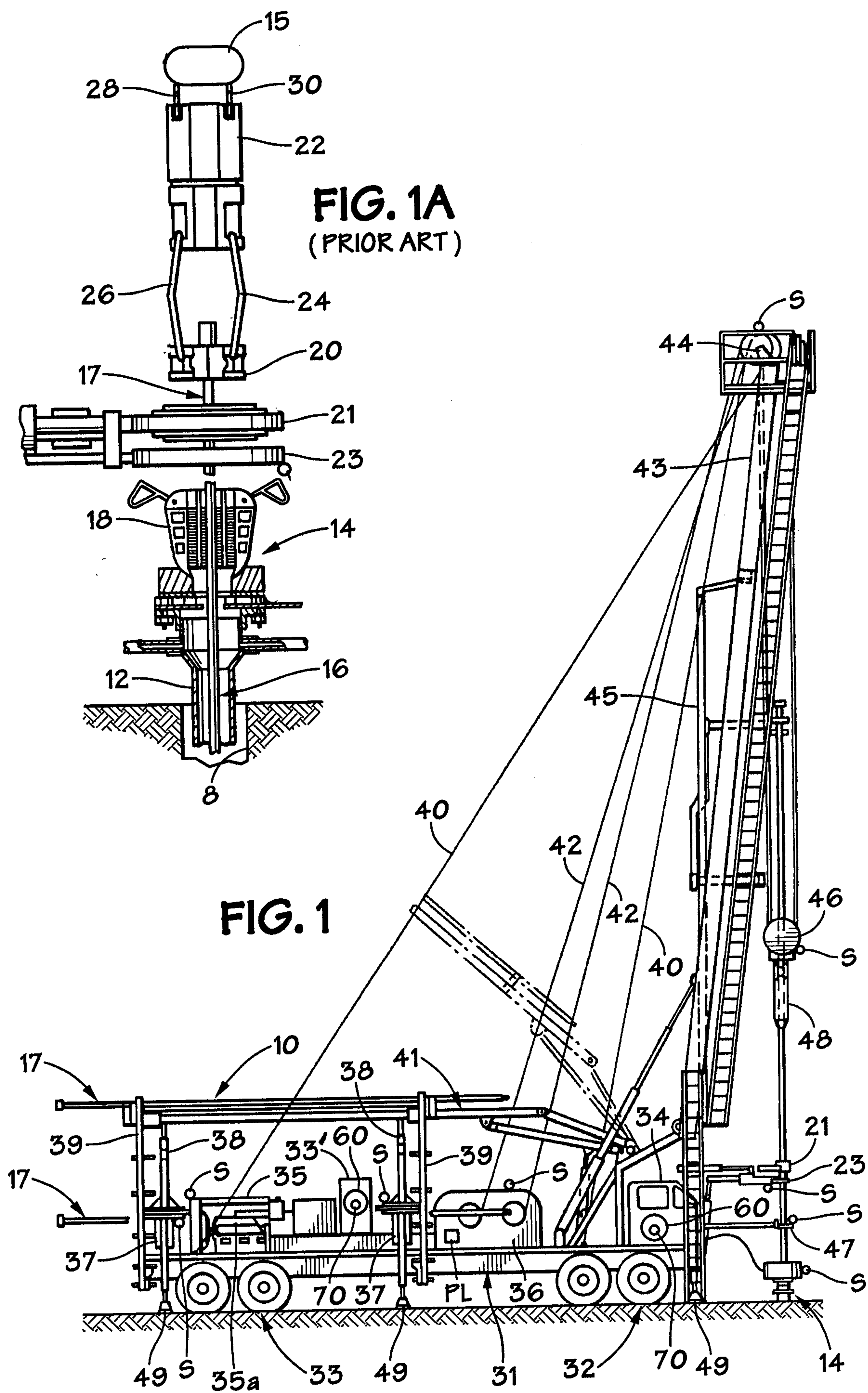
13. A method of servicing a well, which method comprises the steps of:

(a) moving well servicing equipment to a well site; and

(b) employing the method according to any one of claims 1 to 12 during servicing of said well.

