



(22) Date de dépôt/Filing Date: 2016/05/03

(41) Mise à la disp. pub./Open to Public Insp.: 2016/11/03

(45) Date de délivrance/Issue Date: 2021/08/03

(30) Priorité/Priority: 2015/05/03 (US62/156,303)

(51) Cl.Int./Int.Cl. *E21B 43/26* (2006.01),
E21B 41/00 (2006.01), *F04B 23/04* (2006.01),
H02P 27/04 (2016.01), *H02P 5/74* (2006.01)

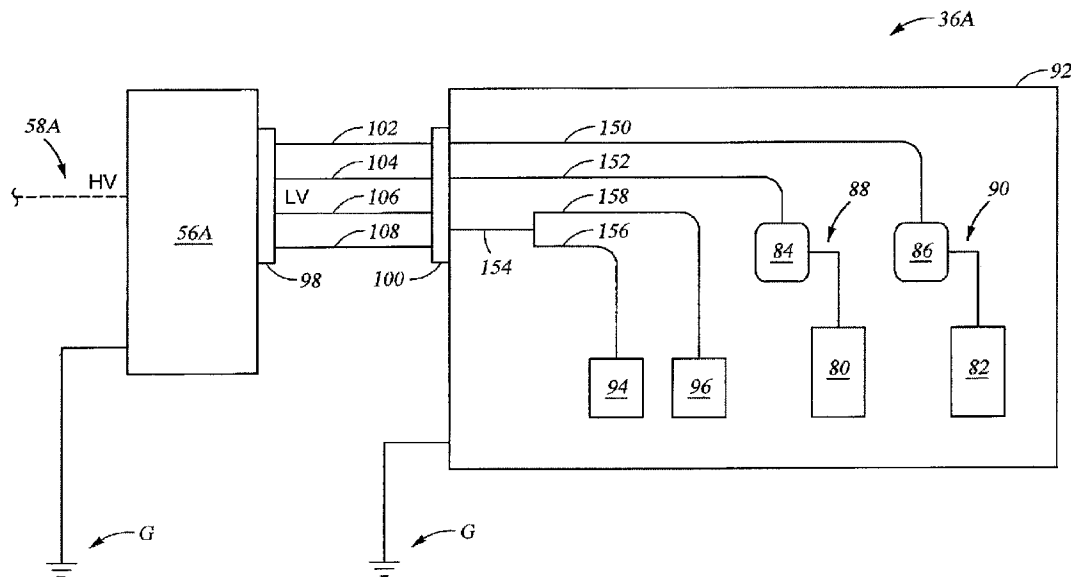
(72) Inventeur/Inventor:
OEHRING, JARED, US

(73) Propriétaire/Owner:
US WELL SERVICES LLC, US

(74) Agent: BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.

(54) Titre : GESTION DE CABLE D'UN MODULE DE POMPE DE FRACTURATION HYDRAULIQUE ALIMENTÉ À L'ELECTRICITE

(54) Title: CABLE MANAGEMENT OF ELECTRIC POWERED HYDRAULIC FRACTURING PUMP UNIT



(57) Abrégé/Abstract:

A hydraulic fracturing system includes a pump, an electrically powered motor for driving the pump, a trailer on which the pump and motor are mounted, and a transformer that steps down electricity for use by the motor. Electrical output from the transformer connects to a series of receptacles mounted onto a housing around the transformer. A similar set of receptacles is provided on the trailer and which are electrically connected to the motor. Power cables equipped with plugs on their opposing ends insert into the receptacles to close an electrical circuit between the transformer and pump.

ABSTRACT

A hydraulic fracturing system includes a pump, an electrically powered motor for driving the pump, a trailer on which the pump and motor are mounted, and a transformer that steps down electricity for use by the motor. Electrical output from the transformer connects to a series of receptacles mounted onto a housing around the transformer. A similar set of receptacles is provided on the trailer and which are electrically connected to the motor. Power cables equipped with plugs on their opposing ends insert into the receptacles to close an electrical circuit between the transformer and pump.

CABLE MANAGEMENT OF ELECTRIC POWERED HYDRAULIC FRACTURING PUMP UNIT

BACKGROUND OF THE INVENTION

1. Field of Invention

[0001] The present disclosure relates to hydraulic fracturing of subterranean formations and/or in oil and gas wells. In particular, the present disclosure relates to electrical components and connections connected to an electric hydraulic fracturing pump to minimize space and time requirements for rig up and rig down and/or pumping fracturing fluid into an oil or gas well using pumps powered by electric motors.

2. Description of Prior Art

[0002] Hydraulic fracturing has been used for decades to stimulate production from conventional oil and gas wells. Hydraulic fracturing is a technique used to stimulate production from some hydrocarbon producing wells. The technique usually involves injecting fluid into a wellbore at a pressure sufficient to generate fissures in the formation surrounding the wellbore. Typically the pressurized fluid is injected into a portion of the wellbore that is pressure isolated from the remaining length of the wellbore so that fracturing is limited to a designated portion of the formation. The fracturing fluid slurry, whose primary component is usually water, includes proppant (such as sand or ceramic) that migrate into the fractures with the fracturing fluid slurry and remain to prop open the fractures after pressure is no longer applied to the wellbore. Other primary fluids sometimes used for the slurry include nitrogen, carbon dioxide, foam, diesel, or other fluids. A typical hydraulic fracturing fleet may include a data van unit, blender unit, hydration unit, chemical additive unit, hydraulic fracturing pump unit, sand equipment, electric wireline, and other equipment.

[0003] Fracturing rock in a formation requires that the fracture fluid be pumped into the wellbore at very high pressure. Traditionally, the fracturing fluid slurry has been pressurized on surface by high pressure pumps powered by diesel engines. Such pumps are able to pump fracturing fluid into a wellbore at a high enough pressure to crack the formation, but they also have drawbacks. To produce the pressures required

for hydraulic fracturing, the pumps and associated engines have substantial volume and mass. Heavy duty trailers, skids, or trucks are required for transporting the large and heavy pumps and motors to sites where wellbores are being fractured. Each hydraulic fracturing pump usually includes power and fluid ends, as well as seats, valves, springs, and keepers internally. These parts allow the hydraulic fracturing pump to draw in low pressure fluid slurry (at approximately 100 psi) and discharge the same fluid slurry at high pressures (up to 15,000 psi or more). In addition, the diesel engines required to drive the pumps require a relatively high level of expensive maintenance. Furthermore, the cost of diesel fuel is much higher than in the past, meaning that the cost of running the pumps has increased. What is needed therefore, is a pump system for hydraulic fracturing fluid that overcomes the problems associated with diesel pumps.

[0004] Recently electrical motors have been introduced to replace the diesel motors, which greatly reduces the noise generated by the equipment during operation. After being transported to a wellsite electrically powered fracturing equipment, i.e. motors for pressurizing fracturing and hydraulic fluids, are connected to electrical power sources. Electrical connection for this equipment is time consuming, and the current electrical distribution configurations require numerous cables that occupy valuable space.

SUMMARY OF THE INVENTION

[0005] Disclosed herein is an example of a hydraulic fracturing system for fracturing a subterranean formation, and which includes first and second pumps, first and second motors for driving the first and second pumps, a transformer, a first electrical circuit between the first motor and the transformer, and through which the first motor and transformer are in electrical communication, and a second electrical circuit that is separate and isolated from the first electrical circuit, and that is between the second motor and the transformer, and through which the second motor and transformer are in electrical communication. A cable assembly can be included which has an electrically conducting cable, a transformer end plug on one end of the cable and in electrical communication with the cable, and a motor end plug on an end of the

cable distal from the transformer end plug and that is in electrical communication with the cable. A transformer receptacle can further be included that is in electrical communication with the transformer, and a motor receptacle in electrical communication with a one of the first or second motors, so that when the transformer end plug is inserted into the transformer receptacle, and the motor end plug is inserted into the motor receptacle, the transformer and a one of the first or second motors are in electrical communication, and wherein the plugs are selectively withdrawn from the receptacles. The hydraulic fracturing system can further include a multiplicity of cable assemblies, transformer receptacles, and motor receptacles, wherein three phase electricity is transferred between the transformer and the first or second motors in different cables. The receptacles can be strategically arranged so that cable assemblies that conduct electricity at the same phase are adjacent one another. A transformer ground receptacle can further be included that is in electrical communication with a ground leg of the transformer, and a pump ground receptacle in electrical communication with a ground leg of one of the first or second pumps, so that when the transformer ground plug is inserted into the transformer ground receptacle, and the pump ground plug is inserted into the pump receptacle, the transformer ground leg and the ground leg of one of the first or second pumps are in electrical communication, and wherein the plugs are selectively withdrawn from the receptacles. The hydraulic fracturing system can also include a platform on which the first and second pumps and motors are mounted, an enclosure on the platform, one or more variable frequency drives coupled with one or more of the motors and within the enclosure, and a removable panel on the enclosure adjacent the variable frequency drive, so that by removing the panel the variable frequency drive is easily accessible.

[0006] Another example of a hydraulic fracturing system for fracturing a subterranean formation includes a source of electricity, a row of source receptacles that are in electrical communication with the source of electricity and configured so that some of the source receptacles receive electricity from the source of electricity at a phase that is different from a phase of electricity received by other source receptacles from the source of electricity, an electrically powered motor that is spaced apart from

the source of electricity, a row of motor receptacles that are in electrical communication with the motor, and cable assemblies. The cable assemblies include a source plug that is selectively insertable into a one of the source receptacles, a motor plug that is selectively insertable into a one of the motor receptacles, and a cable in electrical communication with both the source plug and motor plug, so that when the source plug inserts into a one of the source receptacles, and the motor plug inserts into the a one of the motor receptacles, electricity at a designated phase is transmitted from the source of electricity to the variable frequency drive to operate and control a motor. The source of electricity can be a transformer having alternating current electricity at three different phases. In an example, the motor is a first motor, the system further having a second motor, and wherein the first and second motors each drive fracturing pumps. In an embodiment, electricity conducts from the source of electricity to the first motor along a first path, wherein electricity conducts from the source of electricity to the second motor along a second path, and wherein the first and second paths are separate and distinct from one another. In another embodiment, electricity conducts from the source of electricity to a single variable frequency drive which supplies power to a single motor which turns more than one hydraulic fracturing pump. A first pair of the source receptacles can receive electricity at a first phase, so that a corresponding first pair of cable assemblies that have source plugs inserted into the source receptacles conduct electricity at the first phase, wherein a second pair of the source receptacles receive electricity at a second phase, so that a corresponding second pair of cable assemblies that have source plugs inserted into the source receptacles conduct electricity at the second phase, and wherein a third pair of the source receptacles receive electricity at a third phase, so that a corresponding third pair of cable assemblies that have source plugs inserted into the source receptacles conduct electricity at the third phase.

