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(71) Applicant *(for all designated States except US)*: **ROBOTIC CRANES, LP** [US/US]; 1003 Wirt Road, Houston, TX 77055-6864 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **PRESSWOOD, Ronald, Gustav, Jr.** [US/US]; 807 Saybrook Lane, Houston, TX 77024-4505 (US). **THOMPSON, Clark, James** [US/US]; 7 Songbird Lane, Rosharon, TX 77583 (US).

(74) Agent: **STROZIER, Robert, W.**; P.O. Box 429, Houston, TX 77402.0429 (US).

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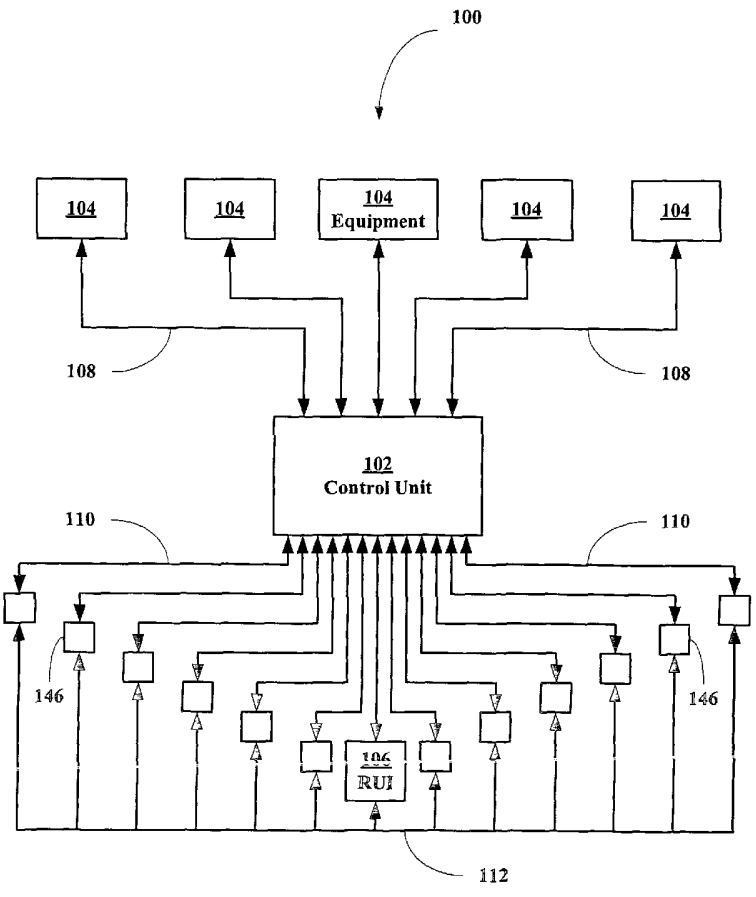
(54) Title: EQUIPMENT CONTROL SYSTEM AND METHODS FOR ITS USE



(57) Abstract: An equipment control system is disclosed, which includes a control unit through which all equipment control instruction are implemented and monitored, at least one piece of equipment to be controlled and at least one remote user interface, designed to allow a user to select and pass commands to the control unit and receive equipment status information from the piece of equipment via the control unit, which can refine the status information. A method for using the system is also disclosed.

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PATENT SPECIFICATION

TITLE: EQUIPMENT CONTROL SYSTEM AND METHODS FOR ITS USE

INVENTOR: Clark James Thompson and Ronald Gustav Presswood

ASSIGNEE: Robotic Cranes, LP

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an equipment control system including a piece of equipment to be controlled, a control unit in two-way communication with the piece of equipment and a remote user interface (RUI) in two-way communication with the control unit, where the RUI forwards user commands and/or command protocols to the control unit and receives refined and/or raw equipment status data from the control unit and the control unit forwards command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment status data from the equipment or from sensors associated with the equipment. The present invention also relates to methods for making and using the system.

[0002] More particularly, the present invention relates to an equipment control system including at least one piece of equipment to be controlled, a control unit in two-way communication with the at least one piece of equipment and at least one remote user interface (RUI) in two-way communication with the control unit, where the RUI forwards user commands and/or command protocols to the control unit from a modifiable command and command protocol selection format and receives refined and/or raw equipment state data from the control unit and the control unit forwards command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment state data from the equipment or from sensors associated with the equipment. The present invention also relates to methods for making and using the system.

2. Description of the Related Art

[0003] Some anti-sway devices for cranes exist in the art, such as those described in United States Pat. Nos.:, incorporated herein by reference. Some of these anti-sway devices attempt to reduce sway by controlling load and crane motion is such a way that as the crane moves the load, the motion speed and direction tends to minimize sway.

[0004] Although these system do act to reduce sway, they are difficult to use and generally do not completely or substantially eliminate load sway. Thus, there is a need in the art of a

more efficient, cost effective and easy anti-sway device for cranes.

SUMMARY OF THE INVENTION

[0005] The present invention provides an equipment control system including a piece of equipment to be controlled, a control unit in two-way communication with the piece of equipment and a remote user interface (RUI) in two-way communication with the control unit, where the RUI forwards user commands and/or command protocols to the control unit and receives refined and/or raw equipment status data from the control unit and the control unit forwards command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment status data from the equipment or from sensors associated with the equipment

[0006] The present invention also provides an equipment control system including at least one piece of equipment to be controlled, a control unit in two-way communication with the at least one piece of equipment and at least one remote user interface (RUI) in two-way communication with the control unit, where the RUI forwards user commands and/or command protocols to the control unit from a modifiable command and command protocol selection format and receives refined and/or raw equipment state data from the control unit and the control unit forwards command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment state data from the equipment or from sensors associated with the equipment.

[0007] The present invention also provides a modifiable user command or command protocol selection format implemented on the RUIs and the control unit so that the commands or command protocols can be easily and quickly reformatted for different equipment control requirements and/or reformatted for user taste and visual preferences, where the different formats can be stored formats selectable from a selection menu, derivable from stored user preferences or created on the fly by the user for a particular piece of equipment or control protocol.

[0008] The present invention provides a method for controlling a piece of equipment including the steps of selecting a command or a command protocol selectable on a remote user interface (RUI) in two-way communication with a control unit. Once the user selects a desired command or command protocol, the RUI forwards the desired command or command protocol to the control unit. The control unit processes the command or command protocol converting the command or command protocol into equipment executable instructions. The

control unit then checks to determine whether the equipment is currently executing another command or whether the command or command protocol includes an override and/or emergency command. If the command or command protocol includes an override and/or emergency command, then the control unit forwards the instructions to the piece of equipment. If the control unit determines that the piece of equipment is currently executing a command and command protocol, then the control units sends a hold notice to the issuing RUI, waits for the piece of equipment to complete its currently executing command or command protocol and then forwards the new instructions to the piece of equipment, after completion of the current task.

[0009] The present invention also provides method for controlling equipment including the steps of selecting a command or a command protocol selectable on a plurality of remote user interfaces (RUIs) in two-way communication with a control unit and in two-way communication with each other. Once a user selects a desired command or command protocol, that RUI forwards the desired command or command protocol to the control unit and to the other RUIs as notification of the issuance of a command or a command protocol to a particular piece of equipment. The control unit processes the command or command protocol converting the command or command protocol into equipment executable instructions. The control unit then checks to determine whether the equipment is currently executing another command or whether the command or command protocol includes an override and/or emergency command. If the command or command protocol includes an override and/or emergency command, then the control unit forwards the instructions to the piece of equipment. If the control unit determines that the piece of equipment is currently executing a command and command protocol, then the control units sends a hold notice to the issuing RUI, waits for the piece of equipment to complete its currently executing command or command protocol and then forwards the new instructions to the piece of equipment, after completion of the current task.

[0010] The present invention also provides a method for modifying the user interface display format including the step of either selecting a pre-defined display format from a selection menu, selecting a pre-defined display format and selecting a user preference, or reformatting the display format on the fly using format edit commands accessible from menus or entered directly from user interface commands or command strings.