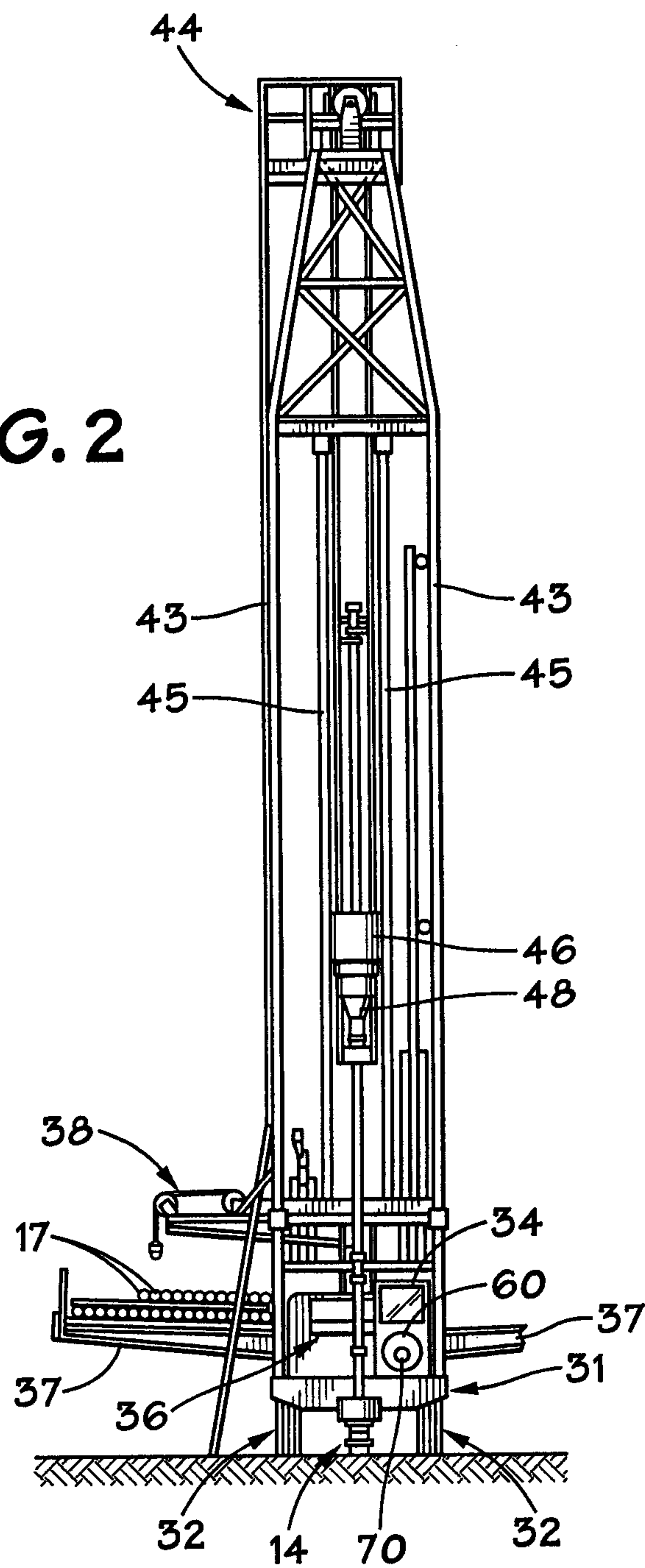
14. An apparatus for servicing a well, which apparatus comprises a computer, such as a PLC, having a memory storing computer executable instructions for implementing the method according to any one of claims 1 to 12.

