

Petitioner Halliburton Energy Services, Inc.
Hearing Presentation

IPR2023-00558 (U.S. Patent No. 11,136,870)

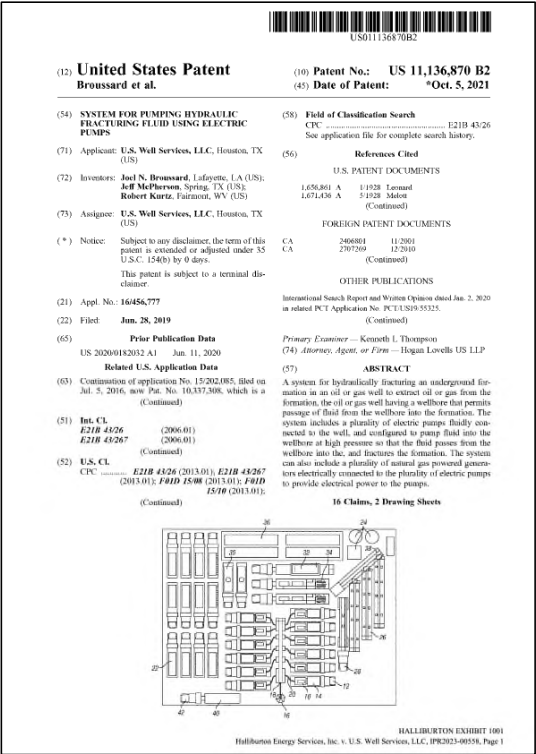
Outline of Arguments

- I. Overview of the '870 Patent**
- II. Summary of the Grounds**
- III. Overview of the Dispute**
- IV. Claims 1-6: "Electric Motor Diagnostics" (Grounds 1 & 2)**
- V. Claims 1-16: Motivation to Combine Coli & Toshiba Manual (Ground 1)**
- VI. Claims 7-16: "Heat Sinks Having Thermal Sensors" (Grounds 1 & 3)**
- VII. Dependent Claims 13, 15, 16 (Grounds 1 & 3-5)**

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- VII. Dependent Claims 13, 15, 16 (Grounds 1 & 3-5)

'870 Patent: Earliest Filing Date



'870 Patent: Overview of Independent Claims

1. 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 comprising:

- a trailer for attachment to a truck;
- two or more pumps attached to the trailer and fluidly connected to the well, the pumps configured to pump fluid into the wellbore;
- one or more electric motors attached to the pumps to drive the pumps, the electric motors attached to the trailer; and
- a variable frequency drive connected to the electric motor to control the speed of the motor, wherein the variable frequency drive performs electric motor diagnostics to prevent damage to the one or more electric motors.

4. A method of 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 method comprising:

- pumping fluid into the wellbore using hydraulic fracturing pumps;
- powering the hydraulic fracturing pumps using an electric motor; and
- controlling the speed of the motor using a variable frequency drive, wherein the variable frequency drive performs electric motor diagnostics to prevent damage to the electric motor.

'870 Patent: Overview of Independent Claims

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'870 Patent: Overview of Independent Claims

7. 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 comprising:

- a pump fluidly connected to the well; and
- an electric motor to power the pump;
- the pump configured to pump fluid into the wellbore; and
- a variable frequency drive connected to the electric motor to control the speed of the motor and having one or more power semiconductor heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat.

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Summary of the Grounds: '870 Patent

Ground	Claims	Prior Art
1	1-16	<i>Coli</i> in view of <i>Toshiba Manual</i>
2	1-6	<i>Coli</i> in view of <i>Horikoshi</i>
3	7-16	<i>Coli</i> in view of <i>Loucks</i>
4A	12 and 13	<i>Coli</i> in view of <i>Toshiba Manual</i> and <i>Vliet</i>
4B	12 and 13	<i>Coli</i> in view of <i>Loucks</i> and <i>Vliet</i>
5A	14 and 15	<i>Coli</i> in view of <i>Toshiba Manual</i> and <i>Gardner</i>
5B	14 and 15	<i>Coli</i> in view of <i>Loucks</i> and <i>Gardner</i>

Coli

- Hydraulic fracturing with pumps, **electric motors** and **variable frequency drives**

Toshiba Manual

- Details of **electric motors** and **variable frequency drives** and **heat sinks**

Horikoshi

- Details of **electric motors** and **variable frequency drives**

Loucks

- Details of **heat sinks having thermal sensors**

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5B	14 and 15	<i>Coli</i> in view of <i>Loucks</i> and <i>Gardner</i>

Patent Owner Does Not Dispute:

- References qualify as prior art
- Motivation to combine *Coli* and *Horikoshi*
- *Coli*’s disclosure of independent claims

Patent Owner Disputes:

- Disclosure of “electric motor diagnostics”
- Disclosure of “heat sink having thermal sensors”
- Motivation to combine *Coli* with *Toshiba Manual* or *Loucks*
- *Coli* disclosure of claims 13, 15, & 16

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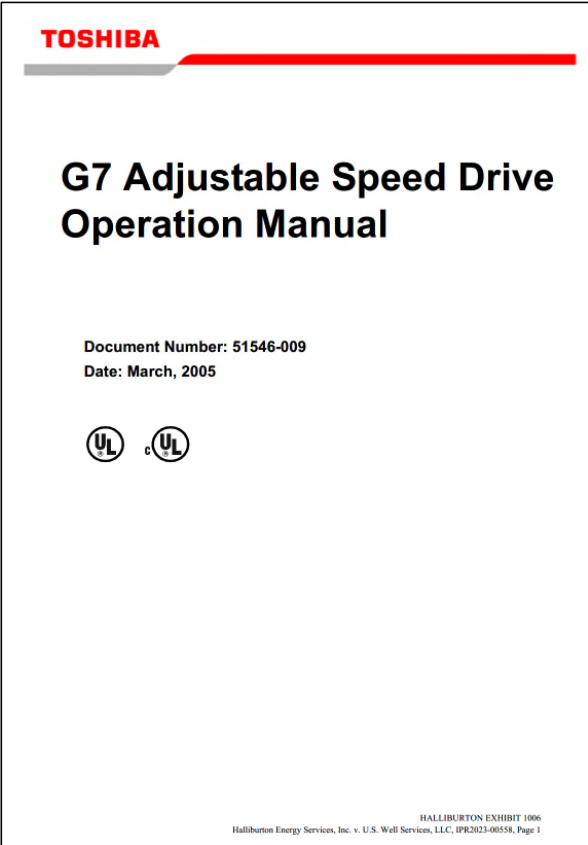
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- A. Ground 1: Toshiba Manual discloses “electric motor diagnostics”**
- B. Ground 2: Horikoshi discloses “electric motor diagnostics”**

Claims 1-6: “Electric Motor Diagnostics” (Grounds 1 & 2)

- A. Ground 1: Toshiba Manual discloses “electric motor diagnostics”**
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Overview of Toshiba Manual



Introduction

Congratulations on the purchase of the new **G7 True Torque Control² Adjustable Speed Drive (ASD)**. The **G7 True Torque Control² Adjustable Speed Drive** is a solid-state AC drive that features **True Torque Control²**. TIC's **Vector Control Algorithm** enables the motor to develop high starting torque and provide compensation for motor slip, which results in smooth, quick starts and highly efficient operation. The G7 uses digitally-controlled pulse width modulation. The programmable functions may be accessed via the easy-to-use menu or via the **Direct Access Numbers** (see [page 59](#)). This feature, combined with Toshiba's high-performance software, **delivers unparalleled motor control and reliability.**

The G7 is a very powerful tool, yet surprisingly simple to operate. The user-friendly **Electronic Operator Interface (EOI)** of the G7 has an easy-to-read 240 x 64 pixel graphical LCD screen. The **EOI** provides easy access to the many monitoring and programming features of the G7.