DESCRIPTION OF THE DRAWINGS

[0011] The invention can be better understood with reference to the following detailed description together with the appended illustrative drawings in which like elements are numbered the same:

[0012] Figure 1A depicts a schematic diagram of a preferred embodiment of the equipment control system of this invention;

[0013] Figure 1B depicts a schematic diagram of a preferred embodiment of the equipment control system of this invention;

[0014] Figure 1C depicts a schematic diagram of a preferred embodiment of the equipment control system of this invention;

[0015] Figure 1D depicts a schematic diagram of a preferred embodiment of the equipment control system of this invention;

[0016] Figure 2 depicts a schematic diagram of a preferred embodiment of a control unit of this invention;

[0017] Figure 3 depicts a schematic diagram of a preferred embodiment of a remote user interface of this invention;

[0018] Figures 4A-C depict a conceptual flowchart of a preferred method for controlling a piece of equipment using the system of this invention; and

[0019] Figure 5 depicts a preferred equipment interface format of this invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] The inventors have found that a new equipment control system can constructed and implemented which provides control unit mediated user control of one or more pieces of equipment using remote user interfaces (RUIs), which is in two-way communication with the control unit, which is in turn in two-way communication with the one or more pieces of equipment. The systems is designed to allow the user to interact with the one or more of the piece of equipment via communication with the control unit which, depending on the status of a given piece of equipment, converts user commands or command protocols to equipment executable instructions. The RUIs allow the user to select equipment from equipment lists and control the actions of the selected equipment from a pre-defined interface format, from user configured interface format or from an on the fly modified interface format.

[0021] The two-way communication between the control unit and the each piece of

equipment allows the control unit to forward equipment executable instructions to any of the pieces of equipment and allows any of the pieces of equipment to send back status information, where the status information includes data associated with equipment status and/or data from sensors associated with the equipment. The two-way communication between the control unit and the RUIs allows each user to select and issue commands or command protocols to the control to instruct to any of the pieces of equipment in two-communication with the control unit to execute the command or command protocol depending on the status of the equipment and to receive equipment status and command execution status information from the control unit.

[0022] Some of the advantages of using a central control unit to receive commands or command protocols from the RUIs, convert the commands or command protocols into equipment executable instructions and transmit the instruction to the desire piece of equipment is to efficiently orchestrate control of many different pieces of equipment and/or by many different user having RUIs in two-way communication with the control unit. Moreover, by having a control unit, which can of course be a single digital processing unit, a collection of digital processing units or a distributed collection of digital processing units, complex equipment protocols can be developed and implemented by selection formats accessible on the RUIs and mirrored on the control unit. Furthermore, because multiple users may try to simultaneously control a given piece of equipment, the control unit will monitor equipment status and command execution timing to decrease or eliminate multiple and potentially conflicting instructions being issued to any given piece of equipment improving safety. Additionally, centralizing control provides for efficient emergency and supervisor override capability.

[0023] The present invention broadly relates to an equipment control system including a piece of equipment to be controlled, a control unit in two-way communication with the piece of equipment and a remote user interface (RUI) in two-way communication with the control unit. The RUI is adapted to forward user commands and/or command protocols to the control unit and receives refined and/or raw equipment status data from the control unit. The control unit is adapted to forward command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment status data from the equipment or from sensors associated with the equipment

[0024] The system of this invention is ideally suited for controlling a plurality of pieces of

equipment from a plurality of remote user interface (RUI), where the RUIs are in independent two-way communication with the control unit and each other and the control unit is in independent two-way communication with each piece of equipment.

[0025] In a second aspect, the present invention broadly relates to a modifiable user command or command protocol selection format implemented on the RUIs and the control unit, so that the commands or command protocols can be easily and quickly reformatted for different equipment control requirements and/or reformatted for user taste and visual preferences, where the different formats can be stored formats selectable from a selection menu, derivable from stored user preferences or created on the fly by the user for a particular piece of equipment or control protocol.

[0026] In another aspect, the present invention broadly relates to a method for controlling a piece of equipment including the steps of selecting a command or a command protocol selectable on a remote user interface (RUI) in two-way communication with a control unit. Once the user selects a desired command or command protocol, the RUI forwards the desired command or command protocol to the control unit. The control unit processes the command or command protocol converting the command or command protocol into equipment executable instructions. The control unit then checks to determine whether the equipment is currently executing another command or whether the command or command protocol includes an override and/or emergency command. If the command or command protocol includes an override and/or emergency command, then the control unit forwards the instructions to the piece of equipment. If the control unit determines that the piece of equipment is currently executing a command and command protocol, then the control units sends a hold notice to the issuing RUI, waits for the piece of equipment to complete its currently executing command or command protocol and then forwards the new instructions to the piece of equipment, after completion of the current task.

[0027] The method of this invention is ideally suited for controlling a plurality of pieces of equipment from a plurality of remote user interface (RUI), where the RUIs are in independent two-way communication with the control unit and each other and the control unit is in independent two-way communication with each piece of equipment.

[0028] In another aspect, the present invention broadly relates to a method for modifying the user interface display format including the step of either selecting a pre-defined display format from a selection menu, selecting a pre-defined display format and selecting a user

preference, or reformatting the display format on the fly using format edit commands accessible from menus or entered directly from user interface commands or command strings.

[0029] Suitable pieces of equipment that can be controlled by the system of this invention includes, without limitation, any piece of commercial, industrial, or residential equipment capable of being controlled by a centralized control unit or by remote control. Preferred pieces of equipment include, without limitation, cranes, robots, automated manufacturing equipment, presses, stamping equipment, injectors, extruders, mixers, reactors, instrumentation, instrument gauges, sorting equipment, commutating equipments, mills, internal mixers, production or manufacturing lines, or any other equipment controllable from a control unit (central or remote).

[0030] Suitable control units include, without limitation, one or more digital processing unit directly connected to each other or a distributed network of a plurality of digital processing unit.

[0031] Suitable remote user interfaces include, without limitation, digital processing units, especially hand help digital processing units, standard telephones, especially telephones with displays, cellular phones, especially cellular phones with displays, digital processing units connected to a distributed computer network such as an intranet or an internet, such as the world wide web, or any other device capable of two-way communication with the control unit.

[0032] Suitable digital processing units or computer systems for use in this invention, include, without limitation, any device including a central processing unit for executing digital microcode and programs and an optional cache memory, a memory associated with the processing unit connected by a bus, optionally one or more mass storage devices such as a disk drive, solid state disks, CD drive or the like, connected to the processing unit and/or memory by a bus, communication hardware and software for communicating with external devices such as displays, printers, scanners, voiced activated devices, or the like as is well-known in the art. Such devices can be mainframe computer, mini-mainframe computer, PCs, palm, smart controllers, or the like. The computer equipment can be made by any manufacturer such as Compaq, Dell, Intel, Motorola, Apple, or the like. The computer equipment can also have loaded therein software including operating systems especially windowing operating systems, user interfaces especially graphics user interfaces, communication software, security software, internet browser software, or the like.

[0033] Suitable operating systems running on the digital processing units of this invention, include, without limitation, windowing operating systems such as Window®, Linux®, Apple® OS, or the like, or any other operating system capable of supporting the programs operating the cable control devices and other software used in the apparatuses of this invention.

[0034] Referring now to Figure 1A, a preferred system, generally **100**, of this invention is shown to include a central control unit **102**, a plurality of pieces of equipment **104** controllable by the control unit **102** and a plurality of RUIs **106**. The control unit **102** is in two-way communication with each piece of equipment **104** via first communication pathways **108**; and the control unit **102** is in two-way communication with each RUI **106** via second communication pathways **110**.The system **100** also includes third two-way communication pathways **112** between the RUIs **106**. The communication pathways **108**, **110** and **112** may be wireless communication pathways or hard wired communication pathways.

[0035] Referring now to Figure 1B, a preferred system, generally **120**, of this invention is shown to include a central control unit **122**, a plurality of pieces of equipment **124** controllable by the control unit **122** and a plurality of RUIs **126**. The control unit **122** is in two-way communication with each piece of equipment **124** via first communication pathways **128**. The control unit **122** is in two-way communication with a network, an intranet (local area network) or an internet (distributed network), **130** via second communication pathway **132**; and each RUI **126** is in two-way communication with the network **130** via third communication pathways **134**. The system **120** also includes fourth two-way communication pathways **136** between the RUIs **126**. The communication pathways **128**, **132**, **134** and **136** may be wireless communication pathways or hard wired communication pathways.

[0036] Referring now to Figure 1C, a preferred system, generally **140**, of this invention is shown to include a central control unit **142**, a plurality of pieces of equipment **144** controllable by the control unit **142** and a plurality of RUIs **146**. The control unit **142** is in two-way communication with each piece of equipment **144** via first communication pathways **148**. The control unit **142** is in two-way communication with a first network, an intranet (local area network) or an internet (distributed network), **150** via second communication pathway **152**; and each RUI **146** is in two-way communication with the first network **150** via third communication pathways **154**. The system **140** also includes fourth two-way communication pathways **156** between the RUIs **146** and a second network **158**, which allow

the RUIs to exchange information. The networks **150** and **158** may be the same or different network. The communication pathways **148**, **152**, **154** and **156** may be wireless communication pathways or hard wired communication pathways.