15. A well service vehicle comprising the apparatus as claimed in claim 14.



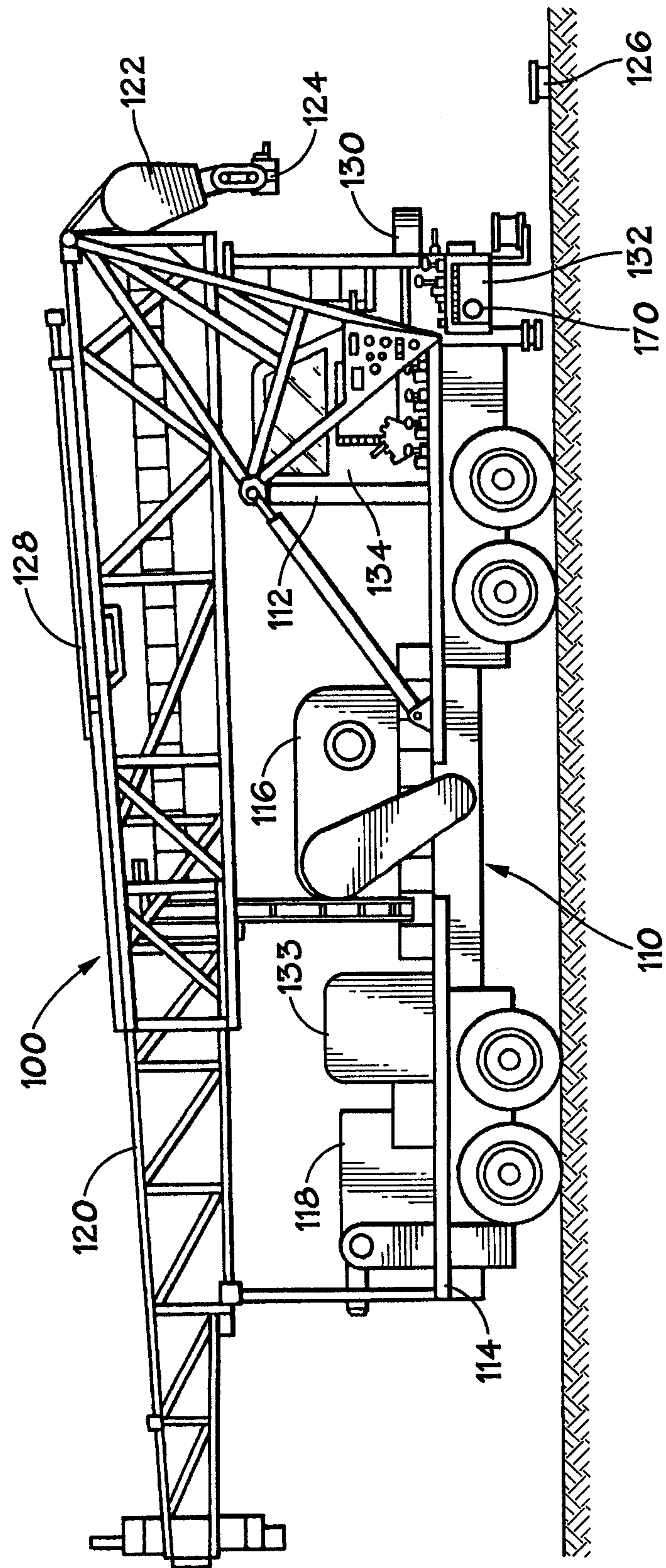
2 / 11

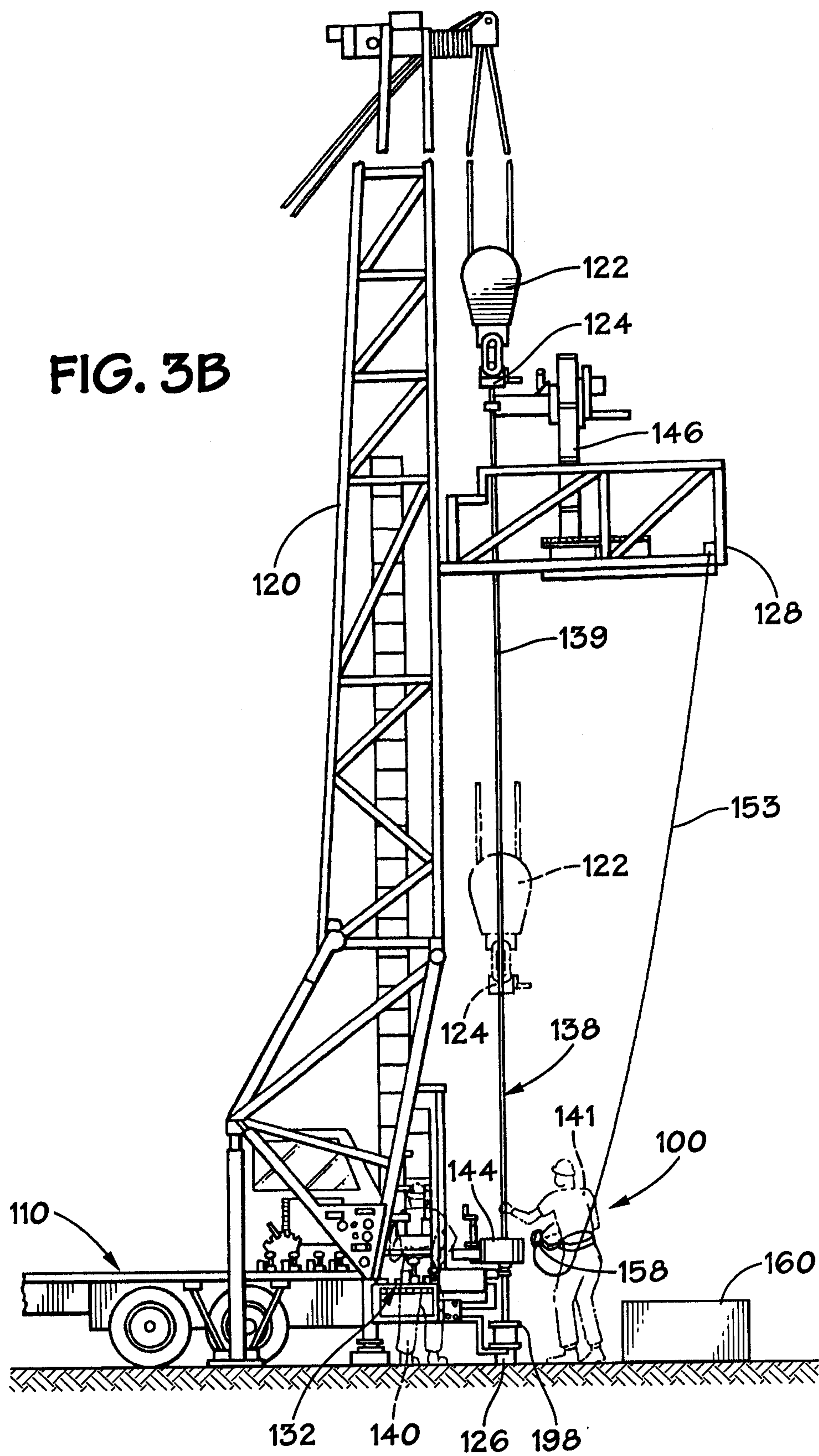