[0007] A method of hydraulic fracturing is described herein and that includes electrically connecting a fracturing pump motor with a source of electricity by inserting a source end of a cable assembly into a source receptacle that is in electrical communication with the source of electricity and inserting a motor end of the cable assembly, which is in electrical communication with the source end of the cable

assembly, into a motor receptacle that is in electrical communication with variable frequency drive, which is in electrical communication with the motor, which is in mechanical communication with the hydraulic fracturing pump that discharges high pressure hydraulic fracturing fluid slurry to the wellbore. The source of electricity transmits electricity to the source receptacle, so that electricity conducts from the source receptacle, to the motor receptacle, to the variable frequency drive, and to the motor. The source of electricity can be a transformer that transmits 3-phase electricity. In an embodiment, the fracturing pump motor includes a first fracturing pump motor, and wherein the cable assembly comprises a first cable assembly, the method further comprising repeating the steps of electrically connecting a fracturing pump motor with a source of electricity by inserting a source end of a cable assembly into a source receptacle that is in electrical communication with the source of electricity and inserting a motor end of the cable assembly, which is in electrical communication with the source end of the cable assembly, into a motor receptacle that is in electrical communication with the fracturing pump motor, directing fracturing fluid to a suction end of a fracturing pump that is coupled with the fracturing pump motor, and causing the source of electricity to transmit electricity to the source receptacle, so that electricity conducts from the source receptacle, to the source and motor ends, to the motor receptacle, and to the motor using a second fracturing pump motor and a second cable assembly. The method can also include removing the ends of the cable assembly from the receptacles, moving the source of electricity and fracturing pump motor to a different location, and repeating the steps of electrically connecting a fracturing pump motor with a source of electricity by inserting a source end of a cable assembly into a source receptacle that is in electrical communication with the source of electricity and inserting a motor end of the cable assembly, which is in electrical communication with the source end of the cable assembly, into a motor receptacle that is in electrical communication with the fracturing pump motor, directing fracturing fluid to a suction end of a fracturing pump that is coupled with the fracturing pump motor, and causing the source of electricity to transmit electricity to the source receptacle, so that electricity conducts from the source receptacle, to the source and motor ends, to the motor receptacle, and to the motor.

The method can optionally further include repeating the step of electrically connecting a fracturing pump motor with a source of electricity by inserting a source end of a cable assembly into a source receptacle that is in electrical communication with the source of electricity and inserting a motor end of the cable assembly, which is in electrical communication with the source end of the cable assembly, into a motor receptacle that is in electrical communication with the fracturing pump motor, so that multiple cable assemblies are connected between multiple source receptacles and multiple motor receptacles, so that electricity at different phases is conducted through the different cable assemblies to the fracturing pump motor. Optionally, a path of electricity between the source of electricity and the first fracturing pump motor is separate and distinct from a path of electricity between the source of electricity and the second fracturing pump motor.

[0008] Disclosed herein is a system for hydraulically fracturing an underground formation in an oil or gas well to extract oil or gas from the formation, the oil or gas well having a wellbore that permits passage of fluid from the wellbore into the formation. The system includes a plurality of electric pumps fluidly connected to the well, and configured to pump fluid into the wellbore at high pressure so that the fluid passes from the wellbore into the formation, and fractures the formation. The system also includes a plurality of generators electrically connected to the plurality of electric pumps to provide electrical power to the pumps. At least some of the plurality of generators can be powered by natural gas. In addition, at least some of the plurality of generators can be turbine generators.

[0009] In one embodiment, the system further includes an A/C console and a variable frequency drive that controls the speed of the pumps. Furthermore, the electric pumps, as well as the electric generators, can be mounted on vehicles, and can be ported from one well to another. The vehicles can be trucks and can have at least five axles.

[0010] Further disclosed herein is a system for fracturing a rock formation in an oil or gas well by pumping hydraulic fracturing fluid into the well that includes a pump, an electric motor, a variable frequency drive, and a natural gas powered electric

generator. The pump is configured for pumping the hydraulic fracturing fluid into the well, and then from the well into the formation, and is capable of pumping the hydraulic fracturing fluid at high pressure to crack the formation. The electric motor can have a high-strength steel or steel alloy shaft attached to the pump and configured to drive the pump. The variable frequency drive can be connected to the electric motor to control the speed of the motor. In addition, the natural gas powered generator, which can be a turbine generator, can be connected to the electric motor and provide electric power to the electric motor.

[0011] In one embodiment, the pump can be a triplex or a quinteplex pump, optionally rated at about 2250 hydraulic horsepower or more. In addition, the pump can also have 4.5 inch diameter plungers with an eight inch stroke. In another embodiment, the electric motor can have a maximum continuous power output of about 1500 brake horsepower, 1750 brake horsepower, or more, and a maximum continuous torque of about 8750 lb-ft or more. Furthermore, the electric motor can have a high temperature rating of about 1100 degrees C or more, and a shaft composed of 4340 alloy steel.

[0012] In another embodiment, variable frequency drive can frequently perform electric motor diagnostics to prevent damage to the electric motor if it becomes grounded or shorted. In addition, the variable frequency drive can include power semiconductor heat sinks having one or more thermal sensors monitored by a microprocessor to prevent semiconductor damage caused by excessive heat.

[0013] Also disclosed herein is a system for hydraulically fracturing an underground formation in an oil or gas well to extract oil or gas from the formation, the oil or gas well having a wellbore that permits passage of fluid from the wellbore into the formation. The system includes a trailer for attachment to a truck. Two or more electric pumps can be attached to the trailer and are fluidly connected to the well, the electric pumps configured to pump fluid into the wellbore at high pressure so that the fluid passes from the wellbore into the formation, and fractures the formation. One or more electric motors are attached to the electric pumps to drive the pumps. The electric motors can also be attached to the trailer. A natural gas powered generator is provided for connection to the electric motor to provide electric power to the electric motor. The

system of claim can further include a variable frequency drive attached to the trailer and connected to the electric motor to control the speed of the motor. In addition, the system can include a skid to which at least one of the electric pumps, the one or more electric motors, and the variable frequency drives are attached.

[0014] Also disclosed herein is a process for stimulating an oil or gas well by hydraulically fracturing a formation in the well. The process includes the steps of pumping fracturing fluid into the well with an electrically powered pump at a high pressure so that the fracturing fluid enters and cracks the formation, the fracturing fluid having at least a liquid component and a solid proppant, and inserting the solid proppant into the cracks to maintain the cracks open, thereby allowing passage of oil and gas through the cracks. The process can further include powering the electrically powered pump with a natural gas generator, such as, for example, a turbine generator.

BRIEF DESCRIPTION OF DRAWINGS

[0015] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0016] FIG. 1 is a schematic of an example of a hydraulic fracturing system.

[0017] FIG. 2 is schematic of an example of electrical communication between a transformer and fracturing pump system of the hydraulic fracturing system of FIG. 1.

[0018] FIG. 3 is an end perspective views of an example of a junction box on the transformer of FIG. 2.

[0019] FIG. 4 is an end perspective views of an example of a junction box on the fracturing pump system of FIG. 2.

[0020] FIG. 5 is a side perspective view of an example of a cable assembly for use in electrical communication between the transformer and fracturing pump system of FIG. 2.

[0021] FIG. 6 is a side perspective view of an example of the fracturing pump system of FIG. 2.

[0022] FIG. 7 is an end perspective view of the fracturing pump system of FIG. 6.

[0023] FIG. 8 is an end perspective view of an example of the transformer of FIG. 2.

[0024] FIG. 9 is a schematic plan view of equipment used in a hydraulic fracturing operation, according to an embodiment of the present technology.

[0025] FIG. 10 is a schematic plan view of equipment used in a hydraulic fracturing operation, according to an alternate embodiment of the present technology.

[0026] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0027] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout. In an embodiment, usage of the term "about" includes +/- 5% of the cited magnitude. In an embodiment, usage of the term "substantially" includes +/- 5% of the cited magnitude.

[0028] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0029] In the following description of preferred embodiments and accompanying drawings, like reference numerals may represent like elements. In describing the

preferred embodiments of the technology illustrated in the appended drawing, specific terminology will be used for the sake of clarity. However, the technology is not intended to be limited to the specific terms used, and it is to be understood that each specific term includes equivalents that operate in a similar manner to accomplish a similar purpose.

[0030] Figure 1 is a schematic example of a hydraulic fracturing system 10 that is used for pressurizing a wellbore 12 to create fractures 14 in a subterranean formation 16 that surrounds the wellbore 12. Included with the system 10 is a hydration unit 18 that receives fluid from a fluid source 20 via line 22, and also selectively receives additives from an additive source 24 via line 26. Additive source 24 can be separate from the hydration unit 18 as a stand-alone unit, or can be included as part of the same unit as the hydration unit 18. The fluid, which in one example is water, is mixed inside of the hydration unit 18 with the additives. In an embodiment, the fluid and additives are mixed over a period of time to allow for uniform distribution of the additives within the fluid. In the example of Figure 1, the fluid and additive mixture is transferred to a blender unit 28 via line 30. A proppant source 32 contains proppant, which is delivered to the blender unit 28 as represented by line 34, where line 34 can be a conveyer. Inside the blender unit 28, the proppant and fluid/additive mixture are combined to form a fracturing slurry, which is then transferred to a fracturing pump system 36 via line 38; thus fluid in line 38 includes the discharge of blender unit 28 which is the suction (or boost) for the fracturing pump system 36. Blender unit 28 can have an onboard chemical additive system, such as with chemical pumps and augers (not shown). Optionally, additive source 24 can provide chemicals to blender unit 28; or a separate and standalone chemical additive system (not shown) can be provided for delivering chemicals to the blender unit 28. In an example, the pressure of the slurry in line 38 ranges from around 80 psi to around 100 psi. The pressure of the slurry can be increased up to around 15,000 psi by pump system 36. A motor 39, which connects to pump system 36 via connection 40, drives pump system 36 so that it can pressurize the slurry. In one example, the motor 39 is controlled by a variable frequency drive ("VFD"). After being discharged from pump system 36, slurry is injected into a wellhead

assembly 41; discharge piping 42 connects discharge of pump system 36 with wellhead assembly 41 and provides a conduit for the slurry between the pump system 36 and the wellhead assembly 41. In an alternative, hoses or other connections can be used to provide a conduit for the slurry between the pump system 36 and the wellhead assembly 41. Optionally, any type of fluid can be pressurized by the fracturing pump system 36 to form a fracturing fluid that is then pumped into the wellbore 12 for fracturing the formation 14, and is not limited to fluids having chemicals or proppant. Examples exist wherein the system 10 includes multiple pumps 36, and multiple motors 39 for driving the multiple pumps 36. Examples also exist wherein the system 10 includes the ability to pump down equipment, instrumentation, or other retrievable items through the slurry into the wellbore.

[0031] An example of a turbine 44 is provided in the example of Figure 1 and which receives a combustible fuel from a fuel source 46 via a feed line 48. In one example, the combustible fuel is natural gas, and the fuel source 46 can be a container of natural gas or a well (not shown) proximate the turbine 44. Combustion of the fuel in the turbine 44 in turn powers a generator 50 that produces electricity. Shaft 52 connects generator 50 to turbine 44. The combination of the turbine 44, generator 50, and shaft 52 define a turbine generator 53. In another example, gearing can also be used to connect the turbine 44 and generator 50. An example of a micro-grid 54 is further illustrated in Figure 1, and which distributes electricity generated by the turbine generator 53. Included with the micro-grid 54 is a transformer 56 for stepping down voltage of the electricity generated by the generator 50 to a voltage more compatible for use by electrical powered devices in the hydraulic fracturing system 10. In another example, the power generated by the turbine generator and the power utilized by the electrical powered devices in the hydraulic fracturing system 10 are of the same voltage, such as 4160 V so that main power transformers are not needed. In one embodiment, multiple 3500 kVA dry cast coil transformers are utilized. Electricity generated in generator 50 is conveyed to transformer 56 via line 58. In one example, transformer 56 steps the voltage down from 13.8 kV to around 600 V. Other example step down voltages include 4,160 V, 480 V, or other voltages. The output or low voltage

side of the transformer 56 connects to a power bus 60, lines 62, 64, 66, 68, 70, and 72 connect to power bus 60 and deliver electricity to electrically powered end users in the system 10. More specifically, line 62 connects fluid source 20 to bus 60, line 64 connects additive source 24 to bus 60, line 66 connects hydration unit 18 to bus 60, line 68 connects proppant source 32 to bus 60, line 70 connects blender unit 28 to bus 60, and line 72 connects motor 39 to bus 60. In an example, additive source 24 contains ten or more chemical pumps for supplementing the existing chemical pumps on the hydration unit 18 and blender unit 28. Chemicals from the additive source 24 can be delivered via lines 26 to either the hydration unit 18 and/or the blender unit 28. In one embodiment, the elements of the system 10 are mobile and can be readily transported to a wellsite adjacent the wellbore 12, such as on trailers or other platforms equipped with wheels or tracks.