The motor control software is menu-driven, which allows for easy access to the motor control parameters and quick changes when required.

Ex. 1006 (Toshiba Manual) at 2

Toshiba Manual Discloses Electric Motor Diagnostics

The output terminals of the ASD (T1/U, T2/V, and T3/W) must be connected to the motor that is to be controlled (see Figure 18 on pg. 30).

Soft Stall

Program ⇒ Protection Parameters ⇒ **Overload**

This parameter **Enables/Disables** the **Soft Stall** function. When enabled, the **Soft Stall** function reduces the output frequency of the ASD when the current requirements of the motor exceed the **Electronic Thermal Protection #1** setting (**F600**); thus, reducing the output current.

If the current drops below the motor overload protection level setting within a specified time, the output of the ASD will accelerate to the programmed frequency setpoint. If not, a trip will be incurred.

The **Soft Stall** feature is available when the (Program ⇒ Protection Parameters ⇒ Overload ⇒) **Motor Overload Trip Enable/Disable** parameter is enabled only.

Soft Stall is highly effective in preventing motor overload trips when used on fans, blowers, pumps, and other centrifugal loads which require less torque at lower frequencies.

Direct Access Number — F017

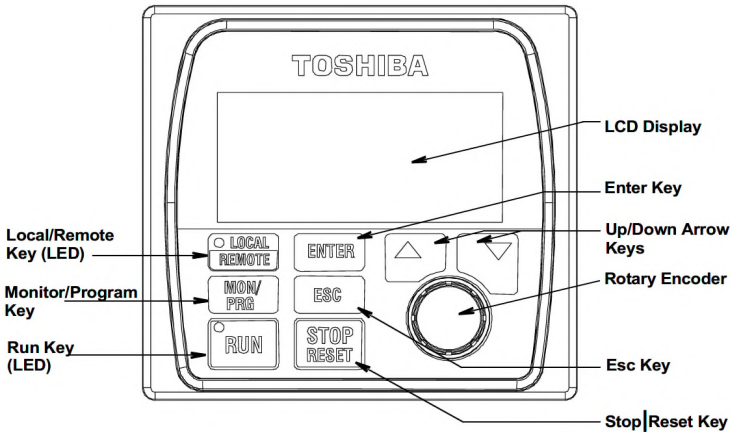
Parameter Type — **Check Box**

Factory Default — **Disabled**

Changeable During Run — **No**

Toshiba Manual Discloses Electric Motor Diagnostics

Figure 19. The G7 Electronic Operator Interface.



EOI Operation

The **EOI** is the primary input/output device for the user. The **EOI** may be used to monitor system functions, input data into the system, or perform diagnostics.

Trips/Faults

A **Trip** is an ASD response to a **Fault** (though, **Fault** and **Trip** are sometimes used interchangeably). A **Trip** is a safety feature that disables the ASD system in the event that a subsystem of the ASD is malfunctioning.

Listed in Table 12 are the possible **Faults** that may cause a **Trip** and the possible causes. When a **Trip** is incurred the system displays the **Fault** screen. The **Fault** screen identifies the active **Fault**.

Toshiba Manual Discloses Electric Motor Diagnostics

Fault Screen Display	Possible Causes
ASD Overload	- Acceleration time is too short. - DC Injection current is too high. - V/f setting needs to be adjusted. - Motor running during restart. - ASD or the motor is improperly matched to the application.
Earth Fault	- Ground fault at the motor. - Ground fault at the output of the ASD. - Current leakage to Earth Ground.
Load End Short Circuit	Improper wiring at the ASD output to the motor.
Motor Overload	- V/f setting needs to be adjusted. - Motor is locked. - Continuous operation at low speed. - Load requirement exceeds ability of the motor. - Startup frequency setting adjustment required.
Overcurrent During Acceleration	- V/f setting needs to be adjusted. - Restart from a momentary power outage. - The ASD is starting into a rotating motor. - ASD/Motor not properly matched. - Phase-to-phase short (U, V, or W). - Accel time too short. - Voltage Boost setting is too high. - Motor/machine jammed. - Mechanical brake engaged while the ASD is running. - ASD current exceeds 340% of the rated FLA on ASDs that are 100 HP or less during acceleration. On ASDs that are greater than 100 HP, this fault occurs when the ASD current exceeds 320% of the rated FLA during acceleration.

- Faults identified with causes relating to motor include:
 - ASD Overload
 - Earth Fault
 - Load End Short Circuit
 - Motor Overload
 - Overcurrent

Toshiba Manual Discloses Electric Motor Diagnostics

117. *Toshiba Manual* discloses numerous examples of electric motor diagnostics. *Toshiba Manual* expressly discloses that the Electronic Operator Interface (EOI) (a touchscreen interface, shown in green above) “may be used to monitor system functions, input data into the system, or *perform diagnostics*.” Ex. 1006 at 43. The diagnostics includes a “fault screen” that “identifies the active Fault.” Ex. 1006 at 182–186 (Table 12, containing a list of 5 pages of faults that are diagnosed). Examples of motor diagnostics used to protect the connected motor disclosed in *Toshiba Manual* include:

118. As discussed above, certain diagnostic actions result in a trip. Table 12 from Ex. 1006 shows several trip conditions and possible causes. Included in this table as it relates to preventing damage to an electric motor are the following:

Overload Protection Adjustment

The **G7 ASD** software monitors the output current of the system and determines when an overload condition occurs. The overload current level is a percentage of the rating of the motor. This function protects the motor from overload.

The default setting for the overload detection circuit is set to the maximum rated current of the ASD at the factory. This setting will have to be adjusted to match the rating of the motor with which the ASD is to be used. To change the overload reference level, see **Electronic Thermal Protection #1 on pg. 154**.

PO Relies on Improper Construction of “Electric Motor Diagnostics”

- Board already rejected construction of “electric motor diagnostics” to require VFD to interrogate the motor

Patent Owner’s present opposition relies on an implicit claim construction of the term “electric motor diagnostics” that would require the VFD to interrogate the motor itself in order to perform the diagnostics. This implicit claim construction is not supported by the “electric motor diagnostics” claim language or the supporting specification, which essentially just repeats the claim language. See Ex. 1001, 2:36–39, 4:16–25,

7:59–61. Based on the present record, we conclude the Toshiba G7 VFD’s monitoring of the electric current being delivered to a motor in order to protect the motor from overload is the performance of electric motor diagnostics, as claimed.

- PO Response’s new construction

Dec., 19. In view of the specification and file history, the phrase “*electric motor diagnostics*” means “diagnostics for an electric motor alone.” EX-2002, ¶ 38.

PO Relies on Improper Construction of “Electric Motor Diagnostics”

- Petitioner’s expert’s testimony does not support PO’s construction

8 Q And do the claimed diagnostics in independent Claims
9 1 and 4 pertain only to the electric motor?
10 MS. FLANNERY: Object to form.
11 A No, sir.
12 BY MR. HOPKINS:
13 Q How so?
14 A Well, they certainly pertain to the variable
15 frequency drive because the variable frequency drive
16 is what is performing the electric motor
17 diagnostics.

16 Q So would diagnostics unrelated to the electric motor
17 satisfy this claim?
18 MS. FLANNERY: Object to form.
19 A It doesn't -- the claim does not exclude those.
20 Certainly, if you're doing diagnostics on the
21 electric motor and doing something else, yes, that
22 would be satisfied.

Claims 1-6: “Electric Motor Diagnostics” (Grounds 1 & 2)

- A. Ground 1: Toshiba Manual discloses “electric motor diagnostics”
- B. **Ground 2: Horikoshi discloses “electric motor diagnostics”**

Overview of Horikoshi

**MOTOR DRIVING APPARATUS HAVING
FAULT DIAGNOSTIC FUNCTION**

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a motor driving apparatus having a fault diagnostic function.