[0037] Referring now to Figure 1D, a preferred system, generally **160**, of this invention is shown to include a central control unit **162**, a plurality of pieces of equipment **164** controllable by the control unit **162** and a plurality of RUIs **166**. The control unit **162** is in two-way communication with a first network **168** via first communication pathway **170**; and each piece of equipment **164** is in two-way communication with the first network **168** via second communication pathways **172**. The control unit **162** is in two-way communication with a second network **174** via third communication pathway **176**; and each RUI **106** is in two-way communication with the second network **174** via fourth communication pathways **178**. The system **160** also includes fifth two-way communication pathways **180** between the RUIs **166** and a third network **182**, which allow the RUIs to exchange information. The communication pathways **170**, **172**, **176**, **178** and **180** may be wireless communication pathways or hard wired communication pathways. The networks **168**, **174** and **182** may the same or different networks. Preferably, the networks **168** and **174** are the same.

[0038] The term wireless communication pathways means that communication is handled by communication hardware and software utilizing any known or yet to be discovered through air communication protocol including, without limitation, electromagnetic waves, sound waves, or the like. Preferred electromagnetic wireless protocols include, without limitation, RF, IR, near IR, microwave, or the like. The term hard wired means that physical devices such as metal based wires, fiber optic wires, or the like capable of carrying electric signals connect the control unit to the pieces of equipment.

[0039] The term network includes local area networks (LANs) or intranets, distributed networks or internets such as the world wide web or the like, phone system such as land based, cellular, satellite or the like, or any other broad band resource for transmitting information from one connection point to another connection point.

[0040] Referring now to Figure 2, a preferred control unit, generally **200**, of this invention is shown to include processing unit **202**, a memory **204** and a communication unit **206** connected to communication port **208**. The processing unit **202**, the memory **204** and the communication unit **206** are in two-way communication one with the others as is typical in computer systems, where the communication is generally over buses. Preferably, the

processing unit **202** is a digital processing unit. Of course, the control unit **200** can also include any of a host of peripheries such as a display device, a mass storage device (a disk drive, solid state disks, optical disks, *etc.*), a printer, a video camera, keyboard, a mouse, or the like. The memory **204** includes a windowing operation system **210**, communication software **212**, an equipment control interface **214**, an equipment control interface designer **216**, an equipment instruction generator **218** and an equipment instruction execution monitor **220**. The equipment control interface **214** is established in the control unit **204** and is designed to include all options and selections for operating a given piece of equipment. The exact nature of the interface **214** depends on the equipment being control, but also depends on user preferences which are stored in a list associated with the interface **214.** The equipment control interface designer **216** allows a user to configure new interface formats for a new piece of equipment, to modify an existing interface format according to a set of user preference, to modify and save or overwrite an existing interface format, to create new commands, to create new command protocols or macro commands, to modify and save or overwrite existing commands or command protocols, or to construct new audio and/or visual feedback formats.

[0041] The equipment instruction generator **218** converts a user selected command or command protocol into equipment instructions that cause the equipment to perform the selected command or command protocol. The conversion processed performed by the generator **218** can include: calculating a trajectory for the equipment (*e.g.*, remote controlled fork lift, *etc.*) to traverse or for a part of the equipment (*e.g.*, a crane hook or end effector, the lift of a fork lift, the arm of a robot, *etc.*) to traverse; calculating the length of cables at each position along a trajectory for cable type cranes, or calculating any other computation that must be made to effectuate the selected command or command protocol. Another important function of the generator **218** is to resolve conflicting commands, to properly sequence multiple commands, and to properly handle override commands or emergency commands.

[0042] The equipment instruction execution monitor **220** processes incoming data from the piece of equipment in response to the instruction sent to the piece of equipment by the control unit **200.** The incoming data can be any data associated or generated by the piece of equipment during operation or can be data from sensors associated either directly (located on the piece of equipment) or indirectly (located in proximity to the equipment) with the piece

of equipment. The incoming data can include numeric, video, audio, or any other data needed to monitor the execution of instruction from the control unit by the piece of equipment.

[0043] The term interface format means the way that the user interface appears on a display device associated with a RUI. The term command means a nemonic representing a set of equipment instructions that cause a given piece of equipment to perform a given task. The term command protocol means a nemonic representing a set of commands that cause a given piece of equipment to perform a complex task including a number of tasks performed in series. The term task means a specific equipment change in state such as a simple move, up or down hook or end effector movement, hook or end effector attachment, or the like. A complex task means a specific equipment operation that may include many equipment changes of states such as an automated sequence to reposition to a start position, move to a given position, lower the end effector to attach to a load, raise the end effector with attached load, move the load to an end position, lower the end effector with the load attached and place the load at the end position.

[0044] Referring now to Figure 3, a preferred remote user interface (RUI), generally **300**, is shown to include a processing unit **302**, a memory **304** and a communication unit **306** connected to communication port **308**. The processing unit **302**, the memory **304** and the communication unit **306** are in two-way communication one with the others as is typical in computer systems, where the communication is generally over buses. Preferably, the processing unit **302** is a digital processing unit. Of course, the control unit **300** can also include any of a host of peripheries such as a display device, a mass storage device (a disk drive, solid state disks, optical disks, *etc.*), a printer, a video camera, keyboard, a mouse, or the like. The memory **304** includes a windowing operation system **310**, communication software **312**, and an equipment control interface **314**. The interface **314** is a pure mimic of the interface **214** of the control unit **200** and merely displays the current interface format in control on the control unit **200.** The interface **214** and its mimic **314** also include selection lists for changing the interface format or alternatively, to selected applications that may control one or more pieces of equipment. The control interface **214** and **314** can also include commands that only continue as long as the user continues to hold down a key, place a finger on a soft button, or the like.

[0045] A user indirectly interacts with the piece of equipment using a RUI **300**, which forwards a user selected command or command protocol to the control unit **200** for

processing, execution and monitoring. Although the control is indirect, the user receives data from the control unit **200**, showing the current status of the equipment as it performs the selected command or command protocol. This feedback of equipment status information to the RUI **300** from the control unit **200** allows the user to check operation status on a continuous or periodic basis and to issue corrections, modifications, changes, overrides or emergency commands to the equipment via the control unit as it performs the selected command or command protocol. The interface **314** also allows the user to access the interface designer **216** of the control unit **200** so that the user can create, modify or set preferences.

[0046] Although Figure 3 depicts a RUI that includes a processing unit and is essentially a computer such as a lap top computer, palm computer, or other hand held computer, the RUIs of this invention can also be simple devices such as touch key phones, where the key pad becomes the command and command protocol selector and the speaker becomes the feedback unit. Thus, the user would call into the control unit via a traditional phone line. Once connected, the user would be advised as to the interface format to be used, that is the user will be advised as to the meaning of each key in the key pad via spoken instruction. The user would then hit keys to select commands and the control unit would send back spoken equipment status information. Of course, the control unit can also have voice recognition software so that the user could simply speak commands or command protocols to the control unit after being advised as so the active commands or command protocols.

[0047] The advantages to indirect control are numerous, but command stacking and efficient override and emergency handling and monitoring are among the most important advantages associated with the systems of this invention. Using the system of this invention, the equipment can be set to default in an OFF condition or automatically reposition to a preset condition, unless a continuous or preset periodic signal is received from the control unit. In this manner, the equipment goes dormant until and unless communications are received according to a given protocol from the control unit.

[0048] Referring now to Figures 4A-C, a preferred embodiment of a control software, generally **400**, of this invention used to control a piece of equipment and depicted in concept flow chart format. The control software **400** is shown to include a power up step **402**, which starts the control process either from a RUI coming on line or when bringing up the control unit. After power on either a RUI or the control unit, the software checks to see is if a

previous application or equipment interface format was selected in a conditional step **404**, if a previous selection was made or if the control unit is in a predefined selection, then control is transferred along a YES branch **406** to a change application or format step **408**. If no previous application or format was selected or the system defaults to a default format, then control is transferred along an NO branch **410** to a display application or format selection list or menu **412**. If a change is made in step **408**, then control is transferred along a YES branch **414** to the display step **412**; otherwise control is transferred along a NO branch **416** to a display equipment interface format step **418**. If control was transferred to step **408**, then the user can select a new application or format in select step **420** and control is passed to the display step **418**. After the desired interface format has been selected, the user can choose to edit or modify the format in an edit/modify conditional step **422**. If editing is requested, then control is transferred along a YES branch **424** to a display control selection list or menu step **426**, where a user can select a control or control modification in select step **428** and control is transferred to a second display interface format step **430** (which can of course be the same display step as step **418**). If no editing is desired in step **422**, then control is transferred along a NO branch **432** to the display step **430**. One should recognize that the application or format select process not only selects a particular form of the user interface, it selects the piece or pieces of equipment to be controlled by the interface. Thus, each interface format not only include the appropriate command and command protocols for accomplishing a given task, each format also includes an association to the equipment needed to accomplish the desired command or command protocol.