[0032] Schematically illustrated in Figure 2 is one example of a fracturing pump system 36A having pumps 80, 82 that are respectively powered by motors 84, 86. Couplings 88, 90 mechanically affix the pumps 80, 82 with motors 84, 86 so that when motors 84, 86 are energized, the motors 84, 86 will drive pumps 80, 82 for pressurizing fracturing fluid that is then delivered to the wellbore 12 (Figure 1). In this example, the fracturing pump system 36A is mounted on a trailer 92 which provides a mobile surface for transporting components of the fracturing pump system 36A to and from designated locations. Thus when operations at a wellsite are deemed complete, the fracturing pump system 36A can be transported to another wellsite for subsequent operations, or to a facility for repair or maintenance. Also schematically represented on trailer 92 and as part of the fracturing pump system 36A, are a motor control center 94 and auxiliary components 96. Examples of auxiliaries include heaters for the motors 84, 86, lights on the fracturing pump system 36A, control power for a variable frequency drive (not shown), heater for lube oil for pumps 80, 82, air blowers (not shown) for motors 84, 86, a hydraulic pump motor, and a hydraulic cooler motor (not shown). Not shown are variable frequency drives to control and operate motors 84, 86. In another embodiment, a single variable frequency drive controls and operates a single motor 84 which turns one or more hydraulic fracturing pumps (80 and 82).

[0033] Also shown in Figure 2 is an example of transformer 56A having a high voltage side HV connected to line 58A; junction boxes 98, 100 respectively mounted on transformer 56A and fracturing pump system 36A provide means for electrical communication between transformer 56A and fracturing pump system 36A. Junction box 98 is mounted on a low voltage side LV of the transformer 56A. As will be described in more detail below, junction boxes 98, 100 are equipped with quick disconnect receptacles so that lines having conductive wires and that conduct electricity between transformer 56A and fracturing pump system 36A, can be easily inserted and removed by operations personnel to significantly reduce the time required for assembly and disassembly of the hydraulic fracturing system 10. The electrically conducting lines between junction boxes 98, 100 include wire bundles 102, 104, which as will be described below each include a number of wires within and that are separable and distinct from one another. Wire bundles 102, 104 conduct electrical power from transformer 56A and to junction box 100 and which is used for energizing motors 84, 86. Also extending between junction boxes 98, 100 is line 106 and which conducts electricity that is used for powering the motor control center 94 and auxiliary components 96. Also extending between junction boxes 98, 100 is line 108 which is used as a ground between the transformer 56A and the hydraulic fracturing pump unit 36A. In one embodiment, the power generated is of the same voltage as the power supplied to the hydraulic fracturing pump unit 36. In this case, power for the hydraulic fracturing pump unit 36 is supplied directly without needing a transformer 56.

[0034] Figure 3 shows an end perspective view of an example of junction box 98 and having a row 110 of receptacles 1121-1126. The receptacles 1121-1126 are each equipped with an opening 1141-1146 in which an electrical conducting plug can be readily inserted and removed thereby providing electrical communication between the plug and attached conducting lead (such as a cable). Set below and extending generally parallel with row 110 is row 116 which also includes receptacles 1181-1186, wherein the receptacles 1181-1186 are each equipped with openings 1201-1206 for receiving an electrically conducting plug. Set adjacent receptacle 1126 is a ground connection 122 which connects to ground leads within transformer 36A (Figure 2). Below ground

connection 122 is an auxiliary/MCC connection 124, which provides a source of electrical power for the auxiliary components 96 and motor control center 94 (Figure 2). In another embodiment, the receptacles can be arranged in different patterns and configurations.

[0035] Figure 4 shows an end perspective view of one example of junction box 100 which includes a row 126 of receptacles 1281-1286, wherein the receptacles each have an opening 1301-1306 on their ends distal from where they mount to junction box 100. Parallel with and set below row 126 is row 132, which is made up of a line of receptacles 1341-1346 each having openings 1361-1366. Also included with receptacle 100 is a ground connection 138 and an auxiliary/MCC connection 140. In another embodiment, the receptacles can be arranged in different patterns and configurations.

[0036] Figure 5 shows in a side perspective view one example of a cable assembly 142 which includes plugs 144, 146 and a cable 148 extending between the plugs 144, 146 which provides electrical communication between plugs 144, 146. Plugs 144, 146 as shown each have an outer periphery configured so that plugs 144, 146 can be readily inserted into and removed from openings 1141-1146, 1201-1206, 1301-1306, 1361-1366. Optionally included with the plugs 144, 146 are electrodes 149 which are electrically conductive elements. Electrodes 149 are shown formed along the outer curved surface of plugs 144, 146 and can be recessed or inlaid on the surface of the plugs 144, 146 or can project radially outward. Alternate examples of electrodes 149A resemble planar prongs that project axially outward from the respective ends of plugs 144, 146 opposite from their connection to cable 148. When the plugs 144, 146 are inserted into one of the receptacles 1121-1126, 1181-1186, 1281-1286, 1341-1346 of Figures 3 or 4, the electrodes 149, 149A come into electrically conducting contact with corresponding electrodes (not shown) provided within the receptacles 1121-1126, 1181-1186, 1281-1286, 1341-1346; and thereby providing electrical communication one of the receptacles 1121-1126, 1181-1186 disposed in junction box 98 and one of the receptacles 1281-1286, 1341-1346 disposed in junction box 100.

[0037] Referring back to Figure 2, line 150 is shown within fracturing pump system 36A and extending from a side of junction box 100 opposite from cable bundle

102 and connecting to motor 86. Accordingly, electrical communication between transformer 56 and motor 86 takes place from junction box 98, through cable bundle 102, to junction box 100, then to line 150. Although shown as a single line, line 150 can be made up of a plurality of electrically conducting elements such as lines or cables and may include a variable frequency drive. One specific example of forming cable bundle 102, six of the cable assemblies 142 are provided, and one of plugs 144, 146 are inserted into each of the openings 1141-1146 of receptacles 1121-1126. The other one of the plugs 144, 146 of cable assemblies 142 is then inserted into a corresponding opening 1301-1306 of receptacles 1281-1286. Thus in one example the six cable assemblies 142 extending between the receptacles 1121-1126 to receptacles 1281-1286 define cable bundle 102 for powering motor 86. An advantage of the cable assemblies 142 with insertable and removable plugs 144, 146 and receptacles 1121-1126 and receptacles 1281-1286 is that the electrical communication between transformer 56A and motor 86 can be assembled in a matter of minutes, versus the hours that has typically been required for hardwiring the electrical connection between the transformer 56A and motor 86. Similarly, cable bundle 104 is formed by providing six of the cable assemblies 142 and connecting them with the plugs 144, 146 into the receptacles 1181-1186 and receptacles 1341-1346. In similar fashion, a ground connection 108 between transformer 56A and fracturing pump system 36A is created by providing cable assembly 142 and inserting one of plugs 144, 146 into ground connection 122 and the other one of the plugs 144, 146 into ground connection 138. Optionally, simple bolt on lug attachments (not shown) can be used in lieu of the cable assemblies 142 for the ground connections 122, 138. Thus, while cable bundles 102, 104 each include six or more of the cable assemblies 142, example lines 106, 108 can include a single cable assembly 142. Alternatively, line 106 is made up of four internal conductors and have threaded end connections instead of the plugs. Optionally, cable bundles 102, 104 can be made up of less than six cable assemblies 142, or more than six cable assemblies 142.

[0038] In the example of Figure 2 power to motors 84, 86 from transformer 56A is provided along separate and distinctive paths. A separate VFD may control and operate

motor 84 while a second VFD controls and operates motor 86. An advantage of the separate and distinct paths of providing power to motors 84, 86 is that should power to one of motors 84, 86 be interrupted, power to the other one of the motors 84, 86 is not affected. More specifically, adjacent rows 110, 116 are not in communication with one another, adjacent rows 126, 132 are not in communication with one another; and adjacent cable bundles 102, 104 are not in communication with one another. Finally, lines 150, 152 are also separate and insulated from each other so that independent electrical paths are maintained for both the motors 84, 86. An additional advantage is provided by the dedicated ground line which plugs into ground connections 122, 138. The dedicated ground line may reduce voltage differential between equipment. In another embodiment, one VFD controls and operates one motor (either 84 or 86), which then controls both pump 80 and pump 82.

[0039] Figure 6 shows in a side perspective view one example of a fracturing pump system 36B mounted on trailer 92B. In this example, an end of trailer 92B distal from pumps 80B, 82B includes an enclosure 160 and inside of which is an example of a variable frequency drive 162 shown in a dashed outline. Adjacent variable frequency drive 162 a panel 164 is formed on enclosure 160, where panel 164 is readily removable from enclosure to give ready and full access to variable frequency drive 162. Panel 164 thus provides a way of quick and easy access for the repair, replacement, and/or maintenance of variable frequency drive 162. Also provided on enclosure 160 is a door 166 which allows access by operations personnel to inside of enclosure 160 to access and monitor various controls provided within enclosure 160. In one embodiment, the enclosure 160 includes two air conditioning units. Having two air conditioning units provides redundant cooling systems. Each air conditioning unit is capable of cooling both VFDs in the enclosure by itself should the other fail or need to be shut down for repair and maintenance.

[0040] Figure 7 shows an end perspective view of one example of enclosure 160, and wherein rows 126, 132 are provided in a recess 168 formed within junction box 100. Included in this example is an optional electric filter 201A in communication with the first VFD and motor 84 and a second electric filter 201B in communication with the second

VFD and motor 86. Optionally, a second variable frequency drive (not shown) is provided within enclosure 160 and on a side opposite panel 164; a second panel (not shown) can be formed on enclosure to facilitate access to second variable frequency drive. In this example, each motor 8013, 82B is coupled with a dedicated variable frequency drive. In one embodiment, there is a second door for the enclosure providing a second, separate and distinct escape path from the enclosure. In one embodiment, the exit doors open outwards to allow for quick egress from the enclosure 160.