- PO argues that Horikoshi does not disclose performing multiple “electric motor diagnostics”

P0 Relies on Improper Construction of “Electric Motor Diagnostics”

US01136870B2

(12) **United States Patent**
Broussard et al.

(10) **Patent No.:** US 11,136,870 B2
(45) **Date of Patent:** *Oct. 5, 2021

(54) **SYSTEM FOR PUMPING HYDRAULIC FRACTURING FLUID USING ELECTRIC PUMPS**

(58) **Field of Classification Search**
CPC E21B 43/26
See application file for complete search history.

(71) **Applicant:** U.S. Well Services, LLC, Houston, TX (US)

(56) **References Cited**
U.S. PATENT DOCUMENTS

(72) **Inventors:** Joel N. Broussard, Lafayette, LA (US);
Jeff McPherson, Spring, TX (US);
Robert Kurtz, Fairport, WV (US)

1,656,861 A 1/19/21 Lemard
1,671,436 A 3/19/21 Malott
(Continued)

(73) **Assignee:** U.S. Well Services, LLC, Houston, TX (US)

FOREIGN PATENT DOCUMENTS

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

CA 2460881 11/2001
CA 2907809 12/2010
(Continued)

This patent is subject to a terminal disclaimer.

OTHER PUBLICATIONS

(21) **Appl. No.:** 16/456,777

International Search Report and Written Opinion dated Jan. 2, 2020 in related PCT Application No. PCT/US19-55525.
(Continued)

(22) **Filed:** Jun. 28, 2019

(65) **Prior Publication Data**

US 2020/0182032 A1 Jun. 11, 2020

Related U.S. Application Data

(63) **Continuation of application** No. 15/202,085, filed on Jul. 5, 2016, now Pat. No. 10,337,508, which is a (Continued)

Primary Examiner — Kenneth L. Thompson

(74) **Attorney, Agent, or Firm** — Iqbal Lovells US LLP

(31) **Int. Cl.** (2006.01)
E21B 43/26 (2006.01)
E21B 43/267 (Continued)

(57) **ABSTRACT**
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, and fractures the formation. The system can also include a plurality of natural gas powered generators electrically connected to the plurality of electric pumps to provide electrical power to the pumps.

(52) **U.S. Cl.** (Continued)
CPC E21B 43/26 (2013.01); E21B 43/267 (2013.01); F01D 15/06 (2013.01); F01D 15/10 (2013.01);

16 Claims, 2 Drawing Sheets

HALLIBURTON EXHIBIT 1001

Halliburton Energy Services, Inc. v. U.S. Well Services, LLC, IP#2023-00535, Page 1

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 14. The electric motor diagnostics can be disabled, if desired, when using, for example, a low impedance or high-speed electric motor.

Horikoshi Discloses Multiple “Electric Motor Diagnostics”

[0011] Accordingly, it is an object of the present invention to achieve, while minimizing an increase in cost, a motor driving apparatus having a fault diagnostic function capable of detecting during operation a ground fault and a phase-to-phase short circuit by distinguishing one from the other.

86. *Horikoshi* teaches a system that monitors and performs fault diagnostic functions “during operation.” In fact, *Horikoshi* describes the system monitoring a fault that occurs momentarily, in operation on only part of a cycle and then clears.

Figure 2 and Figure 4 of *Horikoshi* show these momentary faults as a portion of a single cycle of an AC signal. At 60 Hz (most North American Utility AC Power), and even if the output frequency was as low as 0.1 Hz, the time required for completion of a single cycle of the AC output signal would be 10 Seconds.

Horikoshi Discloses Multiple “Electric Motor Diagnostics”

[0011] Accordingly, it is an object of the present invention to achieve, while minimizing an increase in cost, a motor driving apparatus having a fault diagnostic function capable of detecting during operation a ground fault and a phase-to-phase short circuit by distinguishing one from the other.

Horikoshi further teaches that the “motor driving apparatus [has] a fault diagnostic function.” Ex. 1008, [0002]. Specifically, *Horikoshi* teaches that that the apparatus can include current sensors to “detect any overcurrent occurring in the DC/AC converter and can also identify whether the cause [of the overcurrent] is a ground fault or a phase-to-phase short circuit” associated with “insulation resistance of the motor” or the power source providing power to the apparatus.” *Id.*, [0004], [0006]. A POSITA would have understood that “overcurrent” is a potential source of damage to an electric motor, and detecting overcurrent associated with “a ground fault or a phase-to-phase short circuit” is a way to protect the electric motor from damage. Ex. 1002, ¶¶225-227; Ex. 1052, 205:11-206:18.⁷ Indeed, *Horikoshi*

Horikoshi Discloses Multiple “Electric Motor Diagnostics”

- The Board previously found Horikoshi to disclose “electric motor diagnostics”

Claim 1 recites “at least one variable frequency drive connected to the electric motors to control the speed of the motors, the at least one variable frequency drive frequently performing electric motor diagnostics to prevent damage to the electric motors if they become grounded or shorted.”

Horikoshi discloses “a motor driving apparatus having a fault diagnostic function” in the form of a unit that uses signals received from a zero phase current detector and current sensors to determine whether a detected overcurrent is a short circuit or a ground fault. Ex. 1010 ¶¶ 2, 28–29. Horikoshi expressly teaches that it is desirable to detect and identify such sources of overcurrent (*id.* ¶ 11) and that it is known in the art to use fault detection to “provide[] protection against ground faults” (*id.* ¶ 8). Notably, the '601 patent acknowledges that grounding and shorting are two causes of motor damage. Ex. 1001, 2:33–35.

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Overview of Coli

The present invention provides a method and system for providing on-site electrical power to a fracturing operation, and an **electrically powered fracturing system**. Natural gas can be used to drive a turbine generator in the production of electrical power. A scalable, electrically powered fracturing fleet is provided to pump fluids for the fracturing operation, obviating the need for a constant supply of diesel fuel to the site and reducing the site footprint and infrastructure required for the fracturing operation, when compared with conventional systems.

[0066] Electric motors controlled via variable frequency drive are far safer and easier to control than conventional diesel powered equipment. For example, conventional fleets with diesel powered pumps utilize an electronically controlled transmission and engine on the unit. There can be up to fourteen different parameters that need to be monitored and controlled for proper operation. These signals are typically sent via hardwired cable to an operator console controlled by the pump driver. The signals are converted from digital to analog so the inputs can be made via switches and control knobs. The inputs are then converted from analog back to digital and sent back to the unit. The control module on the unit then tells the engine or transmission to perform the required task and the signal is converted to a mechanical operation. This process takes time.

Why a POSITA Would Combine Coli & Toshiba Manual

- Substitute the VFD in Coli with Toshiba Manual's VFD
- Enhance the VFD of Coli with the diagnostic functionality and temperature monitoring functionality described in Toshiba Manual
 - Mere application of a known technique (i.e., the fault detection and temperature monitoring including heat sinks of the VFD in Toshiba Manual) to predictably improve a similar system (i.e., the VFD of Coli) in the same way

Dr. Durham’s Testimony Is Not Conclusory

112. Toshiba has been a major manufacturer of electric motors and variable frequency drives and has been for decades before the Challenged Patents. Toshiba “entered the North American adjustable speed drives market in 1981 and has continued to grow the market with [its] products.” Ex. 1045. Toshiba has actively marketed and participated in the Oil & Gas industry. “Toshiba’s oil and gas product offerings are packages as a complete solution, increasing maximization of system uptime and mean time between failures...With extensive experience in oil and gas applications, including drilling, pumping, [and] production, we understand your specific applications and can provide highly reliable solutions to meet your needs.” Ex. 1046.