[0049] Once the desired interface format has been selected and/or editing, which could have simply been modifying the interface format according to user preferences, the user can select a command or command protocol from a select step **434**, where the command or command protocol allows the user to perform a given task with one or more pieces of equipment. Figure 4A also includes a continuation step **436**, which corresponds to continuation step **438** of Figure 4B and a FROM step **440**, which corresponds to TO step of Figure 4C.

[0050] Looking now at Figure 4B, from continuation step **438**, the selected command or command protocol is highlighted on the format display in a highlight step **442**, where the highlighting can be a color change, emboldened, flashing or any other highlight technique. Concurrent with the highlighting, the selected command or command protocol is forwarded to the control unit in a forward step **444**. Next, the command or command protocol is

converted to equipment executable instruction is a convert step **446**. Once converted, the instructions are tested to see if an override and/or emergency instruction is included in a test step **448**. If no override or emergency instruction is found, then control is transferred along a NO branch **450** to a test step **452** to determine whether the equipment is busy requiring the instructions to be stacked until the equipment is no longer busy. If the equipment is busy, then control is transferred along a YES branch **454** back to the test step **452**. Of course, the transfer branch **454** can include a delay.

[0051] If an override or emergency instruction is found in step **448**, then control is transferred along a YES branch **456** to a send instruction to equipment step **458**. Also, if the equipment is not busy as found in step **452**, controlled is transferred along a NO branch **460** to the send step **458**. Of course, the emergency and override instructions will override any process currently being performed by the equipment. Additionally, the emergency instruction may activate other safety procedures as well such as setting of sirens or other emergency procedures. Of course, the emergency and override instructions will override any process currently being performed by the equipment. Additionally, the emergency instruction may activate other safety procedures as well such as setting of sirens or other emergency procedures.

[0052] Next, the instruction are received by the equipment in a receive step **462**. The equipment then, processes the instructions in a process step **464**. The equipment then implements the instructions and starts raw data collections in an implement and collect step **466**. As data collection proceeds, raw data is either continuously or periodically sent to the control unit is a send step **468**. Figure 4B also includes a continuation step **470**, which corresponds to continuation step **472** of Figure 4C, and a FROM step **474**, which comes from the modify command or protocol step of Figure 4C.

[0053] Looking at Figure 4C, after the continuation step 472, the raw data is receive by the control unit is a receive data steps **476**. The control unit can optionally refine the raw data into refined data in refine data step **478**, and can send either or both the raw data or refined data to the RUI in send step **480**. The RUI then displays the equipment raw and/or refined status data in a display step **482**. The user can then modify the executing command or protocol in a modify test step **484**. If modification is requested, then control is transferred along a YES branch **486** to a TO step **488** which connects to the FROM step **474** and to the convert step **442** of Figure 4B. Otherwise, control is transferred along a NO branch **490** to

a command or protocol completion step **491**. If the user is done with this session as determined in a done test step **492**, then control is transferred along a YES branch **493** to a power down test step **494**. If the user is not done with this session or does power done, then control is transferred along NO branches **495** and **496** to TO step **497**, where control is sent via the FROM step **473** and TO step **475** of Figure 4B to the FROM step **440** to the change application step **408** of Figure 4A. If the user does power down, then control is transferred along a YES branch **498** to a stop session step **499**.

[0054] All references cited herein are incorporated by reference. While this invention has been described fully and completely, it should be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. Although the invention has been disclosed with reference to its preferred embodiments, from reading this description those of skill in the art may appreciate changes and modification that may be made which do not depart from the scope and spirit of the invention as described above and claimed hereafter.

CLAIMS

We claim:

1. An equipment control system comprising:
a piece of equipment to be controlled,
a control unit in two-way communication with the piece of equipment and
a remote user interface (RUI) in two-way communication with the control unit,
where the RUI forwards user commands and/or command protocols to the control unit and receives refined and/or raw equipment status data from the control unit and the control unit forwards command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment status data from the equipment or from sensors associated with the equipment.

2. An equipment control system comprising:
at least one piece of equipment to be controlled,
a control unit in two-way communication with the at least one piece of equipment and
at least one remote user interface (RUI) in two-way communication with the control unit,
where the RUI forwards user commands and/or command protocols to the control unit from a modifiable command and command protocol selection format and receives refined and/or raw equipment state data from the control unit and the control unit forwards command instructions corresponding to the user commands or command protocols to the equipment and receives raw equipment state data from the equipment or from sensors associated with the equipment.

3. A method for controlling a piece of equipment comprising the steps of:
selecting a command or a command protocol selectable on a remote user interface (RUI) in two-way communication with a control unit;
forwarding the desired command or command protocol to the control unit;
converting the command or command protocol into equipment executable instructions;
determining whether the equipment is currently executing previous command and

whether the command or command protocol includes an override and/or emergency command;

if the command or command protocol includes an override and/or emergency command, immediately forwarding the equipment executable instructions to the piece of equipment;

if the control unit determines that the piece of equipment is currently executing the previous command or command protocol, stacking the equipment executable instruction until the equipment is free and notifying the RUI that the command or command protocol is on hold;

otherwise, forwarding the equipment executable instruction to the piece of equipment; and

executing the instruction at the piece of equipment.

4. A method for controlling equipment comprising the steps of:

selecting a command or command protocol selectable on a plurality of remote user interfaces (RUIs) in two-way communication with a control unit and in two-way communication with each other, where the command or command protocol is adapted to control a piece of equipment in two-way communication with the control unit;

forwarding the selected command or command protocol from the RUI to the control unit and to the other RUIs as notification of issuance of a command or command protocol to a particular piece of equipment;

converting the selected command or command protocol in the control unit into equipment executable instructions of the particular piece of equipment;

checking whether the particular piece of equipment is currently executing previous command or command protocol or whether the selected command or command protocol includes an override and/or emergency command;

if the selected command or command protocol includes an override and/or emergency command, then immediately forwarding the instructions to the particular piece of equipment;

if the selected command or command protocol does not includes an override and/or emergency command and the particular piece of equipment is currently executing the previous command or command protocol, then sending a hold notice to the issuing RUI, waiting for the particular piece of equipment to complete execution of the previous command

or command protocol, once free, forwarding the instructions to the particular piece of equipment and issuing a send notice to the issuing RUI; and

if the selected command or command protocol does not includes an override and/or emergency command and the particular piece of equipment is free, forwarding the instructions to the particular piece of equipment.

5. A method for modifying the user interface display format including the step of either selecting a pre-defined display format from a selection menu, selecting a pre-defined display format and selecting a user preference, or reformatting the display format on the fly using format edit commands accessible from menus or entered directly from user interface commands or command strings.