[0041] Referring back to Figures 3 and 4, the arrangement of the receptacles 1121-1126, 1181-1186, 1281-1286, 1341-1346 on junction boxes 98, 100 are generally mirror images of one another. Thus, when inserting one of plugs 144, 146 into receptacle 112i, the corresponding receptacle, which is 1281, will be aligned so that the cable assembly 142 can run along a generally straight path between junction boxes 98, 100 and without interfering with other cable assemblies 142 that connect into other receptacles. Moreover, in the illustrated example motors 84, 86 operate on three phase electricity, thus, in an alternative, the adjacent ones of receptacles transmit electricity that is at the same phase. For example, receptacles 1121-1122 may transmit electricity at one phase, whereas receptacles 1123, 1124 transmit electricity at a different phase, and receptacles 1125, 1126 transmit electricity at yet another phase, wherein these different phases are approximately 120° apart. Further in this example, receptacles 1281, 1282 operate at one phase, wherein receptacles 1283, 1284 operate at another phase, and receptacles 1285, 1286 operate at a third phase. In one specific example, receptacles 1121, 1122 operate at the same phase as receptacles 1281, 1282, receptacles 1123, 1124 operated at the same phase as receptacles 1283, 1284, and receptacles 1125, 1126 operate at the same phase as receptacles 1285, 1286. By strategically forming a cable bundle 102, 104 made up of wires having dedicated phases, and allocating the same phase of electricity to cross more than one wire, a gauge of wire for the cable assemblies 142 can be formed which is manageable by operations personnel, which is another advantage of the present disclosure and which speeds the assembly and disassembly of the fracturing system 10.

[0042] Figure 8 shows an end perspective view of an example of transformer 56B having recesses 170, 172 and with its sets of receptacles 112B1-112B6 and 118B1-118B6 each arranged in a pair of rows respectively in the recesses 170, 172. As shown, receptacles 112B1-112B6 are arranged so that receptacles 112B1 and 112B4 are vertically aligned with one another, receptacles 112B2 and 112B5 are vertically aligned with one another, and receptacles 112B3 and 112B6 are vertically aligned with one another. In this example, receptacles 112B1 and 112B4 are in communication with electricity at a first phase, receptacles 112B2 and 112B5 are in communication with electricity at a second phase, and receptacles 112B3 and 112B6 are in communication with electricity at a third phase; where the first, second, and third phases are different, and can be about 120° apart from one another. Further illustrated are that receptacles 118B1-118B6 in recess 172 are arranged so that receptacles 118B1 and 118B4 are vertically aligned with one another, receptacles 118B2 and 118B5 are vertically aligned with one another, and receptacles 118B3 and 118B6 are vertically aligned with one another. In this example, receptacles 118B1 and 118B4 are in communication with electricity at a first phase, receptacles 118B2 and 118B5 are in communication with electricity at a second phase, and receptacles 118B3 and 118B6 are in communication with electricity at a third phase; where the first, second, and third phases are different, and can be about 120° apart from one another. Additionally, ground connection 122B and auxiliary connection 124B are shown disposed in recess 172.

[0043] Fig. 9 shows a plan view of equipment used in a hydraulic fracturing operation according to an embodiment. Specifically, there is shown a plurality of pumps 1010 mounted to pump vehicles 1012. The pump vehicles 1012 can be trucks having at least five axles. In the embodiment shown, the pumps 1010 are powered by electric motors 1014, which can also be mounted to the pump vehicles 1012. The pumps 1010 are fluidly connected to the wellhead 1016 via the missile 1018. As shown, the pump vehicles 1012 can be positioned near enough to the missile 1018 to connect fracturing fluid lines 1020 between the pumps 1010 and the missile 1018. The missile 1018 is then connected to the wellhead 1016 and configured to deliver fracturing fluid provided by the pumps 1010 to the wellhead 1016.

[0044] In some embodiments, each electric motor 1014 can be capable of delivering about 1500 brake horsepower (BHP), 1750 BHP, or more, and each pump 1010 can optionally be rated for about 2250 hydraulic horsepower (HHP) or more. In addition, the components of the system, including the pumps 1010 and the electric motors 1014, can be capable of operating during prolonged pumping operations, and in temperature in a range of about 0 degrees C or less to about 55 degrees C or more. In addition, each electric motor 1014 can be equipped with a variable frequency drive (VFD), and an A/C console, that controls the speed of the electric motor 1014, and hence the speed of the pump 1010.

[0045] The electric motors 1014 of the present technology can be designed to withstand an oilfield environment. Specifically, some pumps 1010 can have a maximum continuous power output of about 1500 BHP, 1750 BHP, or more, and a maximum continuous torque of about 8750 lb-ft or more. Furthermore, electric motors 1014 of the present technology can include class H insulation and high temperature ratings, such as about 1100 degrees C or more. In some embodiments, the electric motor 1014 can include a single shaft extension and hub for high tension radial loads, and a high strength 4340 alloy steel shaft, although other suitable materials can also be used.

[0046] The VFD can be designed to maximize the flexibility, robustness, serviceability, and reliability required by oilfield applications, such as hydraulic fracturing. For example, as far as hardware is concerned, the VFD can include packaging receiving a high rating by the National Electrical Manufacturers Association (such as nema 1 packaging), and power semiconductor heat sinks having one or more thermal sensors monitored by a microprocessor to prevent semiconductor damage caused by excessive heat. Furthermore, with respect to control capabilities, the VFD can provide complete monitoring and protection of drive internal operations while communicating with an operator via one or more user interfaces. For example, motor diagnostics can be performed frequently (e.g., on the application of power, or with each start), to prevent damage to a grounded or shorted electric motor 1014. The electric motor diagnostics can be disabled, if desired, when using, for example, a low impedance or high-speed electric motor.

[0047] In some embodiments, the pump 1010 can optionally be a 2250 HHP triplex or quinteplex pump. The pump 1010 can optionally be equipped with 4.5 inch diameter plungers that have an eight (8) inch stroke, although other size plungers can be used, depending on the preference of the operator. The pump 1010 can further include additional features to increase its capacity, durability, and robustness, including, for example, a 6.353 to 1 gear reduction, autofrettaged steel or steel alloy fluid end, wing guided slush type valves, and rubber spring loaded packing.

[0048] In addition to the above, certain embodiments of the present technology can include a skid (not shown) for supporting some or all of the above-described equipment. For example, the skid can support the electric motor 1014 and the pump 1010. In addition, the skid can support the VFD. Structurally, the skid can be constructed of heavy-duty longitudinal beams and cross-members made of an appropriate material, such as, for example, steel. The skid can further include heavy-duty lifting lugs, or eyes, that can optionally be of sufficient strength to allow the skid to be lifted at a single lift point.

[0049] Referring back to Fig. 9, also included in the equipment is a plurality of electric generators 1022 that are connected to, and provide power to, the electric motors 1014 on the pump vehicles 1012. To accomplish this, the electric generators 1022 can be connected to the electric motors 14 by power lines (not shown). The electric generators 1022 can be connected to the electric motors 1014 via power distribution panels (not shown). In certain embodiments, the electric generators 1022 can be powered by natural gas. For example, the generators can be powered by liquefied natural gas. The liquefied natural gas can be converted into a gaseous form in a vaporizer prior to use in the generators. The use of natural gas to power the electric generators 1022 can be advantageous because, where the well is a natural gas well, above ground natural gas vessels 1024 can already be placed on site to collect natural gas produced from the well. Thus, a portion of this natural gas can be used to power the electric generators 1022, thereby reducing or eliminating the need to import fuel from offsite. If desired by an operator, the electric generators 1022 can optionally be natural gas turbine generators, such as those shown in Fig. 10.

[0050] Fig. 9 also shows equipment for transporting and combining the components of the hydraulic fracturing fluid used in the system of the present technology. In many wells, the fracturing fluid contains a mixture of water, sand or other proppant, acid, and other chemicals. Examples of fracturing fluid components include acid, anti-bacterial agents, clay stabilizers, corrosion inhibitors, friction reducers, gelling agents, iron control agents, pH adjusting agents, scale inhibitors, and surfactants. Historically, diesel has at times been used as a substitute for water in cold environments, or where a formation to be fractured is water sensitive, such as, for example, clay. The use of diesel, however, has been phased out over time because of price, and the development of newer, better technologies.

[0051] In Fig. 9, there are specifically shown sand transporting vehicles 1026, an acid transporting vehicle 1028, vehicles for transporting other chemicals 1030, and a vehicle carrying a hydration unit 1032, such as, for example, a water pump. Also shown are fracturing fluid blenders 1034, which can be configured to mix and blend the components of the hydraulic fracturing fluid, and to supply the hydraulic fracturing fluid to the pumps 1010. In the case of liquid components, such as water, acids, and at least some chemicals, the components can be supplied to the blenders 1034 via fluid lines (not shown) from the respective component vehicles, or from the hydration unit 1032. In the case of solid components, such as sand, the component can be delivered to the blender 1034 by a conveyor belt 1038. The water can be supplied to the hydraulic unit 1032 from, for example, water tanks 1036 onsite. Alternately, the water can be provided by water trucks. Furthermore, water can be provided directly from the water tanks 1036 or water trucks to the blender 1034, without first passing through the hydration unit 1032.

[0052] Pump control and data monitoring equipment 1040 can be mounted on a control vehicle 1042, and connected to the pumps 1010, electric motors 1014, blenders 1034, and other downhole sensors and tools (not shown) to provide information to an operator, and to allow the operator to control different parameters of the fracturing operation. For example, the pump control and data monitoring equipment 1040 can include an A/C console that controls the VFD, and thus the speed of the electric motor

1014 and the pump 1010. Other pump control and data monitoring equipment can include pump throttles, a pump VFD fault indicator with a reset, a general fault indicator with a reset, a main estop, a programmable logic controller for local control, and a graphics panel. The graphics panel can include, for example, a touchscreen interface.

[0053] Referring now to Fig. 10, there is shown an alternate embodiment of the present technology. Specifically, there is shown a plurality of pumps 1110 which, in this embodiment, are mounted to pump trailers 1112. As shown, the pumps 1110 can optionally be loaded two to a trailer 1112, thereby minimizing the number of trailers needed to place the requisite number of pumps at a site. The ability to load two pumps 1110 on one trailer 1112 is possible because of the relatively light weight of the electric pumps 1110 compared to other known pumps, such as diesel pumps. In the embodiment shown, the pumps 1110 are powered by electric motors 1114, which can also be mounted to the pump trailers 1112. Furthermore, each electric motor 1114 can be equipped with a VFD, and an A/C console, that controls the speed of the motor 1114, and hence the speed of the pumps 1110.

[0054] In addition to the above, the embodiment of Fig. 10 can include a skid (not shown) for supporting some or all of the above-described equipment. For example, the skid can support the electric motors 1114 and the pumps 1110. In addition, the skid can support the VFD. Structurally, the skid can be constructed of heavy-duty longitudinal beams and cross-members made of an appropriate material, such as, for example, steel. The skid can further include heavy-duty lifting lugs, or eyes, that can optionally be of sufficient strength to allow the skid to be lifted at a single lift point.

[0055] The pumps 1110 are fluidly connected to a wellhead 1116 via a missile 1118. As shown, the pump trailers 1112 can be positioned near enough to the missile 1118 to connect fracturing fluid lines 1120 between the pumps 1110 and the missile 1118. The missile 1118 is then connected to the wellhead 1116 and configured to deliver fracturing fluid provided by the pumps 1110 to the wellhead 1116.

[0056] Still referring to Fig. 10, this embodiment also includes a plurality of turbine generators 1122 that are connected to, and provide power to, the electric motors 1114 on the pump trailers 1112. To accomplish this, the turbine generators 1122 can be

connected to the electric motors 1114 by power lines (not shown). The turbine generators 1122 can be connected to the electric motors 1114 via power distribution panels (not shown). In certain embodiments, the turbine generators 1122 can be powered by natural gas, similar to the electric generators 1022 discussed above in reference to the embodiment of Fig. 9. Also included are control units 1144 for the turbine generators 1122.