113. Toshiba actively participated in industry organizations and activities, such as the Petroleum and Chemical Industry Committee (PCIC) of the IEEE. A POSITA would have been well aware of Toshiba’s expertise and prevalence in the oil and gas market, particularly with motors and drives. A POSITA would have been motivated to look to Toshiba’s products, manual, documentation and brochures for teachings on solutions to problems integrating motors and variable frequency drives.

Dr. Durham’s Testimony Is Not Conclusory

149. *Coli* discloses the need for “variable frequency drives,” which are used to “essentially ‘tell’ the motors what they are allowed to do.” Ex. 1005, [0065]. *Coli* further discloses the necessity for monitoring VFD and motor operations. Ex. 1005, [0066]. *Coli* explains that because “electric motors are controlled by variable frequency drives . . . the control software and variable frequency drives [“VFD”] calculate a maximum current available to the motors.” Ex. 1005, [0065]. *Toshiba Manual* discloses further details about these features described by *Coli*. See Ex. 1006.

153. A POSITA would have been motivated to combine *Toshiba Manual* with *Coli* for *Toshiba Manual*’s express disclosure of VFD control and monitoring of parameters of the electric motor in *Coli*, such as current, voltage, speed, temperature, torque, and load, and use the diagnostic functionality of *Toshiba Manual* (e.g., the alarms and fault trips) in order to prevent damage to the electric motor. Ex. 1006 at 179; see Ex. 1006 at 182-85 (Table 12, listing trips from diagnostics). The results of the combination would have been predictable and obvious to a POSITA.

154. Furthermore, a POSITA would have been motivated to combine *Toshiba Manual* with *Coli* to include the power semiconductor heat sinks having thermal sensors in order to prevent overheating of the IGBT power electronics. The results of the combination would have been predictable and obvious to a POSITA.

155. In my opinion, a POSITA would have been motivated to simply substitute the VFD of *Coli* for the VFD of *Toshiba Manual* that has the diagnostic functionality and temperature monitoring to prevent damage, without affecting the other functionalities of *Coli*.

Experts Agree That Heat Must be Dissipated from VFDs

- Petitioner's expert

87. It has long been known that power semiconductor devices generate substantial heat that must be dissipated (i.e., the devices must be cooled) in order to prevent damage to the devices. This is particularly true for semiconductor devices used in power applications. Even for the earliest semiconductor devices—namely, transistors—it was generally understood that heatsinks were needed. In fact, in most applications (for example, those described herein), the author simply assumed that the user knew that a heat sink would be necessary.

95. These are only a few examples of the ubiquitous nature of heat sinks and power electronics. A POSITA would have recognized that the use of heat sinks and thermal sensors (such as thermocouples) to monitor and control forced cooling devices (pumps, fans, etc.) would help to maintain a safe temperature for the power electronics. Even an ordinary user of basic power semiconductor devices, such as a computer or mobile phone charger, recognizes that use of these devices generates heat which must be dissipated (allowed to cool) to prevent damage to the electronics, and that often, this heat is dissipated from the heat sinks using forced cooling methods such as fans.

Experts Agree That Heat Must be Dissipated from VFDs

- PO’s current expert concurs

5	Q Do you agree the purpose of the
6	heat sink that's described in this and in
7	Exhibit 1006 is to dissipate heat from
8	the VFD?
9	A It's dissipating heat indeed.
10	Q Do you agree a person of skill
11	in the art would understand that this
12	adjustable speed drive needs to be cooled
13	to a certain level to function properly?
14	A This particular drawing that we
15	are showing here?
16	Q Yes.
17	A Well, by default, this already
18	has a heat sink, so somebody thought that
19	this would be necessary, that's why they
20	built it this way indeed.

Experts Agree That Heat Must be Dissipated from VFDs

- PO’s prior expert concurs

10	Q. And would you agree that one of the
11	known problems with VFDs and their power
12	electronics is that VFDs produce heat?
13	A. Well, anything like that would
14	produce heat.
15	Q. Correct.
16	Any -- any kind of electronics, for
17	that matter, produce heat, right?
18	A. Yes. Yes.
19	Q. And so it was known that, in the
20	context of the power semiconductors for VFDs,
21	that the excessive heat needs to be removed to
22	prevent damage to the -- to the VFD.
23	A. Well, that's -- that's certainly
24	good practice.

7	Q. And, in fact, in reference to heat
8	sinks used with power semiconductors in
9	variable frequency drives, those -- heat sinks
10	were a widely known technology, correct?
11	A. Yes.
12	Q. And, in fact, in the last
13	paragraph -- the last sentence: "Heat sinks
14	are used throughout industry and are prevalent
15	in electronic devices, such as the 'power
16	semiconductor' described in the claim
17	limitation."
18	You would agree that, by November
19	of 2012, heat sinks were prevalent with power
20	semiconductors and used throughout industry.
21	A. In general, yes.

Toshiba Manual's VFD Need Not Reach Coli's Exemplary 2500 HP

- Coli's 2500-hp pump is merely exemplary

[0049] In the illustrative embodiment of FIG. 3, trailer 10 can house four fracturing modules 20, along with a transformer and drive unit 50. In this particular configuration, each single trailer 10 provides more pumping capacity than four of the traditional diesel powered fracturing trailers 5 of FIG. 1, as parasitic losses are minimal in the electric fracturing system compared to the parasitic losses typical of diesel fueled systems. For example, a conventional diesel powered fluid pump is rated for 2250 hp. However, due to parasitic losses in the transmission, torque converter and cooling systems, diesel fueled systems typically only provide 1800 hp to the pumps. In contrast, the present system can deliver a true 2500 hp directly to each pump 22 because pump 22 is directly coupled to electric motor 21. Further, the nominal weight of a conventional fluid pump is up to 120,000 lbs. In the present operation, each fracturing module 20 weighs approximately 28,000 lbs., thus allowing for placement of four pumps 22 in the same physical dimension (size and weight) as the spacing needed for a single pump in conventional diesel systems, as well as allowing for up to 10,000 hp total to the pumps. In other embodiments, more or fewer fracturing modules 20 may be located on trailer 10 as desired or required for operational purposes.

- Combination need not work with every embodiment of Coli to find a motivation to combine.
 - “A reference must be considered for everything that it teaches, not simply the described invention or a preferred embodiment.” *In re Applied Materials, Inc.*, 692 F.3d 1289, 1298 (Fed. Cir. 2012).
 - “On the issue of obviousness, the combined teachings of the prior art as a whole must be considered.” *EWP Corp. v. Reliance Universal Inc.*, 755 F.2d 898, 907 (Fed. Cir. 1985).

Using Multiple Toshiba VFDs in Parallel with Coli's Pump Is Not a New Argument

- Petition and expert declaration: POSITA would have been motivated to substitute Coli's VFD for Toshiba's VFD

For example, a POSITA would have been motivated to simply substitute the VFD of *Coli* for the VFD of *Toshiba Manual* that has the diagnostic functionality and temperature monitoring to prevent damage, without affecting the other functionalities of *Coli*. Ex. 1002, ¶¶155, 158;

155. In my opinion, a POSITA would have been motivated to simply substitute the VFD of *Coli* for the VFD of *Toshiba Manual* that has the diagnostic functionality and temperature monitoring to prevent damage, without affecting the other functionalities of *Coli*.

Using Multiple Toshiba VFDs in Parallel with Coli’s Pump Is Not a New Argument

- PO deposes Petitioner’s expert about the substitution

3 Q So my question is, would the following statement be
4 true: A POSITA would have been motivated to simply
5 substitute the VFD of Coli described in paragraph 49
6 in part of the present system for the VFD described
7 in the Toshiba Manual without affecting the other
8 functionalities of Coli?
9 MS. FLANNERY: Object to form.
10 A Yes, that sentence would still be accurate.