FIG. 2



3 / 11

FIG. 3A





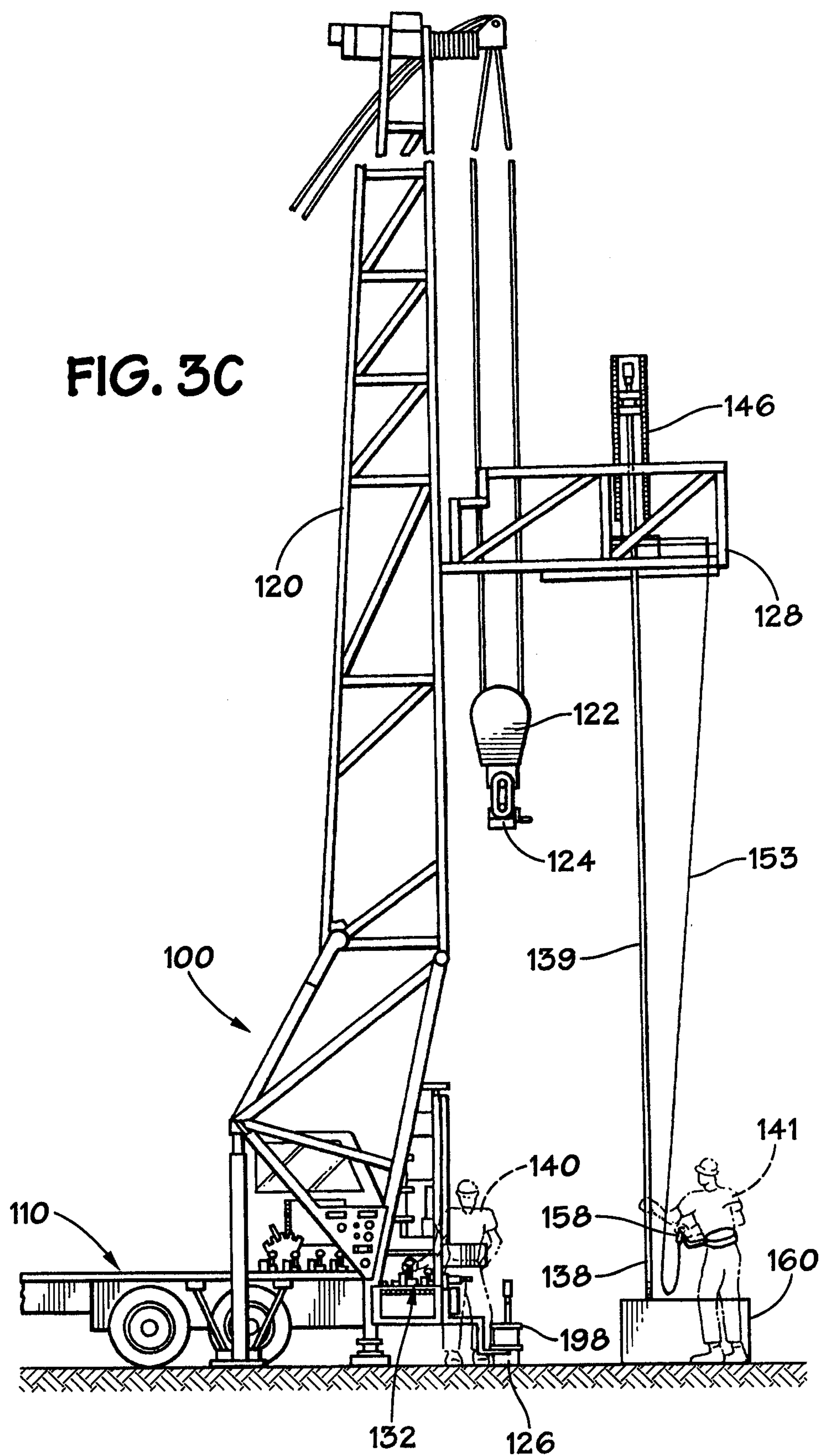


FIG. 4