[0057] The embodiment of Fig. 10 can include other equipment similar to that discussed above. For example, Fig. 10 shows sand transporting vehicles 1126, acid transporting vehicles 1128, other chemical transporting vehicles 1130, hydration units 1132, blenders 1134, water tanks 1136, conveyor belts 1138, and pump control and data monitoring equipment 1140 mounted on a control vehicle 1142. The function and specifications of each of these is similar to corresponding elements shown in Fig. 9.

[0058] Use of pumps 1010, 1110 powered by electric motors 1014, 1114 and natural gas powered electric generators 1022 (or turbine generators 1122) to pump fracturing fluid into a well is advantageous over known systems for many different reasons. For example, the equipment (e.g. pumps, electric motors, and generators) is lighter than the diesel pumps commonly used in the industry. The lighter weight of the equipment allows loading of the equipment directly onto a truck body. In fact, where the equipment is attached to a skid, as described above, the skid itself can be lifted on the truck body, along with all the equipment attached to the skid, in one simple action. Alternatively, and as shown in Fig. 10, trailers 1112 can be used to transport the pumps 1110 and electric motors 1114, with two or more pumps 1110 carried on a single trailer 1112. Thus, the same number of pumps 1110 can be transported on fewer trailers 1112. Known diesel pumps, in contrast, cannot be transported directly on a truck body or two on a trailer, but must be transported individually on trailers because of the great weight of the pumps.

[0059] The ability to transfer the equipment of the present technology directly on a truck body or two to a trailer increases efficiency and lowers cost. In addition, by eliminating or reducing the number of trailers to carry the equipment, the equipment can be delivered to sites having a restricted amount of space, and can be carried to and

away from worksites with less damage to the surrounding environment. Another reason that the electric pump system of the present technology is advantageous is that it runs on natural gas. Thus, the fuel is lower cost, the components of the system require less maintenance, and emissions are lower, so that potentially negative impacts on the environment are reduced.

[0060] In practice, a hydraulic fracturing operation can be carried out according to the following process. First, the water, sand, and other components are blended to form a fracturing fluid, which is pumped down the well by the electric-powered pumps. Typically, the well is designed so that the fracturing fluid can exit the wellbore at a desired location and pass into the surrounding formation. For example, in some embodiments the wellbore can have perforations that allow the fluid to pass from the wellbore into the formation. In other embodiments, the wellbore can include an openable sleeve, or the well can be open hole. The fracturing fluid can be pumped into the wellbore at a high enough pressure that the fracturing fluid cracks the formation, and enters into the cracks. Once inside the cracks, the sand, or other proppants in the mixture, wedges in the cracks, and holds the cracks open.

[0061] Using the pump control and data monitoring equipment 1040, the operator can monitor, gauge, and manipulate parameters of the operation, such as pressures, and volumes of fluids and proppants entering and exiting the well. For example, the operator can increase or decrease the ratio of sand to water as the fracturing process progresses and circumstances change.

[0062] This process of injecting fracturing fluid into the wellbore can be carried out continuously, or repeated multiple times in stages, until the fracturing of the formation is optimized. Optionally, the wellbore can be temporarily plugged between each stage to maintain pressure, and increase fracturing in the formation. Generally, the proppant is inserted into the cracks formed in the formation by the fracturing, and left in place in the formation to prop open the cracks and allow oil or gas to flow into the wellbore.

[0063] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others

inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. For example, other the recesses can be put into arrangements other than those described, such as all being in a vertical or other arrangement. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

CLAIMS:

1. A hydraulic fracturing system for fracturing a subterranean formation comprising:
first and second pumps;
first and second motors for driving the first and second pumps, the first and second motors in electrical communication with a first junction box;
a transformer having a second junction box on a low voltage side of the transformer;
a first electrical circuit between the first motor and the transformer, and through which the first motor and transformer are in electrical communication; and
a second electrical circuit that is separate and isolated from the first electrical circuit, and that is between the second motor and the transformer, and through which the second motor and transformer are in electrical communication;
wherein each of the first and second electrical circuits includes a discrete cable between the first junction box and the second junction box.
2. The hydraulic fracturing system of Claim 1, wherein each cable has a transformer end plug on one end of the cable and in electrical communication with the cable, and a motor end plug on an end of the cable distal from the transformer end plug and that is in electrical communication with the cable.
3. The hydraulic fracturing system of Claim 2, further comprising a transformer receptacle that is in electrical communication with the transformer, and a motor receptacle in electrical communication with a one of the first or second motors, so that when the transformer end plug is inserted into the transformer receptacle, and the motor end plug is inserted into the motor receptacle, the transformer and a one of the first or second motors are in electrical communication, and wherein the plugs are selectively withdrawn from the receptacles.

4. The hydraulic fracturing system of Claim 3, further comprising a multiplicity of cables, transformer receptacles, and motor receptacles, wherein different phase electricity is transferred between the transformer and the first or second motors in different cables.
5. The hydraulic fracturing system of Claim 4, wherein the receptacles are strategically arranged so that cables that conduct electricity at the same phase are adjacent one another.
6. The hydraulic fracturing system of Claim 2, further comprising:
 - a transformer ground receptacle that is in electrical communication with a ground leg of the transformer;
 - a motor ground receptacle in electrical communication with a ground leg of one of the first or second pumps; and
 - a ground cable having a transformer ground plug and a pump ground plug, so that when the transformer ground plug is inserted into the transformer ground receptacle, and the pump ground plug is inserted into the pump receptacle, the transformer ground leg and the ground leg of a one of the first or second pumps are in electrical communication, and wherein the plugs are selectively withdrawn from the receptacles.
7. The hydraulic fracturing system of Claim 1, further comprising a platform on which the first and second pumps and motors are mounted, an enclosure on the platform, a variable frequency drive coupled with the motors and within the enclosure, and a removable panel on the enclosure adjacent the variable frequency drive, so that by removing the panel the variable frequency drive is accessible.
8. A hydraulic fracturing system for fracturing a subterranean formation comprising:
 - a source of electricity;

a first junction box housing a row of source receptacles that are in electrical communication with the source of electricity;
an electrically powered motor that is spaced apart from the source of electricity;
a second junction box housing a row of motor receptacles that are in electrical communication with the motor; and
cable assemblies that each comprise,
 a source plug that is selectively insertable into a one of the source receptacles,
 a motor plug that is selectively insertable into a one of the motor receptacles, and
 a cable in electrical communication with both the source plug and motor plug, so that when the source plug inserts into a one of the source receptacles, and the motor plug inserts into the a one of the motor receptacles, electricity at a designated phase is transmitted from the source of electricity to the motor;
wherein electricity conducts from the source of electricity to the first motor along a first path, from the source of electricity to the second motor along a second path, and the first and second paths are separate and distinct from one another.

9. The hydraulic fracturing system of Claim 8, wherein the source of electricity comprises a transformer having alternating current electricity at three different phases.

10. The hydraulic fracturing system of Claim 8, wherein the motor comprises a first motor, the system further comprising a second motor, and wherein the first and second motors each drive fracturing pumps.

11. The hydraulic fracturing system of Claim 8, wherein a first pair of the source receptacles receive electricity at a first phase, so that a corresponding first pair of cable

assemblies that have source plugs inserted into the source receptacles conduct electricity at the first phase, wherein a second pair of the source receptacles receive electricity at a second phase, so that a corresponding second pair of cable assemblies that have source plugs inserted into the source receptacles conduct electricity at the second phase, and wherein a third pair of the source receptacles receive electricity at a third phase, so that a corresponding third pair of cable assemblies that have source plugs inserted into the source receptacles conduct electricity at the third phase.

12. The hydraulic fracturing system of claim 8, wherein some of the source receptacles receive electricity from the source of electricity at a phase that is different from a phase of electricity by other source receptacles from the source of the electricity.

13. A method of hydraulic fracturing comprising:

- a. providing a first junction box in electrical communication with a source of electricity, and a second junction box in electrical communication with a fracturing pump motor, each of the first and second junction boxes having receptacles;
- b. electrically connecting a fracturing pump motor with a source of electricity by inserting a source end of a cable assembly into a source receptacle of the first junction box and inserting a motor end of the cable assembly, which is in electrical communication with the source end of the cable assembly, into a motor receptacle of the second junction box, wherein the fracturing pump motor comprises a first fracturing pump motor and the cable assembly comprises a first cable assembly;
- c. directing fracturing fluid to a suction end of a fracturing pump that is coupled with the fracturing pump motor;
- d. causing the source of electricity to transmit electricity to the source receptacle, so that electricity conducts from the source receptacle, to the source and motor ends, to the motor receptacle, and to the motor; and

- e. pressurizing the fracturing fluid with the fracturing pump to form pressurized fracturing fluid, and directing the pressurized fracturing fluid to a wellbore;
- f. repeating steps (b)-(d) using a second fracturing pump motor and a second cable assembly; wherein a path of electricity between the source of electricity and the first fracturing pump motor is separate and distinct from a path of electricity between the source of electricity and the second fracturing pump motor.

14. The method of Claim 13, wherein the source of electricity is a transformer that transmits 3-phase electricity.

15. The method of Claim 13, further comprising removing the ends of the cable assembly from the receptacles, moving the source of electricity and fracturing pump motor to a different location, and repeating steps (b)-(d).

16. The method of Claim 13, further comprising repeating step (a) so that multiple cable assemblies are connected between multiple source receptacles and multiple motor receptacles, so that electricity at different phases is conducted through the different cable assemblies to the fracturing pump motor.