2 A Well, my testimony was there's not a VFD described
3 in paragraph 49, but the statement as a whole is
4 still accurate.
5 Q Okay. And why is that?
6 A Well, it's because the Toshiba Manual VFDs for one
7 reason can be paralleled. You can run multiple
8 VFDs to control a single motor, and that would
9 increase the capability of the VFD system above the,
10 for example, 800 horsepower in Exhibit 1047.
11 Q And would a person of skill in the art in the
12 2010/2012 time period, would they have understood
13 how to arrange multiple VFDs from the Toshiba Manual
14 that way?
15 A Yes, it would.

Using Multiple Toshiba VFDs in Parallel with Coli’s Pump Is Not a New Argument

- Petition and expert declaration

For example, a POSITA would have been motivated to simply substitute the VFD of *Coli* for the VFD of *Toshiba Manual* that has the diagnostic functionality and temperature monitoring to prevent damage, without affecting the other functionalities of *Coli*. Ex. 1002, ¶¶155, 158;

155. In my opinion, a POSITA would have been motivated to simply substitute the VFD of *Coli* for the VFD of *Toshiba Manual* that has the diagnostic functionality and temperature monitoring to prevent damage, without affecting the other functionalities of *Coli*.

- Petitioner’s Reply

A. **A POSITA would have substituted *Coli*’s VFD for *Toshiba Manual*’s VFD.**

PO questioned Dr. Durham about this substitution but again takes his testimony out of context to suggest that *Toshiba Manual*’s VFD would not work with *Coli* based on *Coli*’s horsepower requirements. POR 22-23. Dr. Durham never stated that Toshiba’s VFD lacks the necessary horsepower for *Coli*’s pump. Instead, PO asked whether a *single* Toshiba VFD (having up to 1040 hp) is compatible with one example of a 2500-hp pump in *Coli*. But neither *Coli* nor the ’870 Patent requires using only a *single* VFD, and PO’s attempt to require a one-for-one substitution imposes an improper bodily incorporation requirement. *In re Mouttet*, 686 F.3d 1322,

Outline of Arguments

- I. Overview of the '870 Patent
- II. Summary of the Grounds
- III. Overview of the Dispute
- IV. Claims 1-6: "Electric Motor Diagnostics" (Grounds 1 & 2)
- V. Claims 1-16: Motivation to Combine Coli & Toshiba Manual (Ground 1)
- VI. Claims 7-16: "Heat Sinks Having Thermal Sensors" (Grounds 1 & 3)**
- VII. Dependent Claims 13, 15, 16 (Grounds 1 & 3-5)

Claims 7-16: “Heat Sinks Having Thermal Sensors...” (Grounds 1 & 3)

A. Ground 3:

- 1. Loucks Is Analogous Art**
- 2. Loucks Discloses “Thermal Sensors Monitored ... To Prevent Damage Caused by Excessive Heat”**
- 3. A POSITA Would Have Been Motivated to Combine Coli and Loucks**

B. Ground 1: Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

Claims 7-16: “Heat Sinks Having Thermal Sensors...” (Grounds 1 & 3)

A. Ground 3:

- 1. Loucks Is Analogous Art**
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3. A POSITA Would Have Been Motivated to Combine Coli and Loucks

B. Ground 1: Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

Loucks Is Analogous Art

- Loucks is reasonably pertinent to the problem addressed in the '870 Patent

Based on the present record, we conclude Loucks is reasonably pertinent to a particular problem facing the inventors of the '870 patent. As discussed in Section III.E.2(iii) above, the overall problem faced by the inventors of the '870 patent was how to implement a hydraulic fracturing operation using electric motors to drive the fracturing fluid pumps rather than diesel pumps, and one particular aspect of that problem was how to use a VFD to drive the electric motors. *See* Ex. 1001, 1:24–26, 1:52–54, 2:5–7, 2:21–22, 4:8–25. Loucks is reasonably pertinent to those problems, because it discusses the need to cool VFDs and provide methods for doing so. *See* Section III.F.1 *supra* (summarizing Loucks's disclosures).

Loucks Is Analogous Art

- Petitioner’s expert testimony supports that Loucks is relevant to problem in ‘870 Patent

132. *Loucks* teaches that the cooling calculations are applied to various electrical equipment including “transformers, circuit breakers, uninterruptible power supplies (UPSs) or variable frequency drive.” These pieces of electrical equipment are examples in which “a certain percentage of energy consumed is converted into heat.” Ex. 1009, [0036]. *Loucks*’ method “detects changes in cooling performance” in order to prevent “electrical equipment malfunction or accelerated degradation” and “equipment damage” due to “overheated equipment.” Ex. 1009, [0004], [0018], [0003]. *Loucks* teaches that because “electrical or electronic equipment can malfunction due to over-temperature, detecting these [temperature] problems is important.” This is particularly true “for a variable loaded system.” See Ex. 1009,

[0018]. If temperature problems are not detected in a timely manner, “equipment damage [may] occur[] in the time it takes to resolve the cooling problem.” Ex. 1009, [0018]. Accordingly, in my opinion, a POSITA would have understood that *Loucks* teaches a method for preventing damage to electrical equipment due to overheat.

Loucks Is Analogous Art

- Petitioner’s expert testimony supports that Loucks is relevant to problem in ‘870 Patent

235. A POSITA would have been motivated to use *Loucks*’ method and equipment—including the “heat sink temperature sensor 510” monitored by “computer 700,” which includes a processor 702 and cooling efficiency logic 730—in order to protect against thermal degradation and damage to the VFD of *Coli*. This is particularly the case when it was well understood that power semiconductor components of a VFD require cooling to prevent damage caused by overheating, a problem addressed by the use of heat sinks long before the ‘870 Patent. *See supra* Section VIII. Particularly in view of *Loucks*’ applications to VFDs, a POSITA would have been motivated to look to *Loucks*’ heat sinks and temperature sensors and employ *Loucks*’ cooling efficiency monitoring techniques to “detect problems” with *Coli*’s VFD “before temperatures reach alarm limits” and to ensure that it does not “malfunction” or suffer from “accelerated equipment degradation and early failure.” Ex. 1009, [0018].

238. A POSITA would have a reasonable expectation of success in combining *Coli* with *Loucks* because VFD technology and protecting VFDs from damage caused by overheating was well known before the ‘870 patent. *See supra* Section VIII. In my opinion, a POSITA would have a reasonable expectation of success in combining *Coli* and *Loucks* by adding the heat sink, temperature sensors, and processor (including microprocessor(s)) of *Loucks* into the VFD of *Coli* in order to detect cooling problems and prevent damage to the electrical and electronic equipment of *Coli*’s VFD from overheating. A POSITA would have had a reasonable expectation of success because such a combination is simply using a known technique to improve a similar system in the same way. Furthermore, a POSITA would have had a reasonable expectation of success because such a combination is nothing more than an application of a known technique to a known device ready for improvement to yield predictable results.