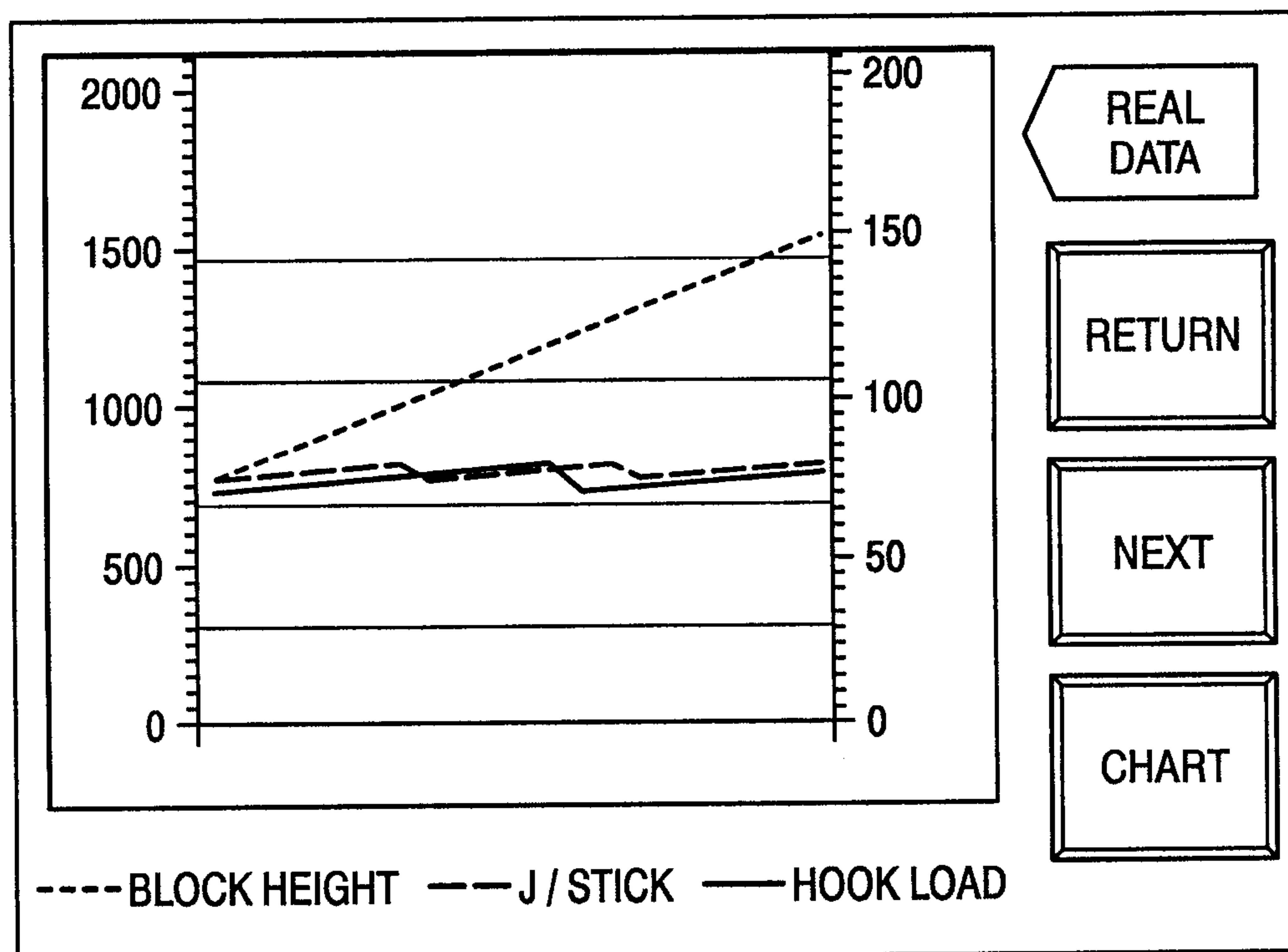
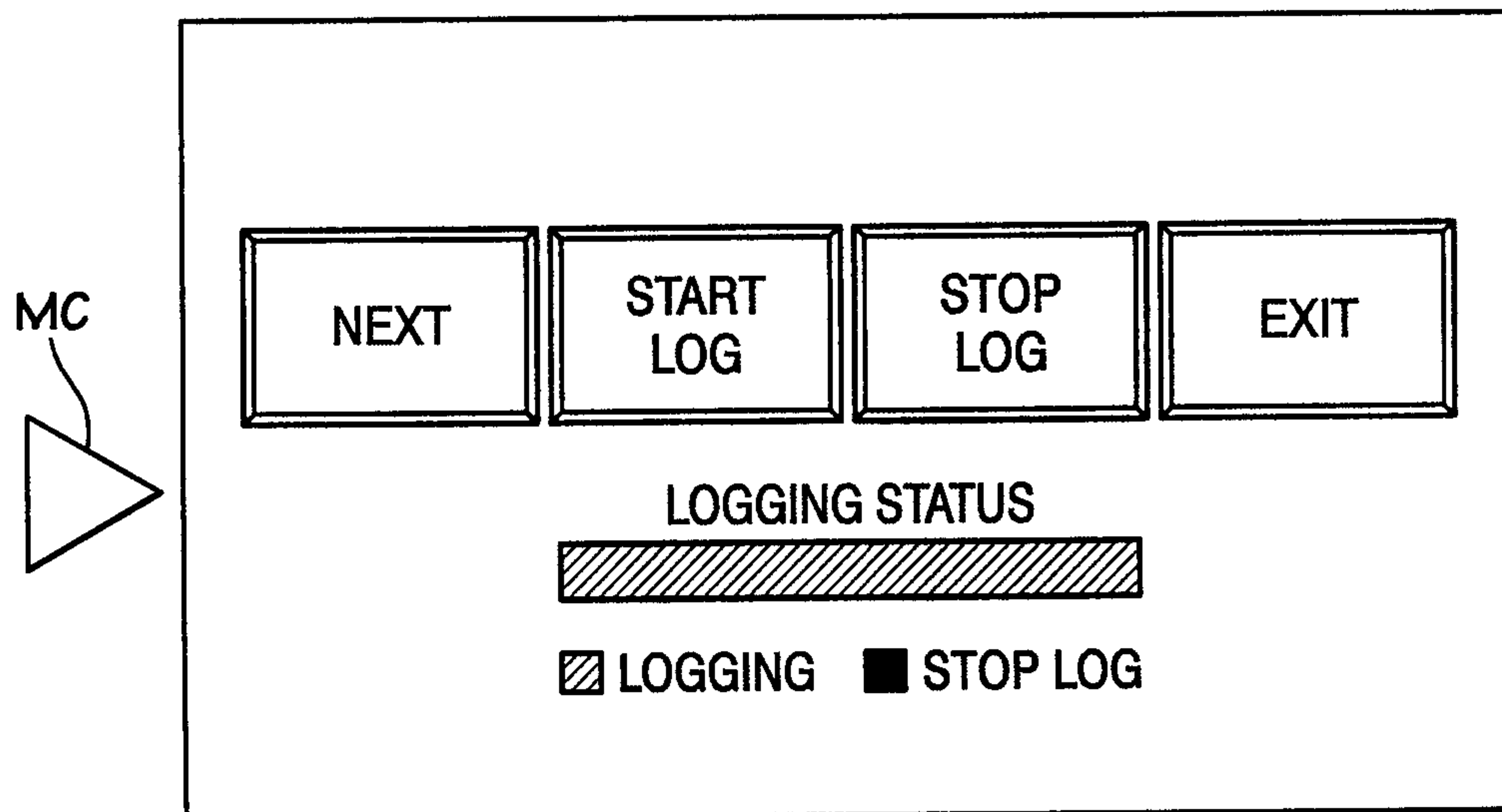