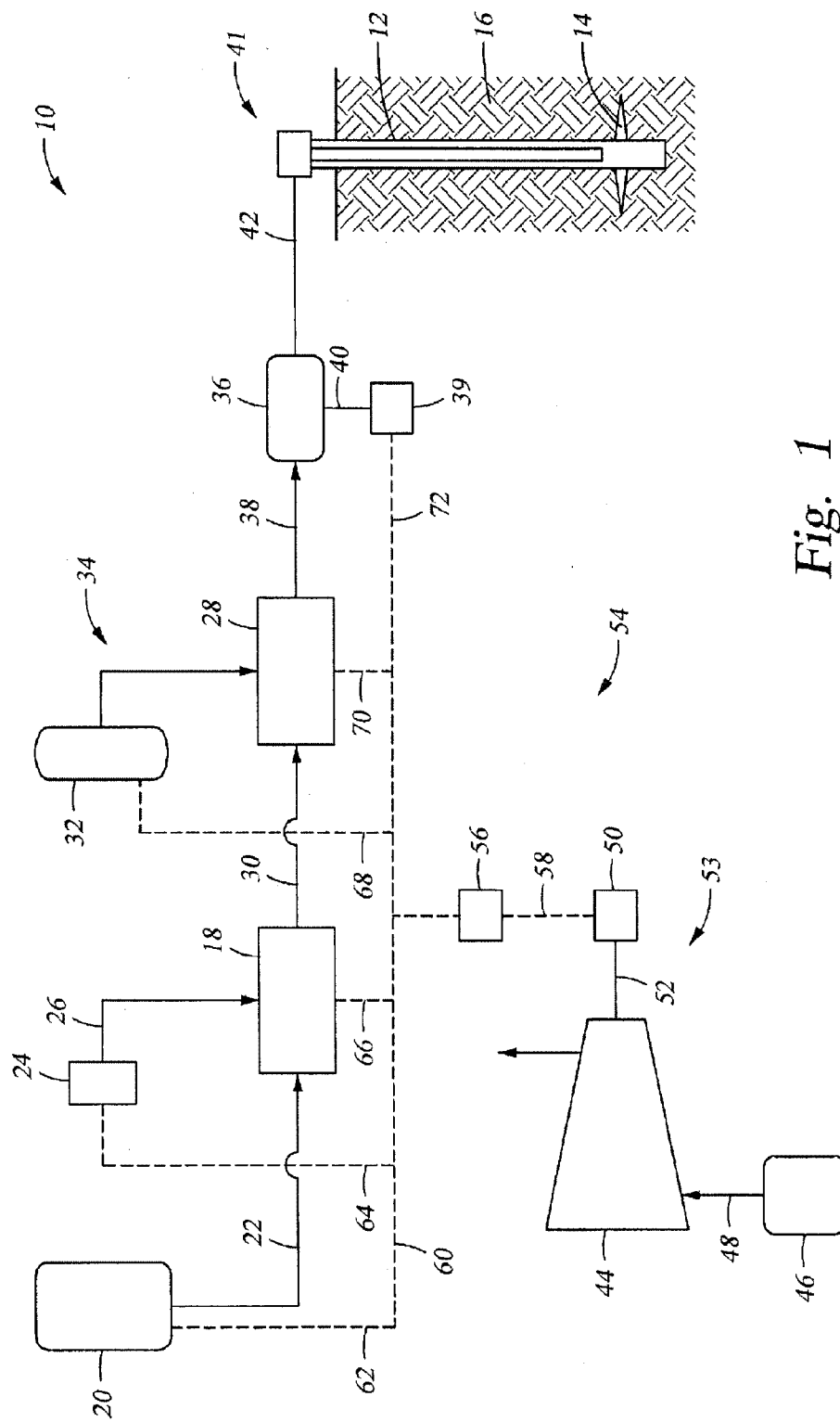


Fig. 1

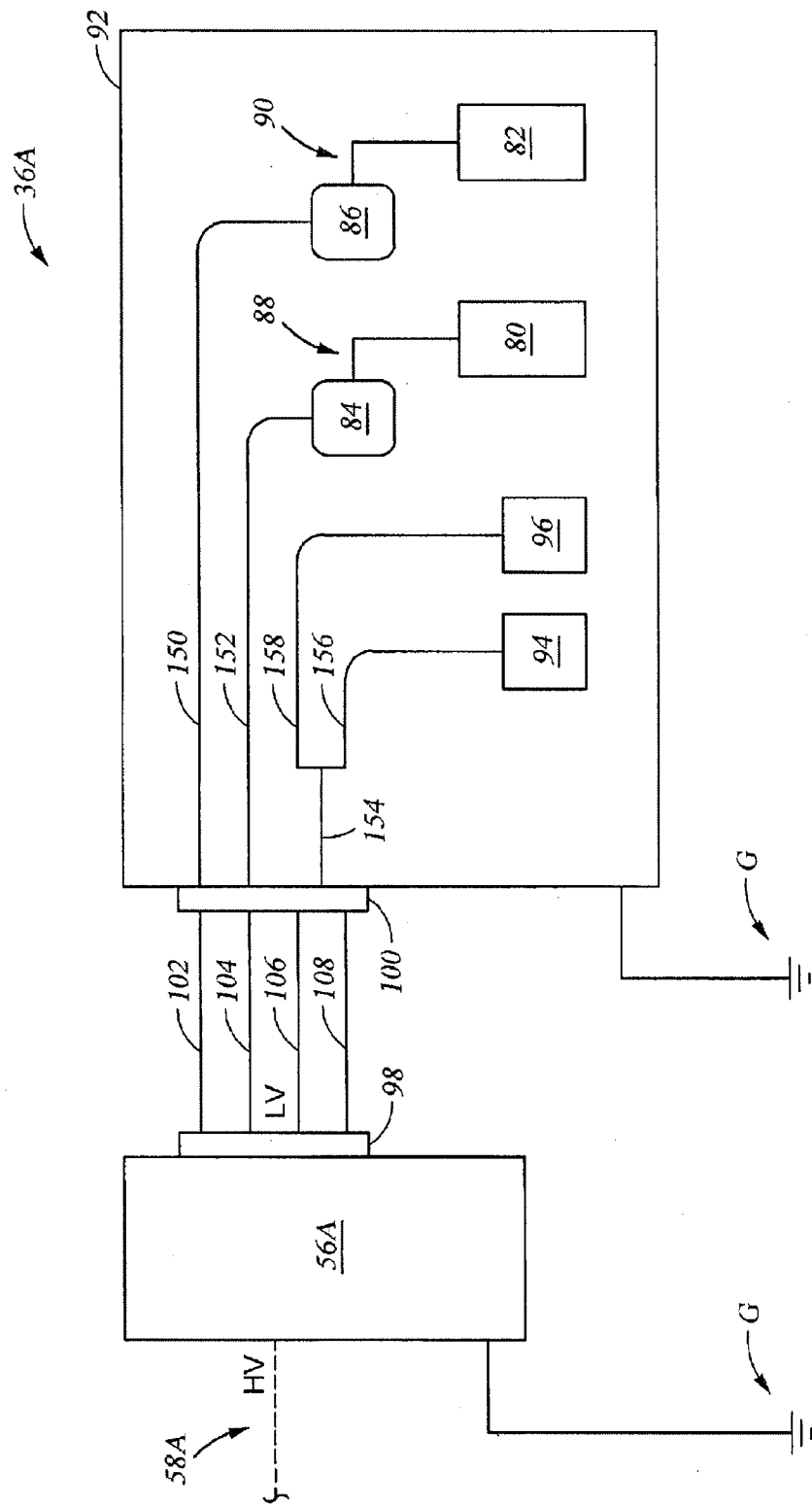


Fig. 2

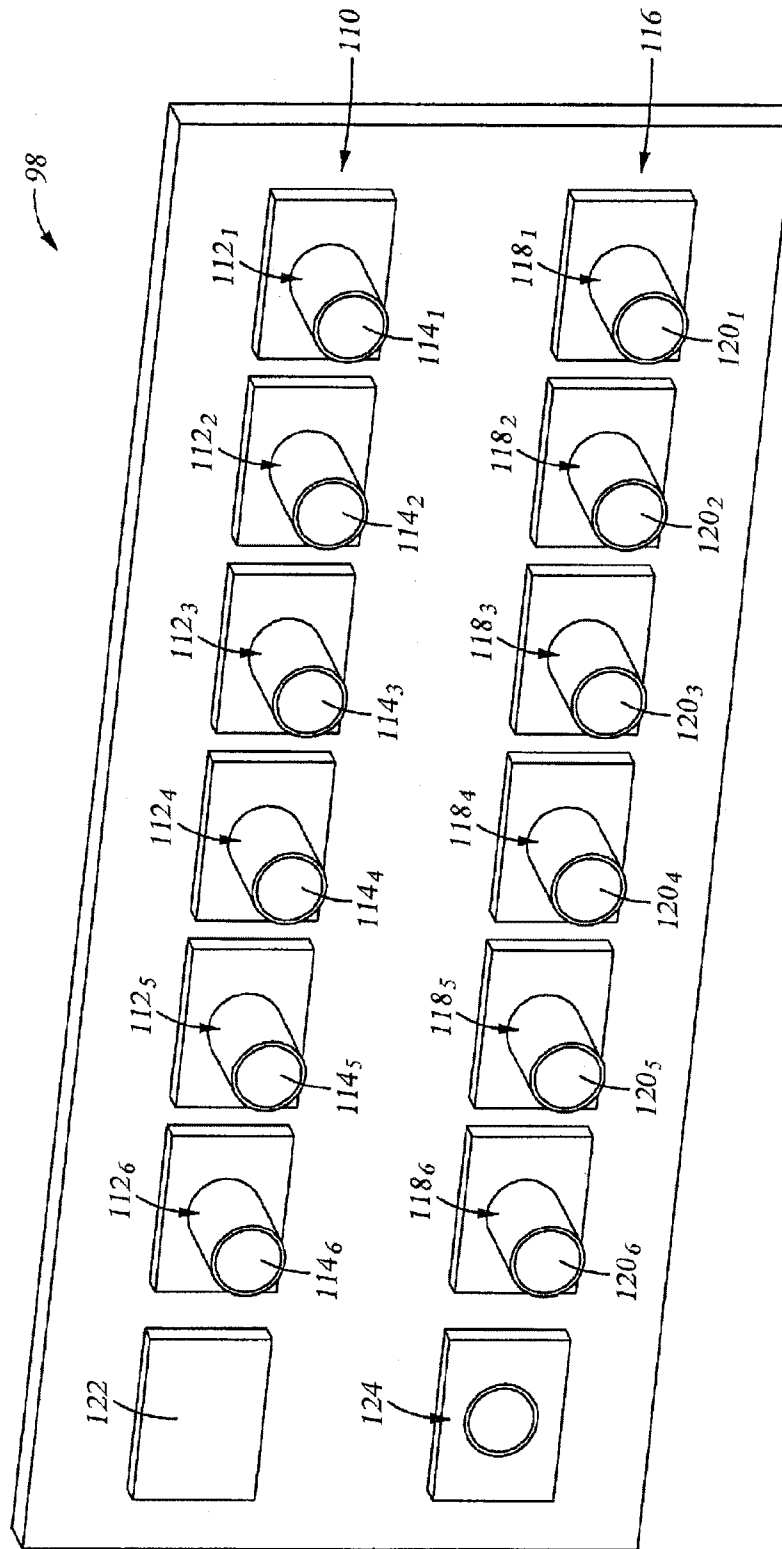


Fig. 3