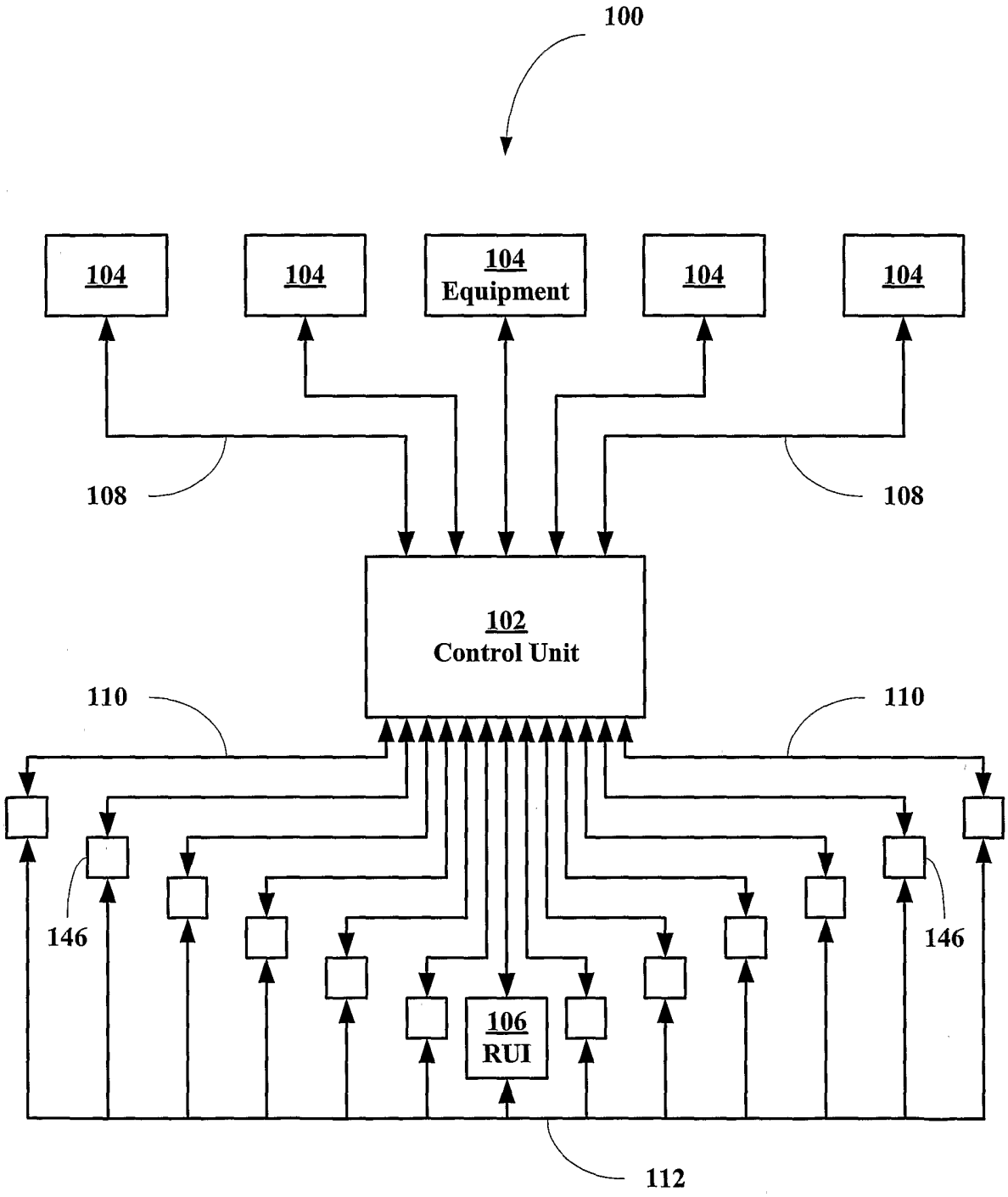
100
104
104
104
Equipment
104
104
108
108
102
Control Unit
110
110
146
146
106
RUI
112

FIG. 1A

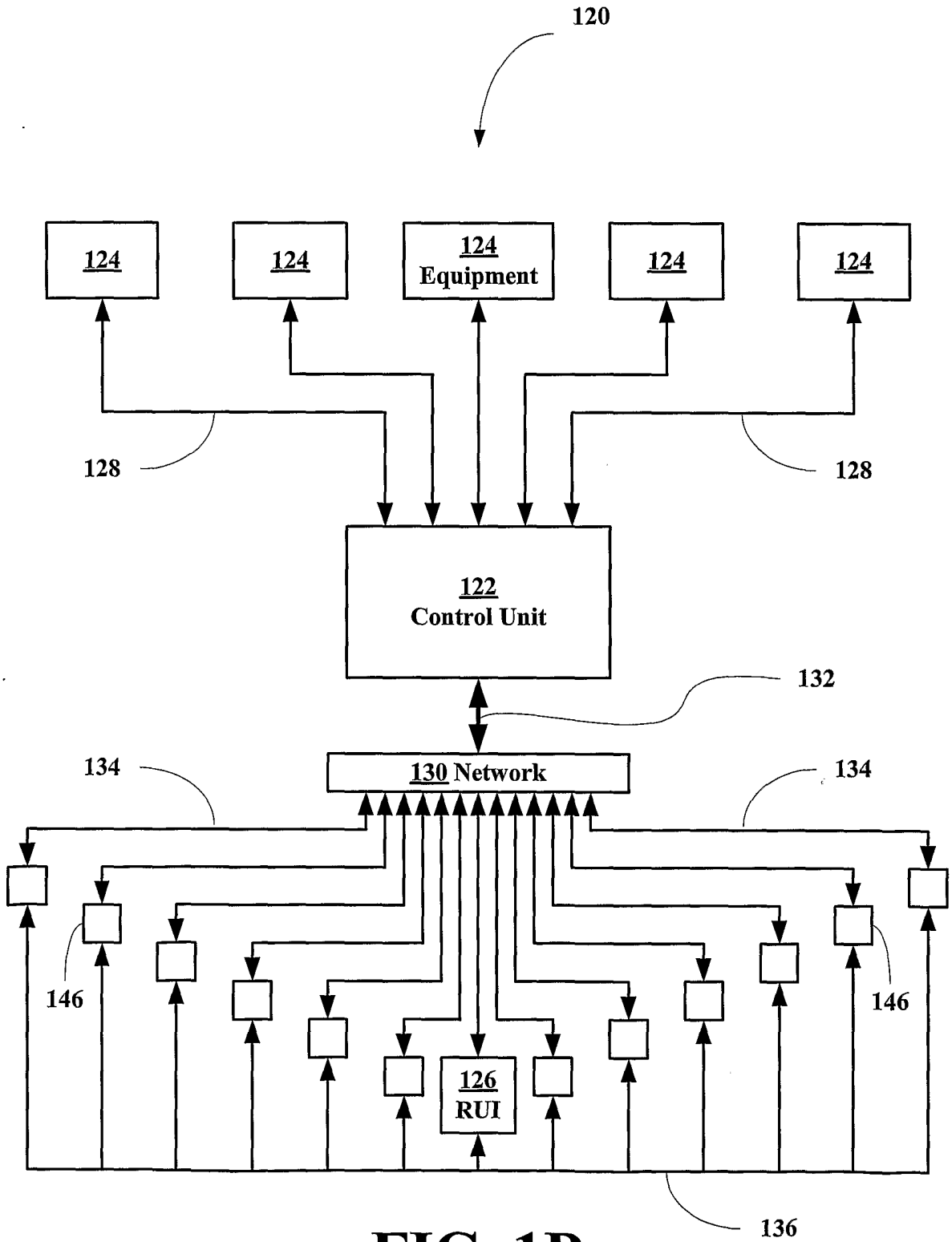
120
124
124
124
Equipment
124
124
128
128
122
Control Unit
132
134
130 Network
134
146
146
126
RUI
136