FIG. 5

FIG. 5A

RESULT MATRIX

SYSTEM STATUS	JOYSTICK (INPUT TO PLC)	ENGINE (SPEED OUTPUT FROM PLC)	ENGINE RPM (FROM SENSOR TO PLC)	ENGINE SOUND	ACTION
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0	0 - 2	0	IDLING	CHECK ENGINE RPM PROXIMITY SENSOR FOR PROPER ALIGNMENT AND OPERATION. CHECK SENSOR CABLE, WIRING AND CONNECTIONS.
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0 - 10 TRACKING JOYSTICK	0 - 10 TRACKING JOYSTICK	0	NONE	NONE. THIS INDICATES THAT JOYSTICK AND PLC ARE GOOD
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0 - 10 TRACKING JOYSTICK	0	0	NONE	CHECK PLC
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0	0	0	NONE	CHECK JOYSTICK. CHECK CABLES, WIRING AND CONNECTIONS FROM OPERATORS CONSOLE TO PLC



MISSING OR PROBLEM SIGNAL

BX

FIG. 6

RESULT MATRIX

SYSTEM STATUS	JOYSTICK (INPUT TO PLC)	ENGINE (SPEED OUTPUT FROM PLC)	ENGINE RPM (FROM SENSOR TO PLC)	ENGINE SOUND	ACTION
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0	0 - 2	0	IDLING	CHECK ENGINE RPM PROXIMITY SENSOR FOR PROPER ALIGNMENT AND OPERATION. CHECK SENSOR CABLE, WIRING AND CONNECTIONS.
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0 - 10 TRACKING JOYSTICK	0 - 10 TRACKING JOYSTICK	0	NONE	NONE. THIS INDICATES THAT JOYSTICK AND PLC ARE GOOD
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0 - 10 TRACKING JOYSTICK	0	0	NONE	CHECK PLC
WITH THE ENGINE STOPPED, THE CONTROL SYSTEM SWITCHED ON AND THE JOYSTICK MOVED TO THE LEFT OR RIGHT.	0	0	0	NONE	CHECK JOYSTICK. CHECK CABLES, WIRING AND CONNECTIONS FROM OPERATORS CONSOLE TO PLC



MISSING OR PROBLEM SIGNAL

BX

FIG. 7A

ENGINE ONLY TEST		
☐	JOYSTICK MICRO SWITCH -	0
☐	JOYSTICK OUTPUT -	0
☐	PLC ENGINE THROTTLE -	2
☐	ENGINE RPM -	200
☐		
☐		
☐		
☐		

SCREENSHOT 1

FIG. 7B

ENGINE ONLY TEST		
☐	JOYSTICK MICRO SWITCH -	1
☐	JOYSTICK OUTPUT -	2
☐	PLC ENGINE THROTTLE -	6
☐	ENGINE RPM -	1500
☐		
☐		
☐		
☐		

SCREENSHOT 2

FIG. 7C

ENGINE ONLY TEST		
☐	JOYSTICK MICRO SWITCH -	1
☐	JOYSTICK OUTPUT -	10
☐	PLC ENGINE THROTTLE -	10
☐	ENGINE RPM -	2100
☐		
☐		
☐		
☐		

SCREENSHOT 3

FIG. 7D

☐	JOYSTICK MICRO SWITCH -	0
☐	<u>JOYSTICK OUTPUT -</u>	<u>0</u>
☐	PLC ENGINE THROTTLE -	2
☐	ENGINE RPM -	200
☐		
☐		
☐		
☐		
☐		
☐		