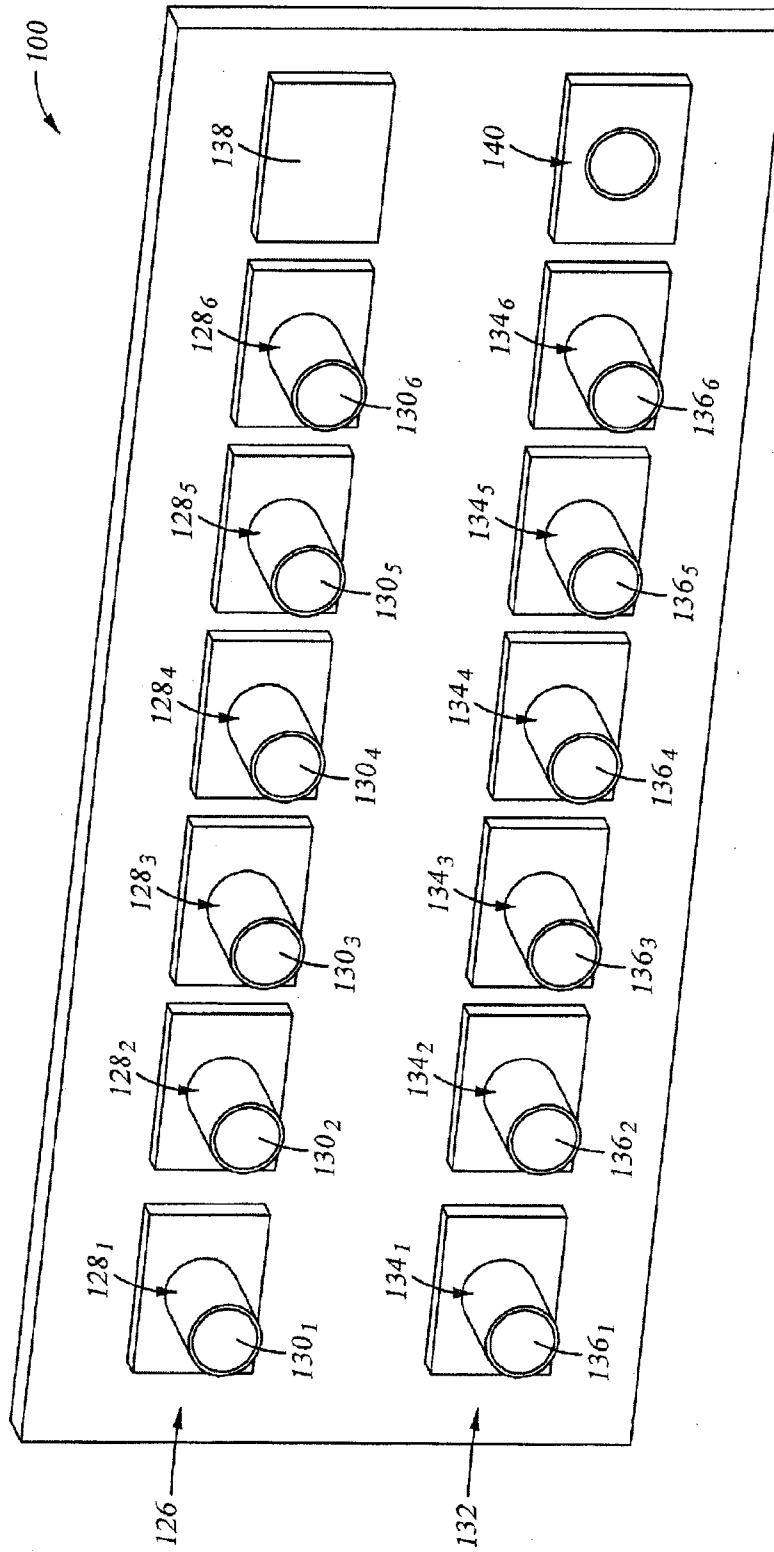


Fig. 4

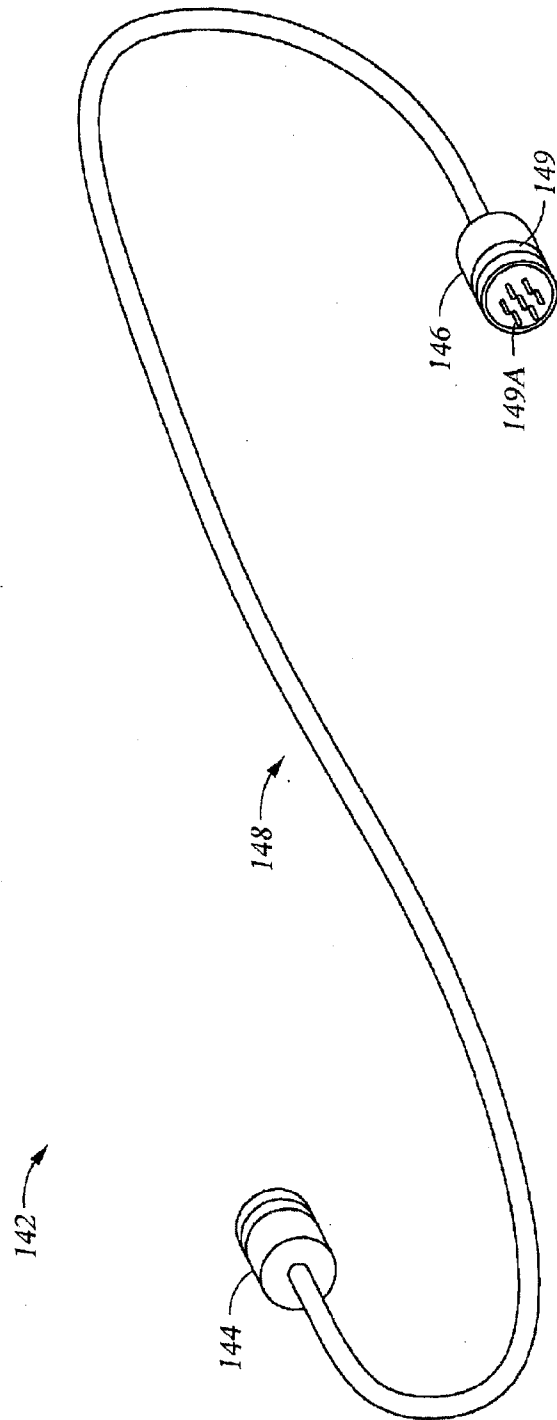


Fig. 5

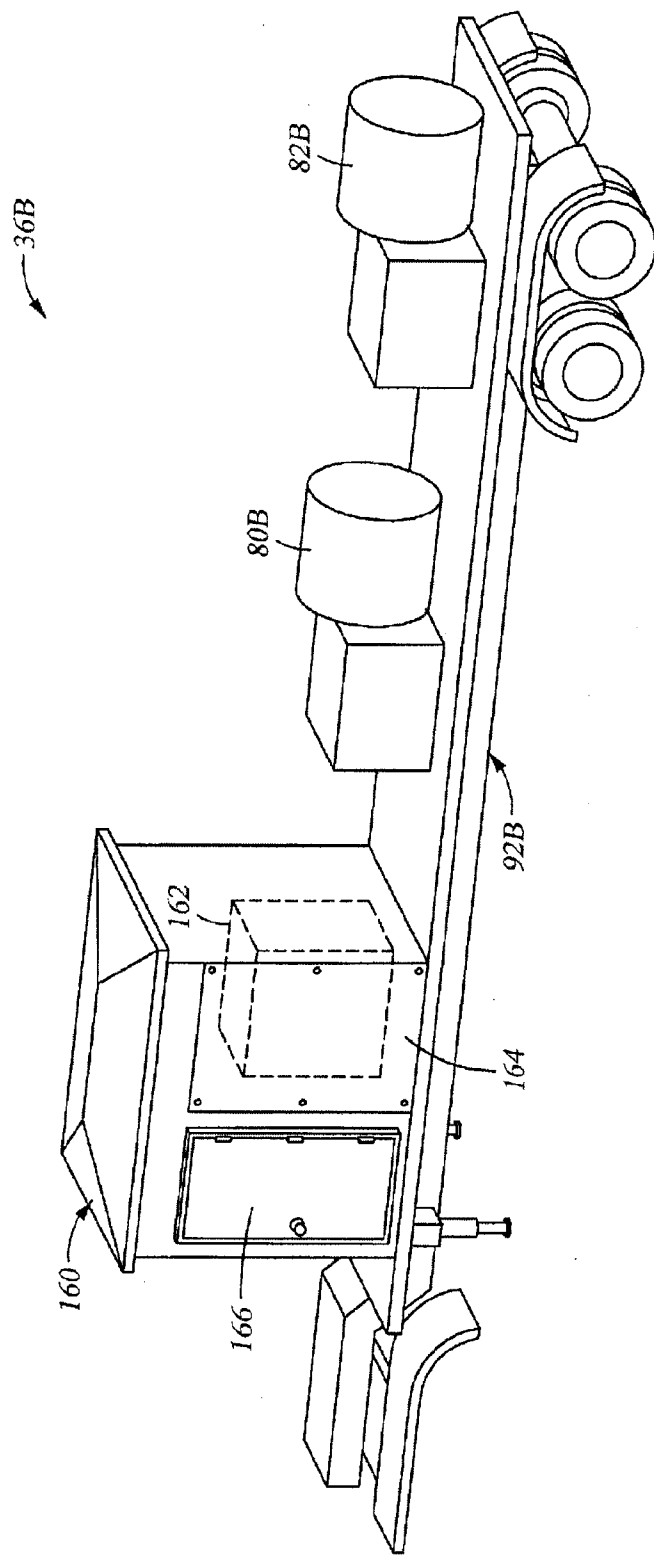


Fig. 6

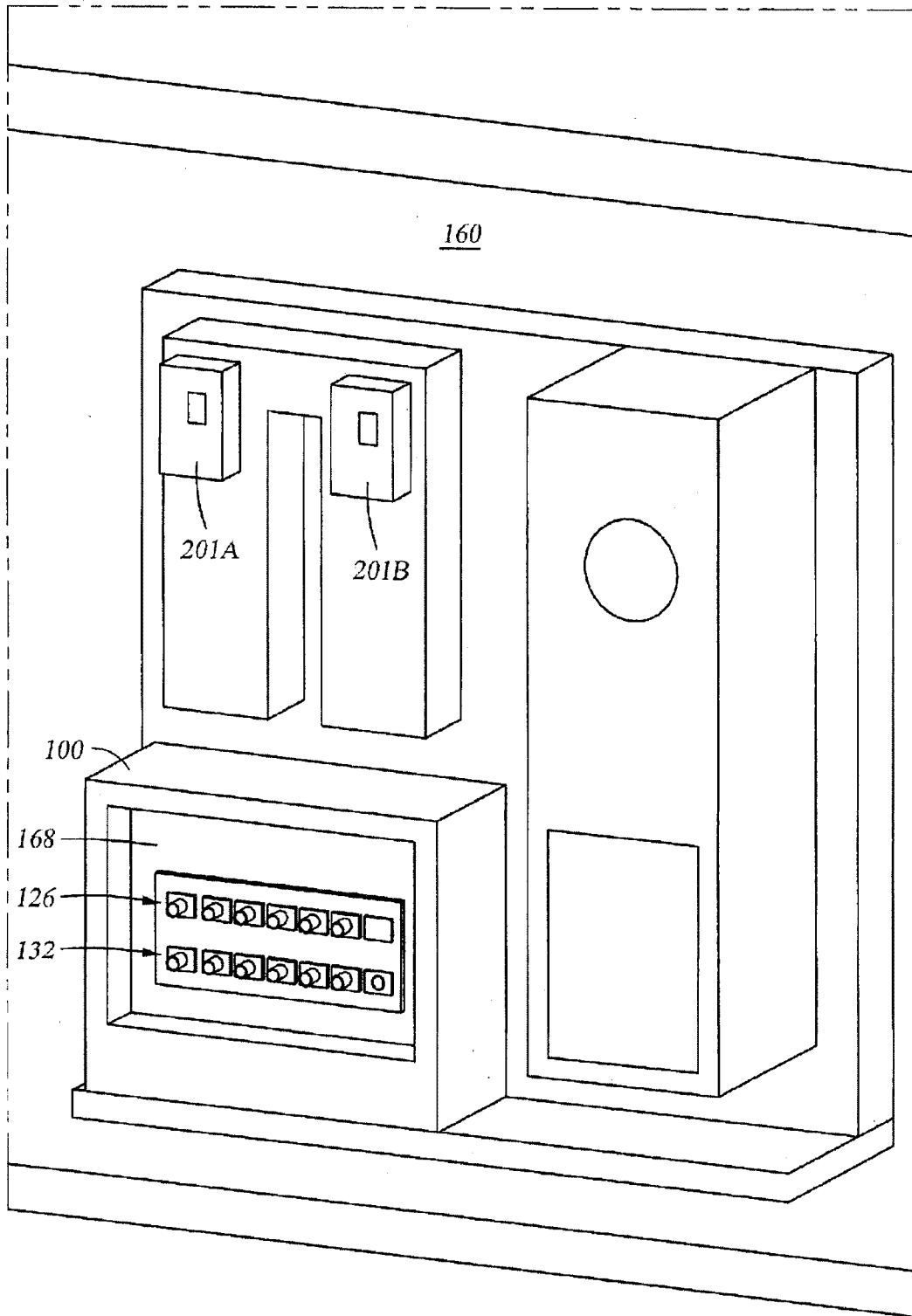