FIG. 1B

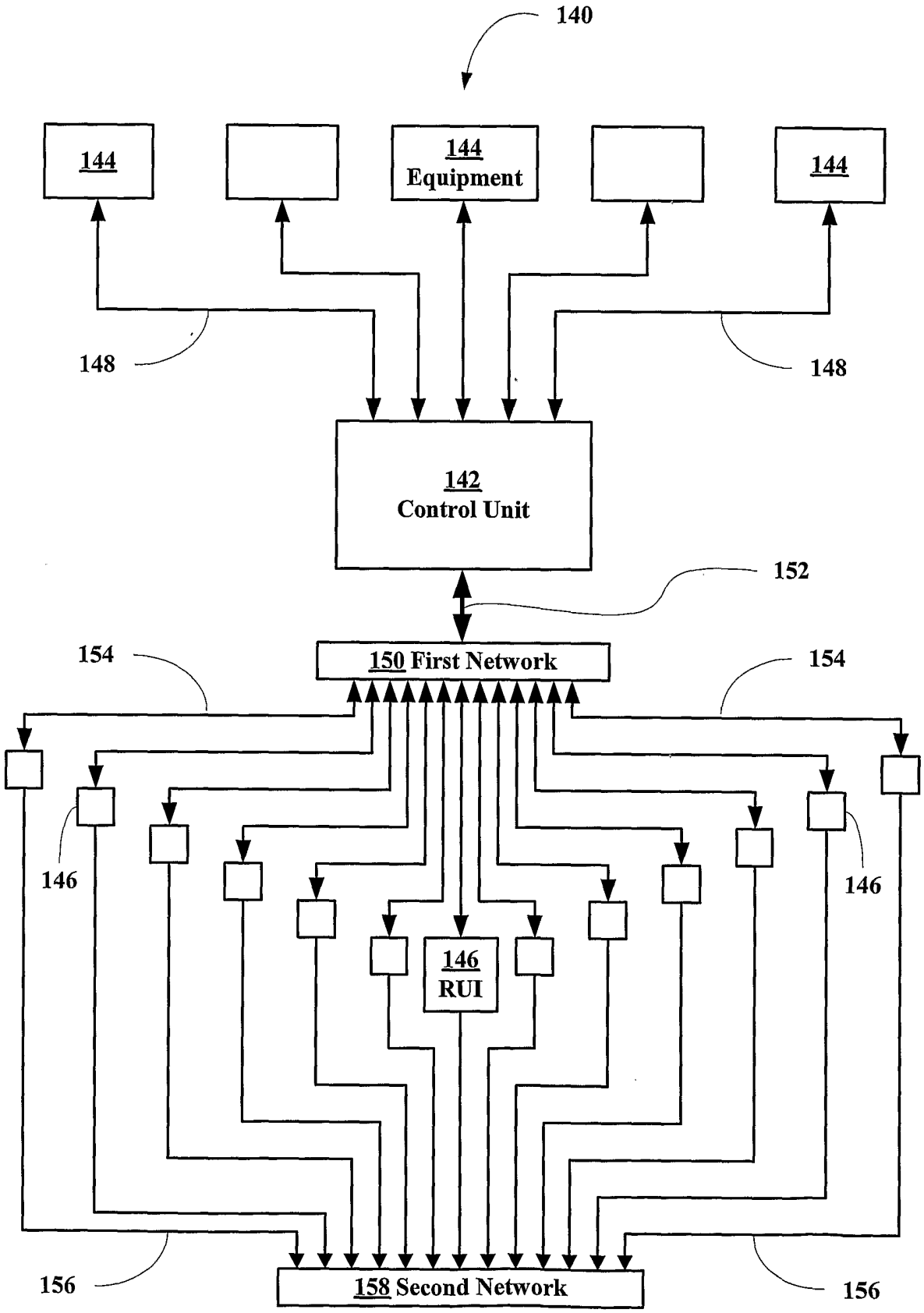
140
144
144
Equipment
144
148
148
142
Control Unit
152
154
150 First Network
154
146
146
146
RUI
156
158 Second Network
156

FIG. 1C

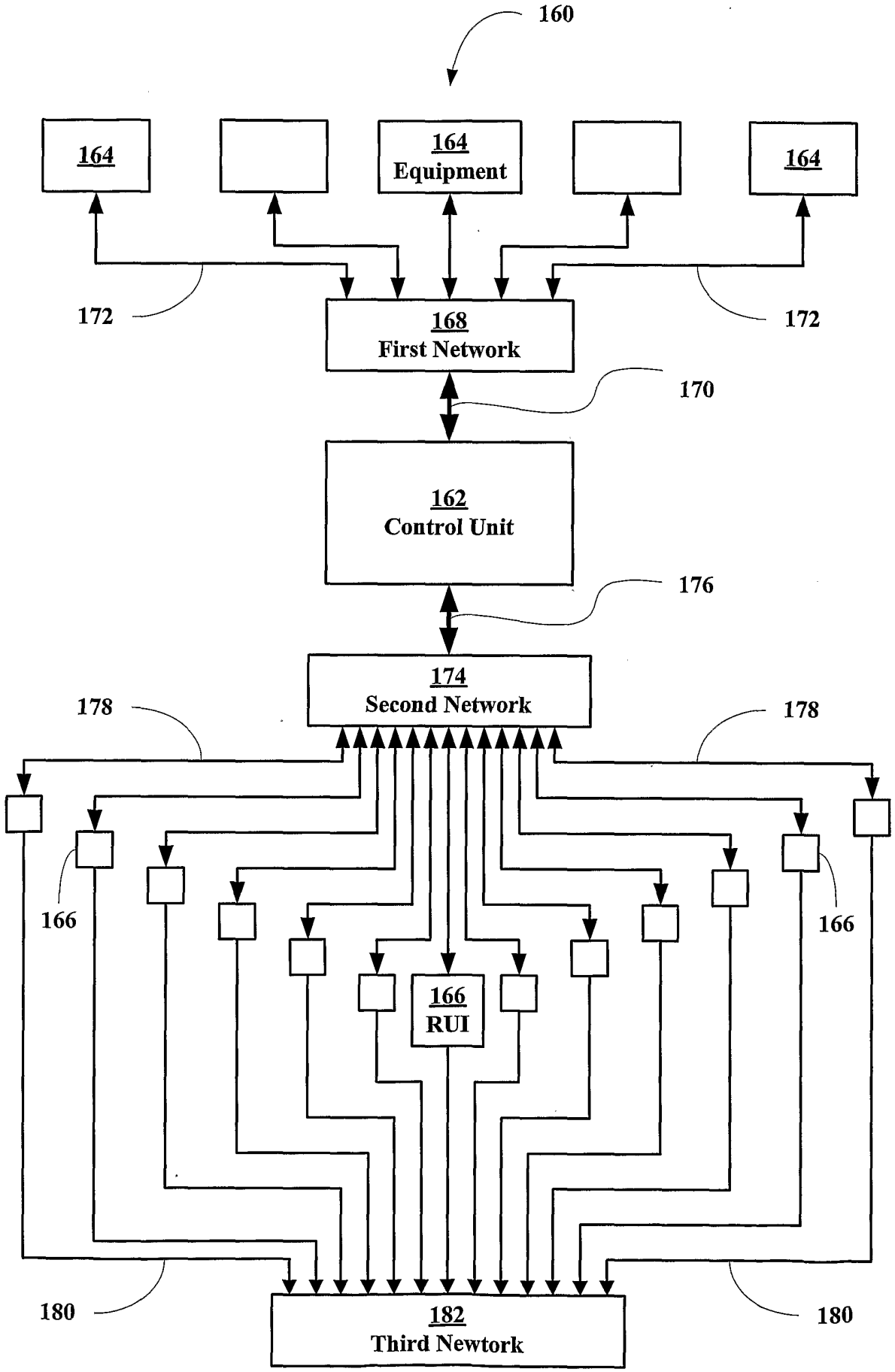
160
164
164
Equipment
164
172
172
168
First Network
170
162
Control Unit
176
174
Second Network
178
178
166
166
166
RUI
180
180
182
Third Newtork

FIG. 1D

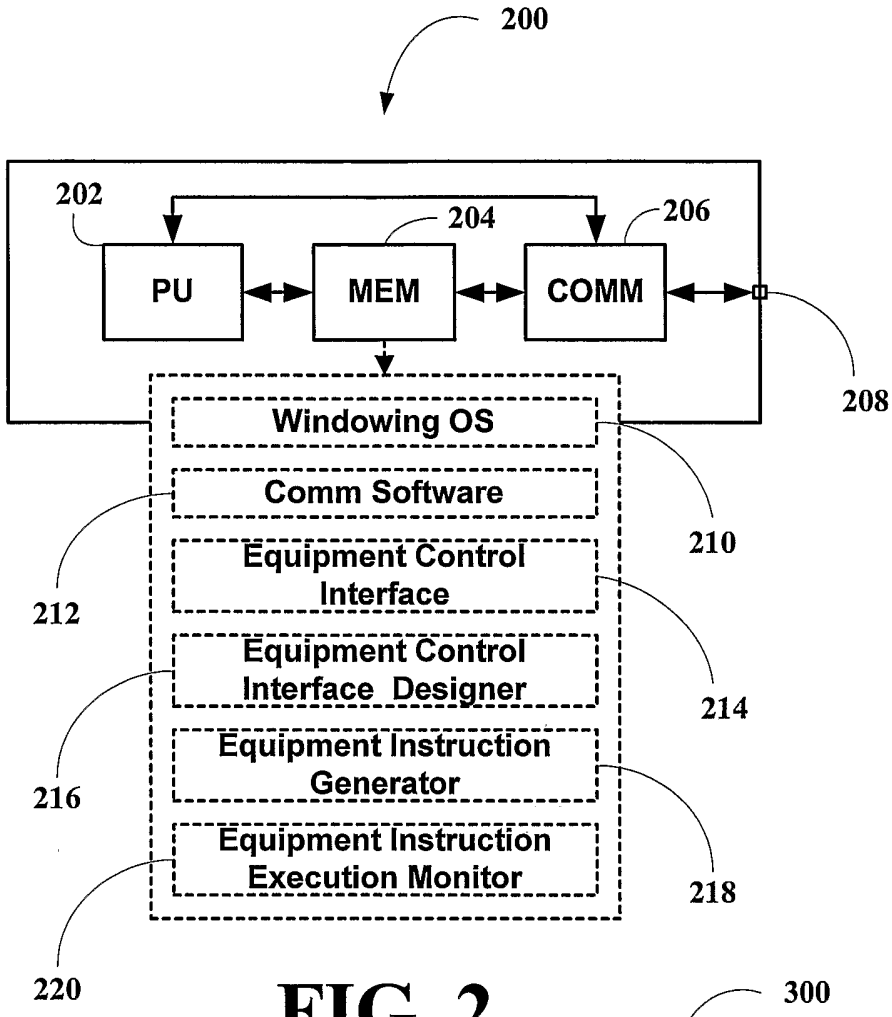
200
202
204
206
PU
MEM
COMM
208
Windowing OS
Comm Software
Equipment Control Interface
Equipment Control Interface Designer
Equipment Instruction Generator
Equipment Instruction Execution Monitor
210
212
214
216
218
220