Loucks Is Analogous Art

- PO's expert: Loucks is not analogous because it does not describe "portable" equipment

and/or data centers. EX-1009, [0018]; [0024]; [0026]. Because *Loucks* does not describe any portable equipment, it is my opinion that an inventor considering the problem addressed in the '870 patent would not be motivated to turn to *Loucks* at the time of the invention, particularly given that *Loucks* addresses a fundamentally different problem (detecting cooling problems in an environment for room containing electrical equipment, such as server IT equipment) than the problem addressed in the '870 Patent (problems associated with portable VFDs and electric motors replacing portable diesel-powered pumps). An inventor considering these

Loucks Is Analogous Art

- PO’s expert’s testimony is unsupported by the record

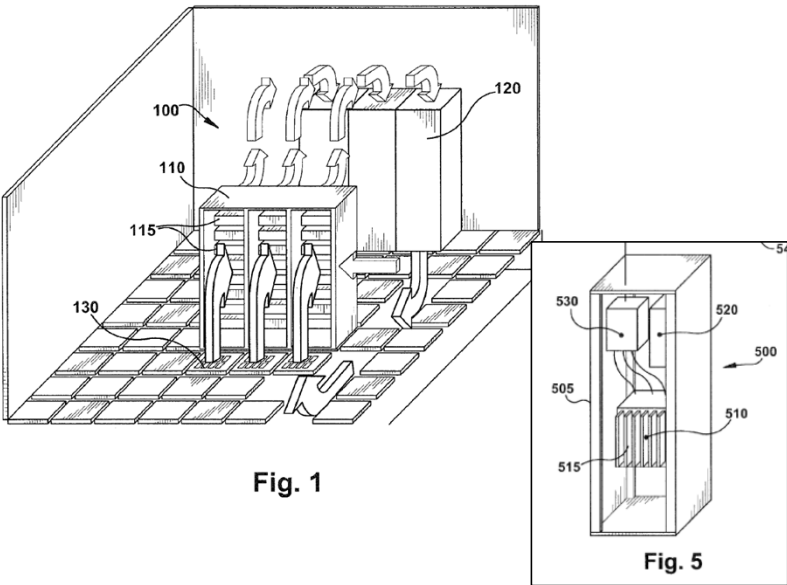
5	Let's look at Claim 7, which I
6	think is conveniently on the screen here
7	on the right.
8	Is there anything in Claim 7
9	that suggests to you the elements of this
10	claim, the pump, the electric motor, the
11	VFD, that those have to be portable?

1	Okay. So on that Claim 7, I
2	don't see any text that talks about
3	portability.

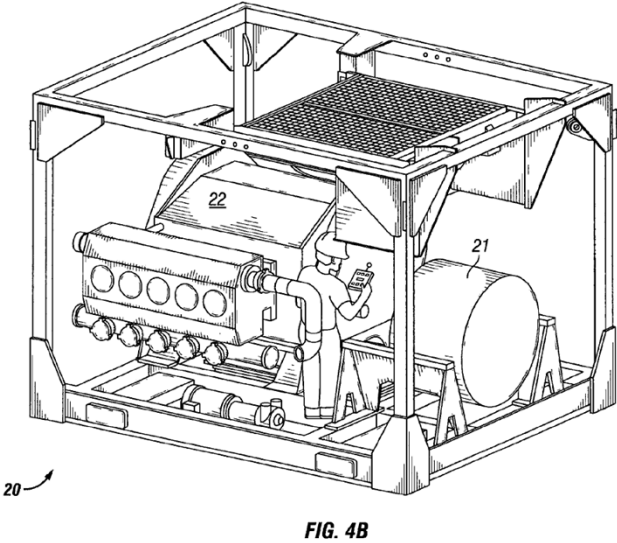
Loucks Is Analogous Art

- PO's expert's testimony is unsupported by the record

Loucks



Coli



Claims 7-16: “Heat Sinks Having Thermal Sensors...” (Grounds 1 & 3)

A. Ground 3:

- 1. Loucks Is Analogous Art
- 2. **Loucks Discloses “Thermal Sensors Monitored ... To Prevent Damage Caused by Excessive Heat”**
- 3. A POSITA Would Have Been Motivated to Combine Coli and Loucks

B. Ground 1: Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

Loucks Discloses “Thermal Sensors Monitored ... To Prevent Damage Caused by Excessive Heat”

VII.A.5.iv, VII.B.2-3. *Loucks* discloses “a cooling efficiency method” that can be applied specifically to VFDs and includes monitoring a “power electronics heat sink temperature sensor 510.” Ex. 1009, [0063]; *see also* [0003] (“Traditional methods of detecting [overheating] problems including ... measuring the temperature of inlet air, exhaust air, heat sinks, or other areas of equipment.”). A computer 700, including a processor 702 and cooling efficiency logic 730, uses data collected from the heat sink temperature sensor 510, “determin[es] a monitored electrical device temperature and an ambient temperature proximate the monitored electrical device to compute a temperature differential,” and calculates the cooling efficiency based in part on the differential. *Id.*, [0066]-[0068]; *see also* [0057] (“Logic may include a software controlled microprocessor.”). In doing so, *Loucks* teaches a cooling efficiency monitoring technique that “detect[s] problems before temperatures reach alarm limits” to prevent equipment damage, accelerated degradation, and early failure. *Id.*, [0018].

architectures.” *Id.*, [0072]. The cooling efficiency logic 730 computes a “temperature differential between the temperature of the monitored device and the ambient temperature, and uses that differential to calculate an “operating cooling efficiency indicator.” *Id.*, [0008], [0068]-[0070].

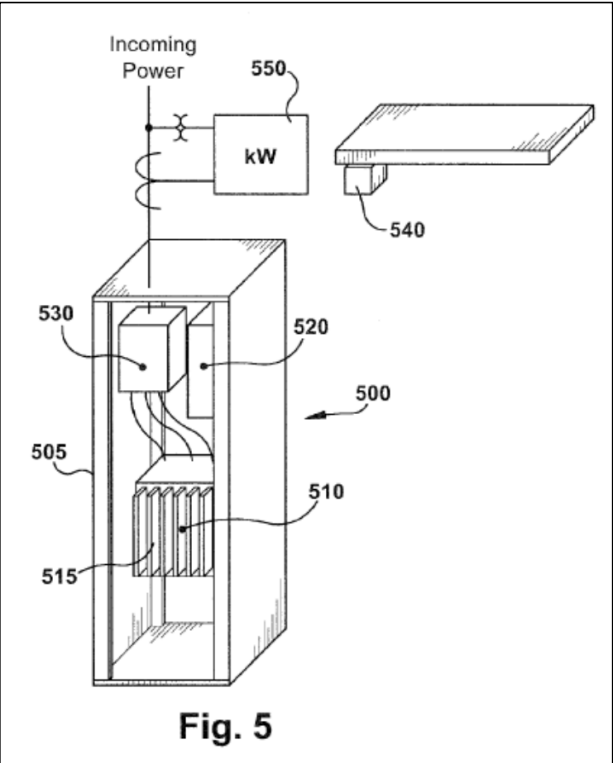
Loucks Discloses “Thermal Sensors Monitored ... To Prevent Damage Caused by Excessive Heat”

- PO’s Sur-reply: Loucks does not monitor temperature
- Loucks: measuring temperature with a temperature sensor

Petitioner misunderstands Patent Owner’s argument regarding *Loucks*. See Reply, 18. *Loucks* does not monitor **temperature** (i.e., against excessive heat) but rather a **cooling efficiency**, which itself is not derived from temperature but rather a **temperature differential**. Petitioner misses the point that *Loucks* discusses “indirectly measuring cooling performance by way of a cooling efficiency indicator” where “[a]n operating cooling efficiency indicator is **calculated** as a ratio between equipment electrical power consumption and a temperature differential between the equipment and an ambient temperature.” EX-1009, Abstract (emphasis added). Because *Loucks* is directed toward the temperature differential, it does not teach “heat sinks having thermal sensors . . . to prevent damage caused by excessive heat” as required by the claim. See EX-1001, 8:35–37.

[0063] FIG. 5 illustrates a cooling efficiency monitoring system 500 that includes a single power consumption sensor 550 that monitors power input to an enclosure 505. Multiple temperature sensors are utilized, including a breaker trip unit temperature sensor 530, a power electronics heat sink temperature sensor 510, and a microprocessor temperature sensor 520 that are installed within the enclosure, as well as an ambient temperature sensor 540. Each temperature sensor within the enclosure is matched with an ambient sensor external to the enclosure and this, along with the kW input to the enclosure can be used to calculate the cooling efficiency indicator. For an enhanced calculation, each separate temperature sensor can be used to calculate a separate cooling efficiency indicator. The redundancy of the temperature sensors provides insights into how the equipment operates, specifically transport delay and detection of sensor calibration error.