Fig. 7

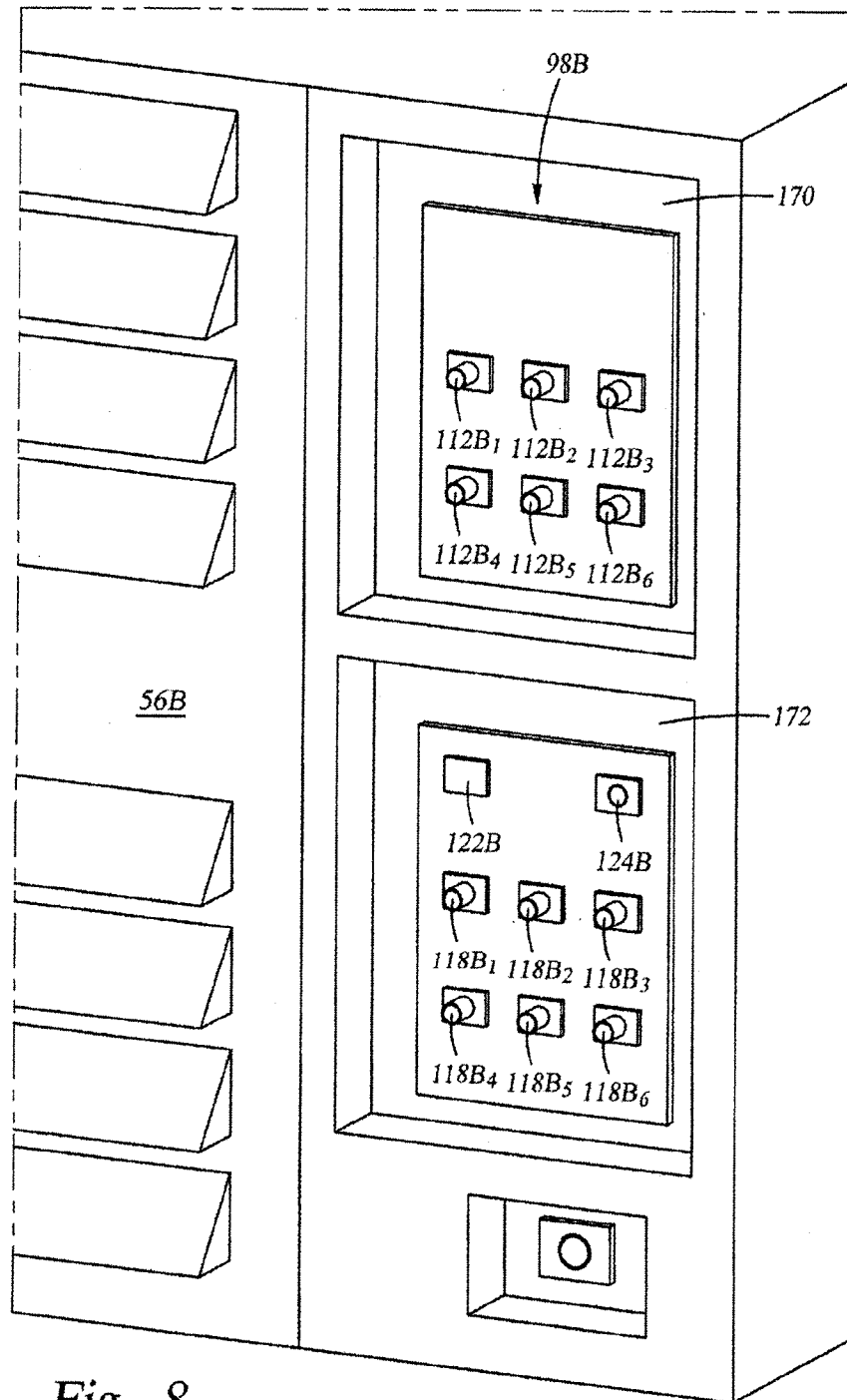


Fig. 8

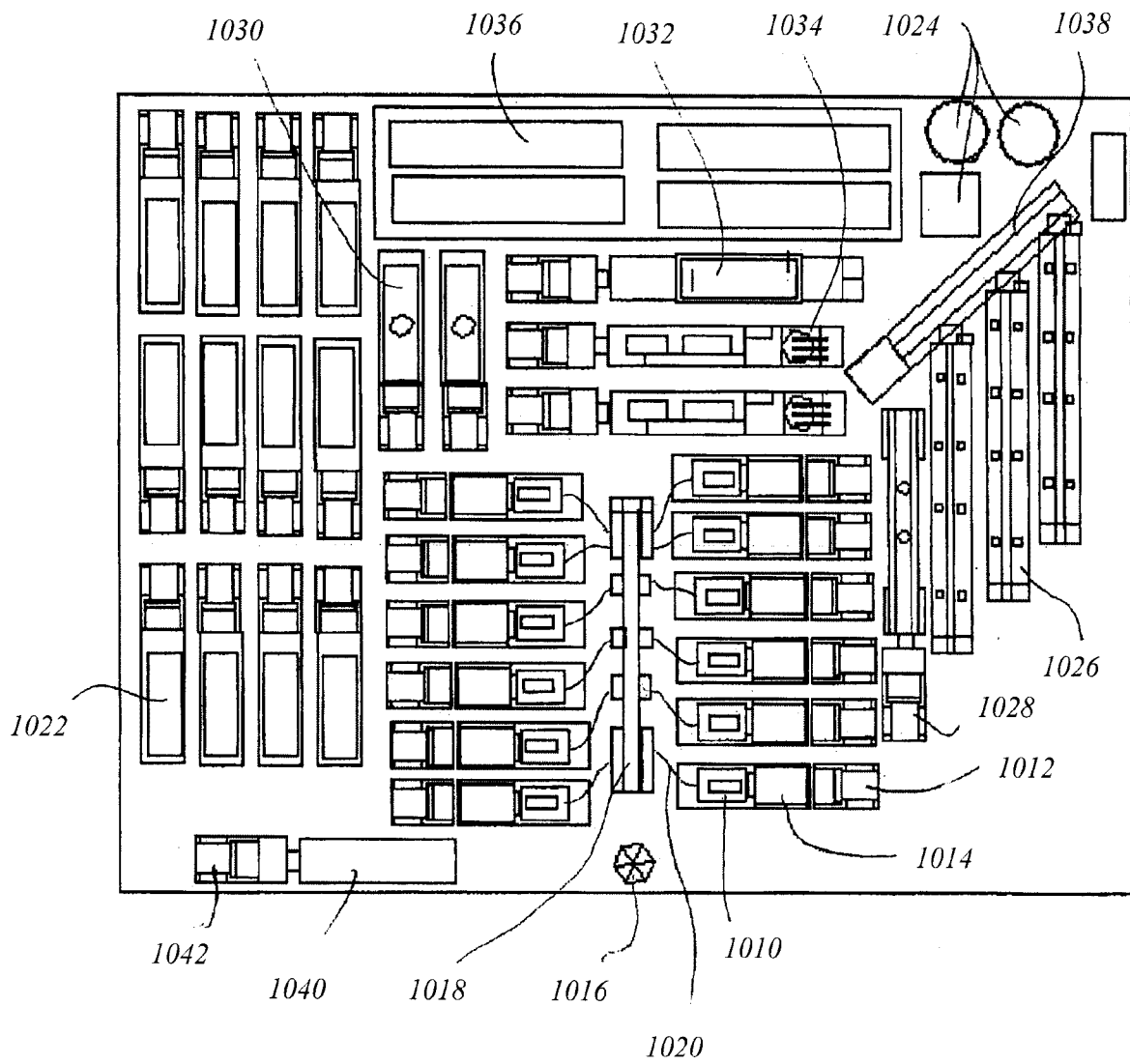


Fig. 9

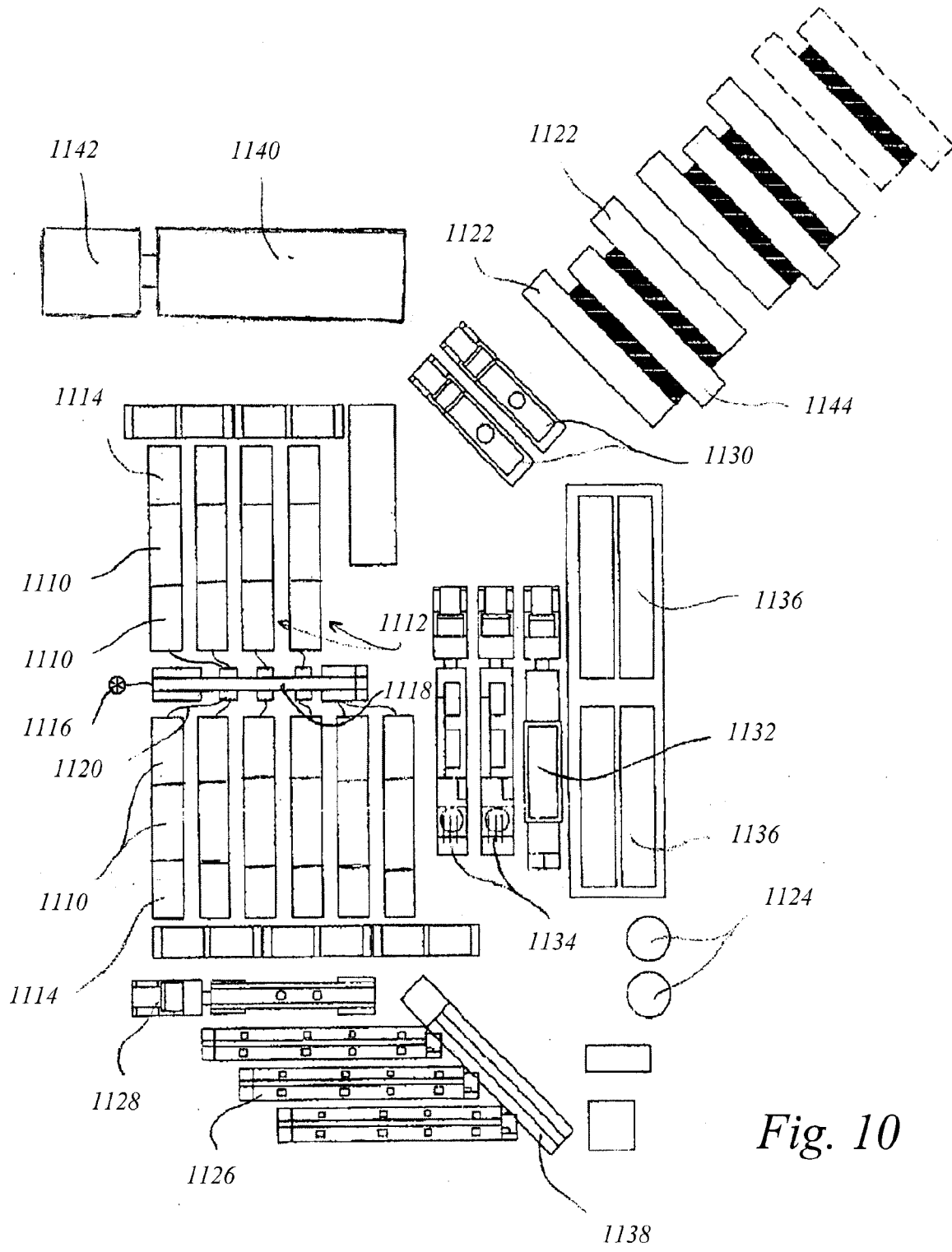


Fig. 10