FIG. 2

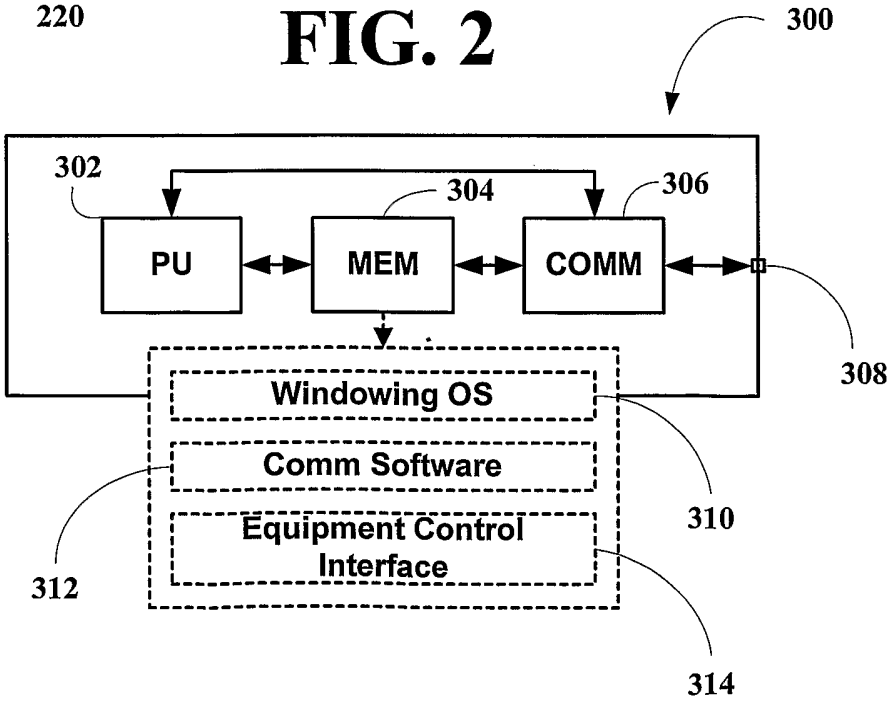
300
302
304
306
PU
MEM
COMM
308
Windowing OS
Comm Software
Equipment Control Interface
310
312
314

FIG. 3

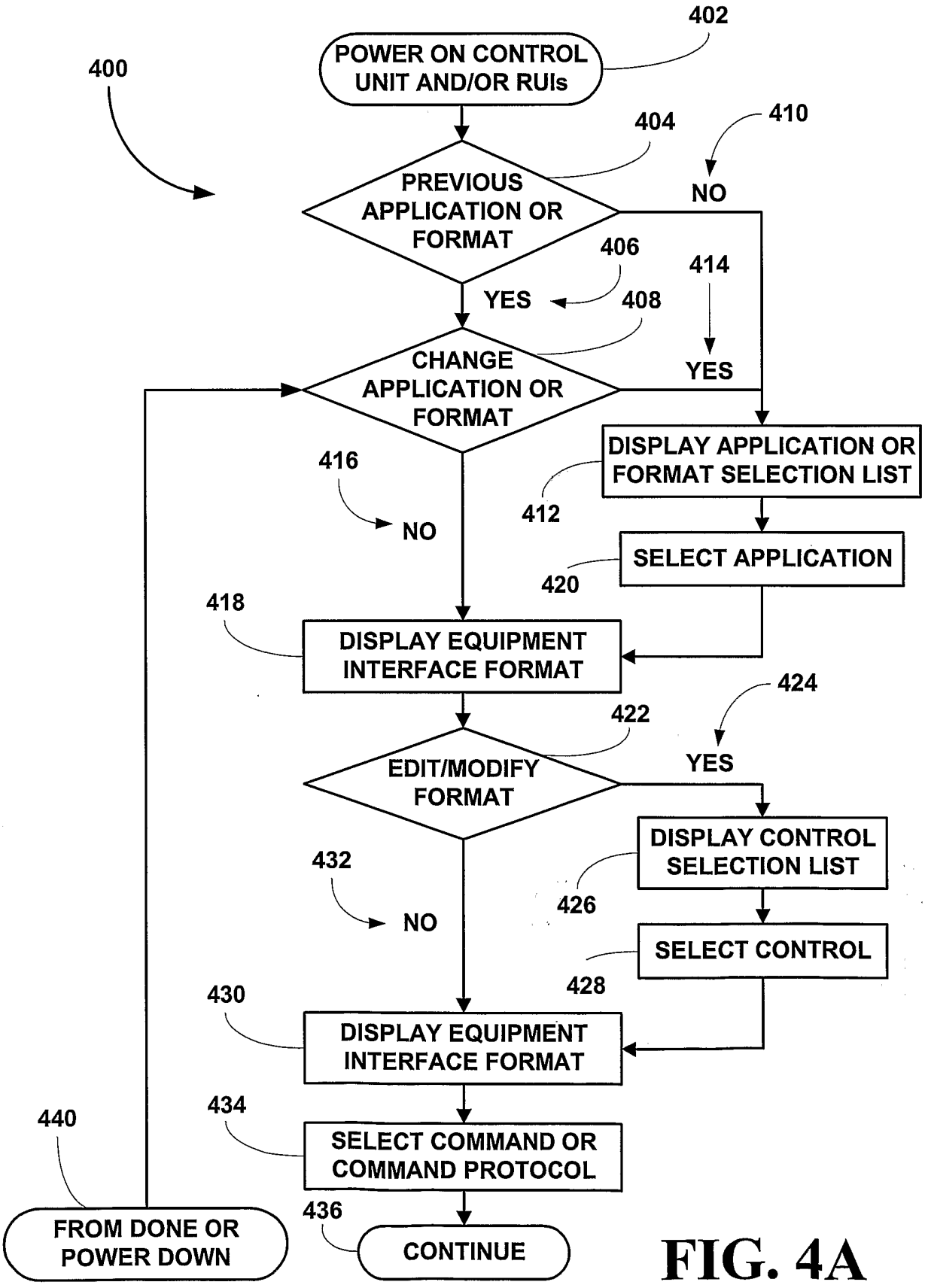
400
402
POWER ON CONTROL UNIT AND/OR RUIs
404
PREVIOUS APPLICATION OR FORMAT
410
NO
406
YES
408
414
YES
CHANGE APPLICATION OR FORMAT
DISPLAY APPLICATION OR FORMAT SELECTION LIST
412
416
NO
SELECT APPLICATION
420
418
DISPLAY EQUIPMENT INTERFACE FORMAT
424
422
EDIT/MODIFY FORMAT
YES
DISPLAY CONTROL SELECTION LIST
426
432
NO
SELECT CONTROL
428
430
DISPLAY EQUIPMENT INTERFACE FORMAT
434
SELECT COMMAND OR COMMAND PROTOCOL
440
436
FROM DONE OR POWER DOWN
CONTINUE