ADDITIONAL INPUT

FIG. 7E

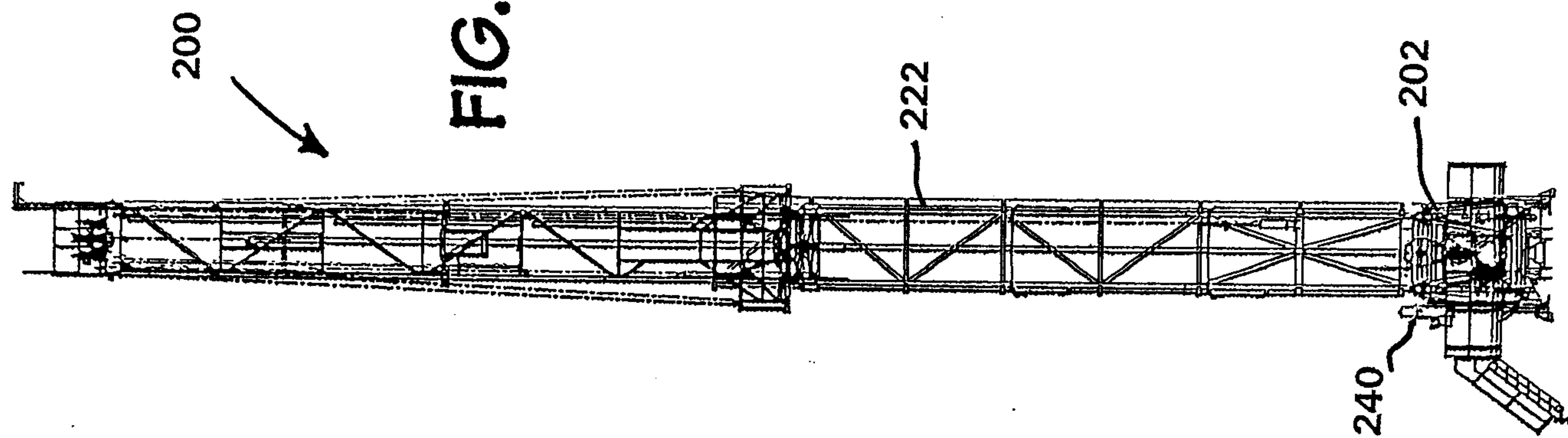
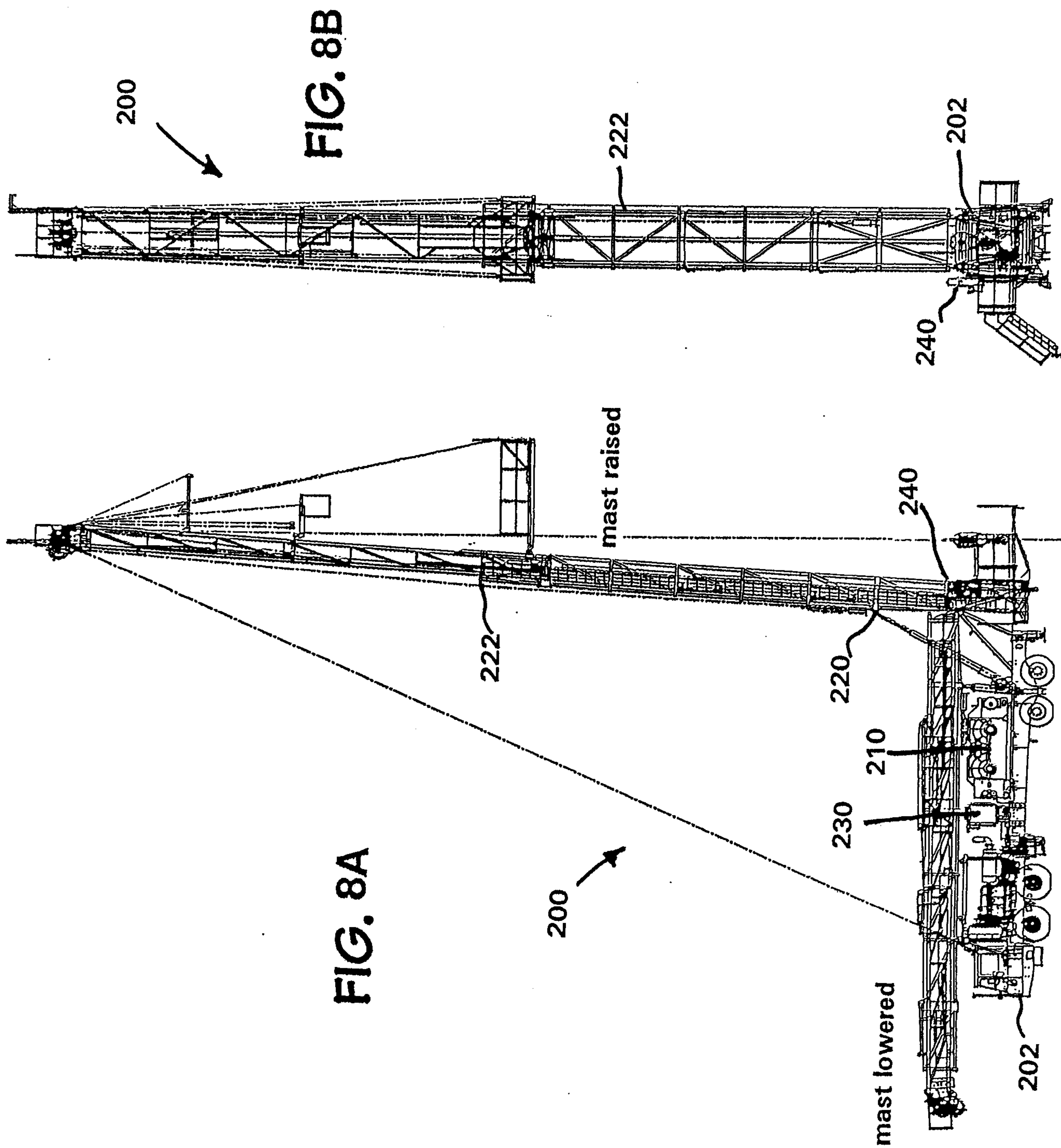
ENGINE STATUS	ENGINE SOUND
IDLING	IDLING
STOPPED	NONE

AUTO

FIG. 7F

ACTION

CHECK ENGINE RPM
PROXIMITY SENSOR FOR
PROPER ALIGNMENT AND
OPERATION. CHECK SENSOR
CABLE, WIRING AND
CONNECTIONS.



MC



NEXT

START
LOG

STOP
LOG

EXIT

LOGGING STATUS



 LOGGING  STOP LOG