FIG. 4A

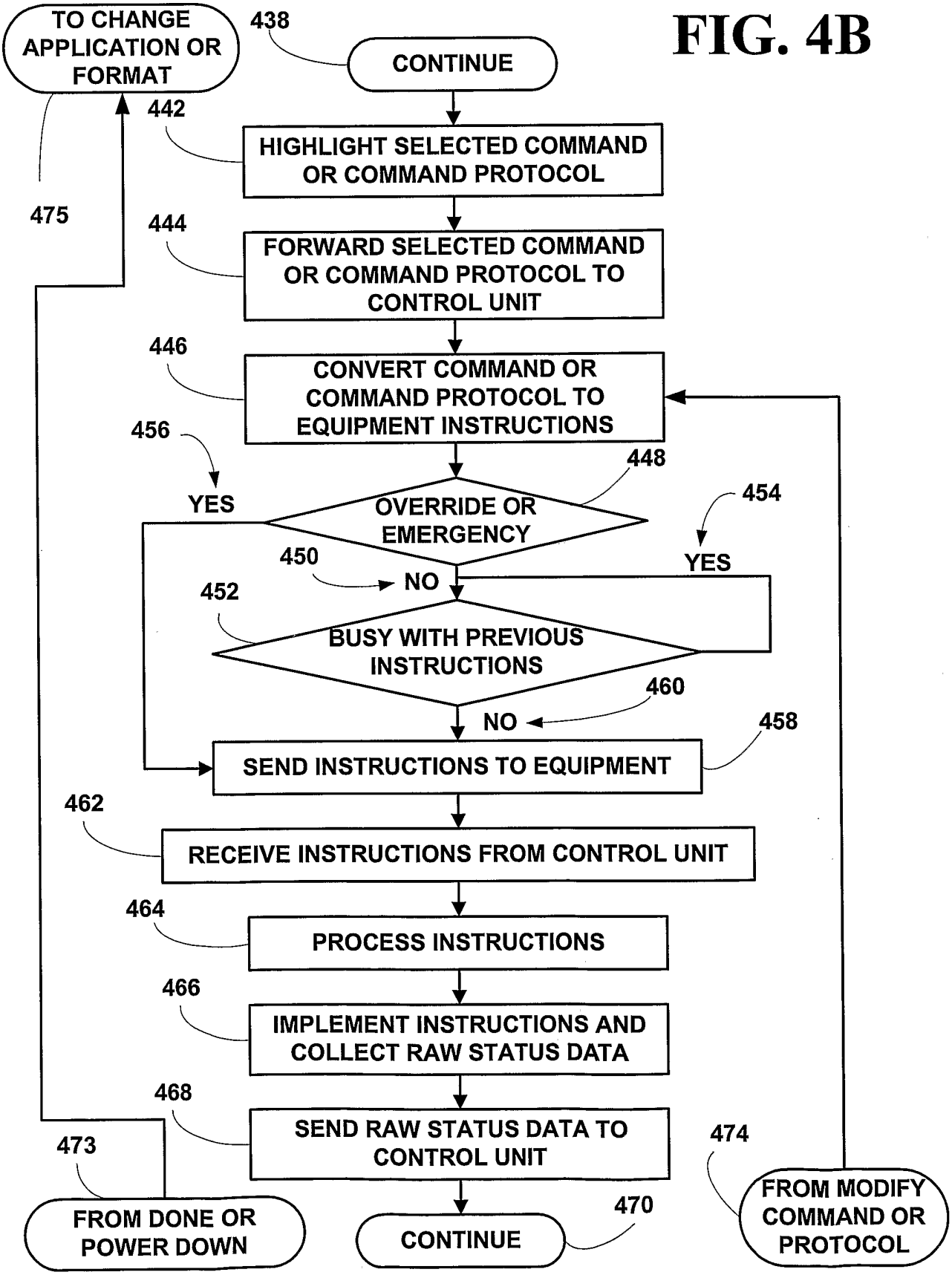
TO CHANGE APPLICATION OR FORMAT
438
CONTINUE
442
HIGHLIGHT SELECTED COMMAND OR COMMAND PROTOCOL
475
444
FORWARD SELECTED COMMAND OR COMMAND PROTOCOL TO CONTROL UNIT
446
CONVERT COMMAND OR COMMAND PROTOCOL TO EQUIPMENT INSTRUCTIONS
456
YES
448
OVERRIDE OR EMERGENCY
454
YES
450
NO
452
BUSY WITH PREVIOUS INSTRUCTIONS
460
NO
458
SEND INSTRUCTIONS TO EQUIPMENT
462
RECEIVE INSTRUCTIONS FROM CONTROL UNIT
464
PROCESS INSTRUCTIONS
466
IMPLEMENT INSTRUCTIONS AND COLLECT RAW STATUS DATA
468
SEND RAW STATUS DATA TO CONTROL UNIT
473
FROM DONE OR POWER DOWN
CONTINUE
470
474
FROM MODIFY COMMAND OR PROTOCOL

FIG. 4B

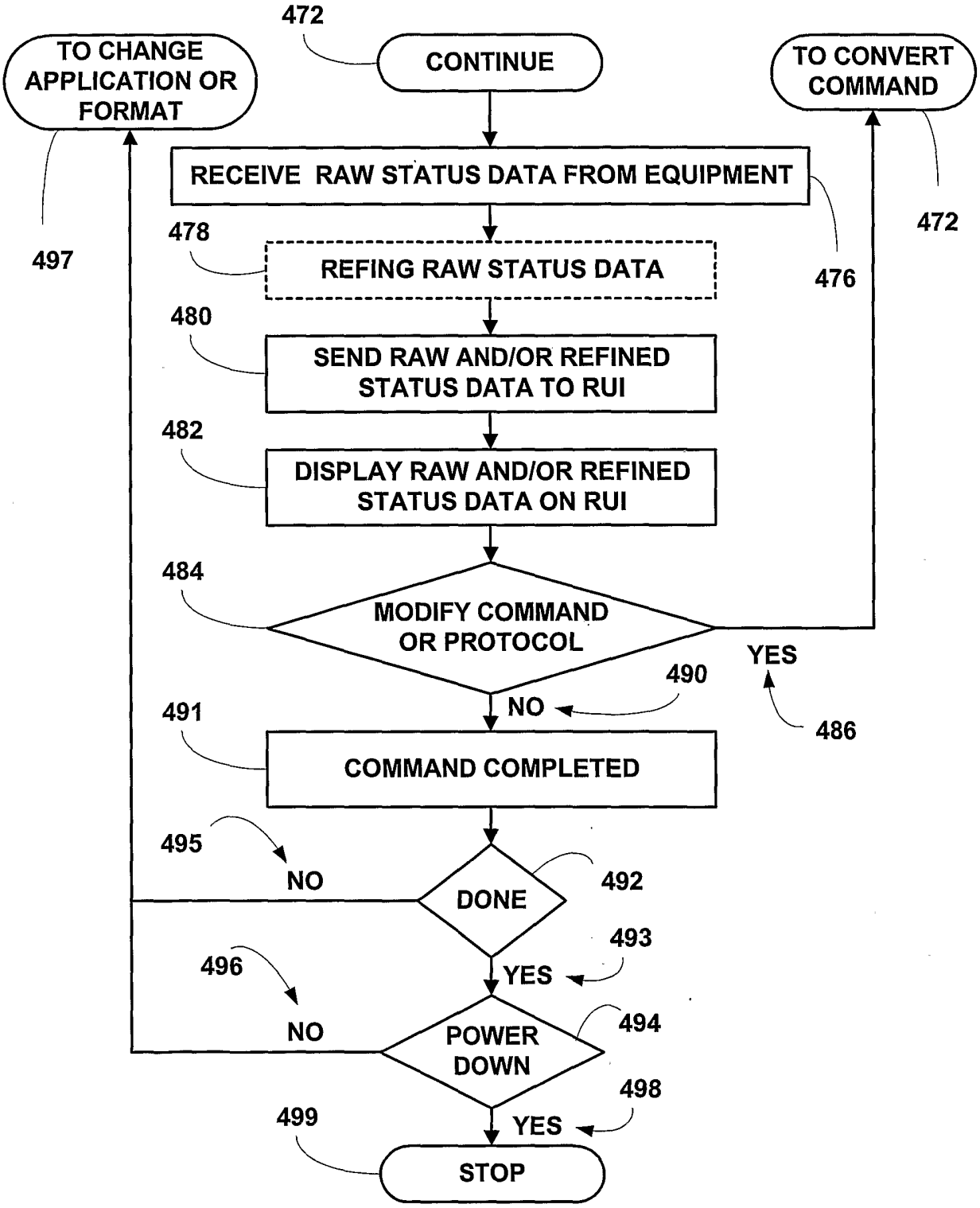
472
CONTINUE
TO CHANGE APPLICATION OR FORMAT
TO CONVERT COMMAND
RECEIVE RAW STATUS DATA FROM EQUIPMENT
497
476
472
478
REFING RAW STATUS DATA
480
SEND RAW AND/OR REFINED STATUS DATA TO RUI
482
DISPLAY RAW AND/OR REFINED STATUS DATA ON RUI
484
MODIFY COMMAND OR PROTOCOL
YES
486
490
NO
491
COMMAND COMPLETED
495
NO
DONE
492
493
YES
496
NO
POWER DOWN
494
498
YES
499
STOP

FIG. 4C