Loucks Teaches Using the Disclosed Methods & Equipment in a VFD



[0015] FIG. 5 is a functional block diagram of cooling efficiency monitoring system installed on an equipment enclosure;

[0063] FIG. 5 illustrates a cooling efficiency monitoring system 500 that includes a single power consumption sensor 550 that monitors power input to an enclosure 505. Multiple temperature sensors are utilized, including a breaker trip unit temperature sensor 530, a power electronics heat sink temperature sensor 510, and a microprocessor temperature sensor 520 that are installed within the enclosure, as well as an ambient temperature sensor 540. Each temperature sensor

[0060] The cooling efficiency techniques and systems described herein may be used on any device that consumes electrical energy and exhausts waste heat. Examples of such devices include: circuit breakers (open or enclosed), fuses and fused switches, variable or adjustable frequency drives, reduced voltage soft starters, uninterruptible power supplies, transformers, electrical assemblies and structures including

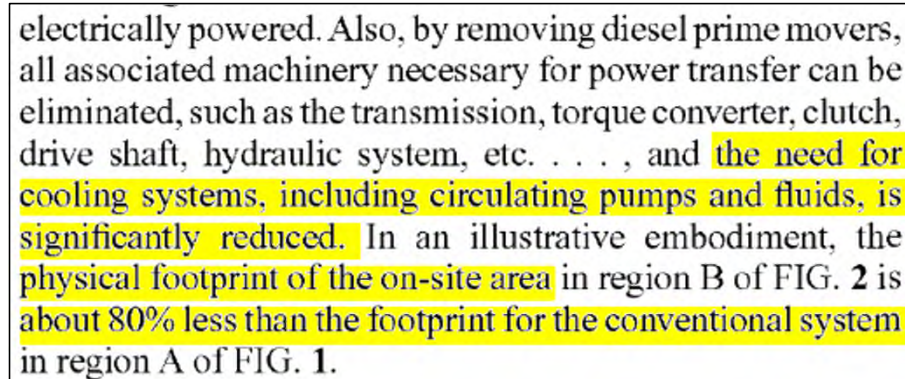
Claims 7-16: “Heat Sinks Having Thermal Sensors...” (Grounds 1 & 3)

A. Ground 3:

1. Loucks Is Analogous Art
2. Loucks Discloses “Thermal Sensors Monitored ... To Prevent Damage Caused by Excessive Heat”
3. **A POSITA Would Have Been Motivated to Combine Coli and Loucks**

B. Ground 1: Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

- Coli does not teach away from using all cooling systems



Coli Does Not Teach Away From Loucks

- Coli does not teach away from Loucks’ cooling systems

95. These are only a few examples of the ubiquitous nature of heat sinks and power electronics. A POSITA would have recognized that the use of heat sinks and thermal sensors (such as thermocouples) to monitor and control forced cooling devices (pumps, fans, etc.) would help to maintain a safe temperature for the power electronics. Even an ordinary user of basic power semiconductor devices, such as a computer or mobile phone charger, recognizes that use of these devices generates heat which must be dissipated (allowed to cool) to prevent damage to the electronics, and that often, this heat is dissipated from the heat sinks using forced cooling methods such as fans.

237. Accordingly, a POSITA would have been motivated to incorporate the heat sink (and associated temperature sensors and temperature monitoring by a microprocessor) as taught in *Loucks* into the variable frequency drive described in *Coli* to prevent damage caused by excessive heat, without affecting the other functionalities in *Coli*. Such a combination represents the application of a known

Coli Does Not Teach Away From Loucks

- The Board's earlier decision relating to the Coli-Stark combination is not relevant to combining Coli with Loucks
 - Stark includes a heat sink cooled by fluid refrigerant
 - Coli relates to an air-cooled heat sink

Claims 7-16: “Heat Sinks Having Thermal Sensors...” (Grounds 1 & 3)

A. Ground 3:

- 1. Loucks Is Analogous Art
- 2. Loucks Discloses “Thermal Sensors Monitored ... To Prevent Damage Caused by Excessive Heat”
- 3. A POSITA Would Have Been Motivated to Combine Coli and Loucks

B. Ground 1: Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

PO's Construction Requiring the Thermal Sensors To Be Located On the Heat Sink Is Not Supported

Claim 7: "one or more power semiconductor heat sinks having thermal sensors..."

- Intrinsic evidence is silent on where the thermal sensors are located
- Institution Decision requires only that heat sink is associated with the thermal sensor

Thus, based on the present record, Petitioner's assertion that Toshiba Manual inherently associates its heat sinks with its thermal sensors is not supported by the evidence.

However, that testimony at best establishes that Toshiba Manual's heat sink might possibly have an associated thermal sensor, not that it necessarily does. Further, Loucks's disclosure of various locations for thermal sensors within electronic equipment belies any such necessity.

PO's Construction Requiring the Thermal Sensors To Be Located On the Heat Sink Is Not Supported

Claim 7: "one or more power semiconductor heat sinks having thermal sensors..."

- PO Surreply at 5:

Petitioner's new evidence, a citation to EX-1007pt2, 251,³ should be disregarded as untimely. Regardless, this new evidence still does not show the heat sink of *Toshiba* having a thermal sensor. At most, it only shows *Toshiba's* heat sink is **associated** with the thermistor, which is not the claim's requirement.

Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

The heat sink and other components may become extremely hot to the touch. Allow the unit to cool before coming in contact with these items.

EOI Display	Function	Description	Possible Causes
*OH	Overheat	ASD ambient temperature excessive.	• ASD is operating at an elevated temperature. • ASD is too close to heat-generating equipment. • Cooling fan vent is obstructed (see Mounting the ASD on pg. 18). • Cooling fan is inoperative. • Internal thermistor is disconnected.

Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

- Schematics published with Toshiba Manual associate the thermistor with the heat sink

PAGE No.	DEVICE	DESCRIPTION	TOSHIBA, MODEL 100A		TOSHIBA, MODEL 1100A	
			TYPE FORM	TYPE FORM	TYPE FORM	TYPE FORM
8	(1) MCCB1	MOLDED CASE SWITCH	SQD PUL3600S12-RE10			
	8FU1, 2	CPT1 PRIMARY FUSE	CRF ATQR 6			
	8FU3	CPT1 SECONDARY FUSE	GLD TRM 12			
	FR, FS, FT	SEMICONDUCTOR FUSE	CRF 6,9URD33TTF0700			
	BF1	BLOWN FUSE INDICATOR	CRF MS3V1-SBS			
	CPT1	CNTL. PWR. TRANSFORMER	GTI			
	ACL1~3	OUTPUT LINE REACTOR	TCI KDRG1C			
	HCTU, V, W	HALL CT	LEM HAX1000-S			
9	MS1	SOFT START CONTACTOR	TMQ LC1F4004U7			
	MS2	CAP DISCHARGE CONTACTOR	CLK 7001-5150-21			
	OH1T~3T	T-STAT 75°C FIXED N.C.	TKN OHD3-75B			
	OH1B~3B	T-STAT 90°C FIXED N.C.	TKN OHD3-90B			
	THR1	HEATSINK THERMISTOR	FEN 590-32BP01-203			
	R1	SOFT START RESISTOR	PWO WR33			
	R2	CAP DISCHARGE RESISTOR	PWO SXR2-500			
	REC1M~6M, 1A~6B	DIODE PACK	EUP DD600N16K			
	SA1~3	SURGE SUPPRESSOR	EPC B40K750			

– See *Hospira, Inc. v. Fresenius Kabi USA, LLC*, 946 F.3d 1322, 1329 (Fed. Cir. 2020) (“Extrinsic evidence can be used to demonstrate what is ‘necessarily present’ in a prior art embodiment even if the extrinsic evidence is not itself prior art.”)

Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

- Ex. 1007 is not new evidence
 - Cited in Petition

Toshiba Manual further discloses operating a VFD with the ability to “perform diagnostics.” Ex. 1007 at 43. The diagnostics includes a “fault screen” that “identifies the active Fault.” *Id.* at 182–186 (Table 12, containing a list of 5 pages of faults that are diagnosed). *Toshiba Manual* further discloses that the variable frequency drive performs electric motor diagnostics to prevent various types of damage to the electric motor, including protecting against overload, overcurrent, overtorque, short circuit, and earth faults. Ex. 1007 at 162; Ex. 1002 ¶¶117, 150,

Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

- Ex. 1007 is not new evidence
 - Cited in Petitioner's expert declaration

A POSITA would have reviewed the Toshiba website and product listings to learn about product offerings and VFD functionality. Ex. 1002, ¶¶ 113-114.

The Toshiba website published schematics of the power electronics to accompany *Toshiba Manual*, and they confirm the presence of an IGBT output converter using the same configuration as in *Horikoshi*.

Ex. 1007 (Internet Archive Declaration) p. 254. *Toshiba Manual* is directed toward the same ASD/VFD topology described in *Horikoshi*.

Toshiba Manual Discloses “Heat Sink Having Thermal Sensors”

- Ex. 1007 is not new evidence
 - Cited in Petitioner's expert declaration

iii. *Thermal Monitoring Heat Sinks*

120. As discussed above, *Toshiba Manual* discloses a VFD with a rectifier circuit and an inverter circuit (AC-DC-AC converter) to convert fixed-frequency input electricity to DC and then to constant-frequency AC. Ex. 1006 at 36. The inverter and rectifiers are examples of “power semiconductors.” *Toshiba Manual* discloses that the VFD contains heat sinks: “The heat sink and other components may become extremely hot to the touch.” Ex. 1006, at 14; *see also* at Ex. 1006 at 204 (“cooling capacity of the heatsink”).²

² Photographs of the heat sinks are shown in the brochure accompanying the *Toshiba Manual*. The Heat sinks are located so as to dissipate heat “out-the-back” of the cabinet of the VFD, which also includes a “Long Life 1200 cfm Front-Removable Heatsink Fan.” Ex. 1007, at p. 20.

Toshiba Manual Also Renders Obvious “Heat Sink Having Thermal Sensors”

87. It has long been known that power semiconductor devices generate substantial heat that must be dissipated (i.e., the devices must be cooled) in order to prevent damage to the devices. This is particularly true for semiconductor devices used in power applications. Even for the earliest semiconductor devices—namely, transistors—it was generally understood that heatsinks were needed. In fact, in most applications (for example, those described herein), the author simply assumed that the user knew that a heat sink would be necessary.

95. These are only a few examples of the ubiquitous nature of heat sinks and power electronics. A POSITA would have recognized that the use of heat sinks and thermal sensors (such as thermocouples) to monitor and control forced cooling devices (pumps, fans, etc.) would help to maintain a safe temperature for the power electronics. Even an ordinary user of basic power semiconductor devices, such as a computer or mobile phone charger, recognizes that use of these devices generates heat which must be dissipated (allowed to cool) to prevent damage to the electronics, and that often, this heat is dissipated from the heat sinks using forced cooling methods such as fans.

Toshiba Manual Also Renders Obvious “Heat Sink Having Thermal Sensors”

- PO’s expert: heat sink is a possible location for thermal sensor within Toshiba Manual’s VFD

63. Although I agree with Dr. Durham that *Toshiba Manual* discloses both a heat sink, EX-1006, 14, and an internal thermistor, EX-1006, 180, I disagree that a POSITA would have understood that the heat sinks “would necessarily have sensors (e.g., thermistors) to report the temperature measurements.” The internal thermistor could be placed in various internal locations of *Toshiba Manual’s* GX7, one of which may be located on the heat sink. But, at least in view the disclosure of Loucks, it is not always “necessarily true” that the internal thermistor is located on the heat sink for the reasons I explain below.

Uber Techs., Inc. v. X One, Inc., 957 F.3d 1334, 1340 (Fed. Cir. 2020) (claimed order of steps was a “simple design choice” where prior art taught the other order)

“Heat Sink Having Thermal Sensors” Being Obvious Is Not a New Argument

- A petitioner's reply must be responsive to arguments either “raised in the patent owner's response brief” or “originally raised in [the] petition.”
 - *Apple Inc. v. Andrea Elecs. Corp.*, 949 F.3d 697, 705–06 (Fed. Cir. 2020).
- Reply is based on same arguments and evidence in the Petition
 - Same ground: Claim 7 would have been obvious in light of Toshiba Manual
 - Same evidence: Dr. Durham's testimony that monitoring the temperature of heat sinks was known and that the heat sink is the main heat dissipating device
- Reply is responsive to PO Response
 - PO asserted that the thermal sensors must be located on the heat sink
 - Reply demonstrated that this location would be obvious

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- VI. Claims 7-16: "Heat Sinks Having Thermal Sensors" (Grounds 1 & 3)
- VII. Dependent Claims 13, 15, 16 (Grounds 1 & 3-5)**

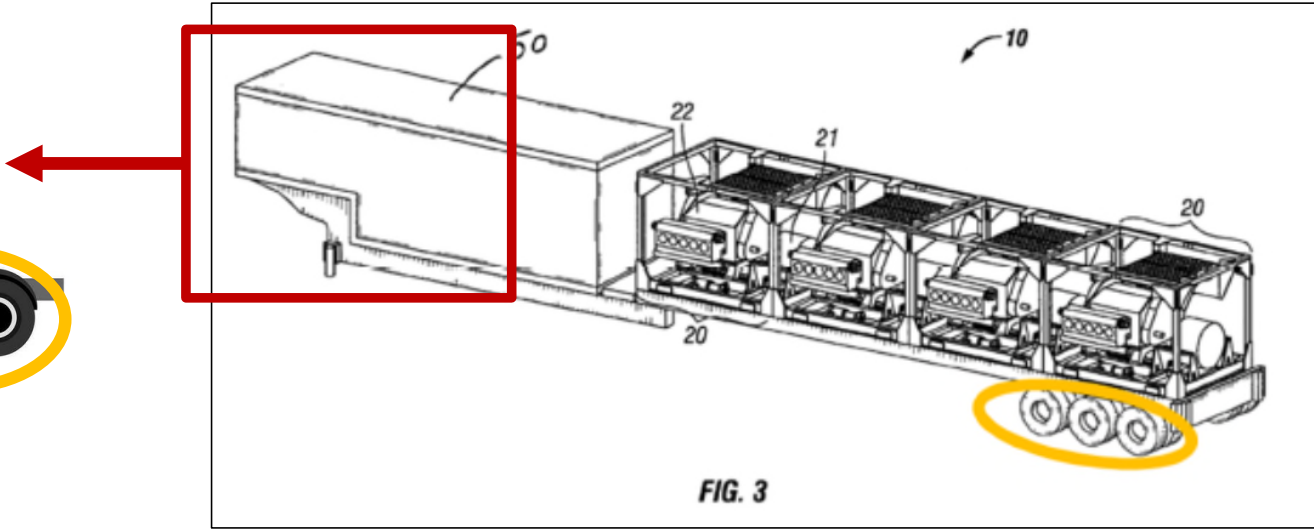
Claim 13: “A Truck Having At Least Five Axles”

12. The system of claim 9, wherein the pump, electric motor, and generator are mounted on a vehicle, and can be ported from one well to another.

13. The system of claim 12, wherein the vehicle is a truck having at least five axles.

Claim 13: “A Truck Having At Least Five Axles”

- Coli discloses to a POSITA that “the vehicle is a truck having at least five axles”



Claim 13: “A Truck Having At Least Five Axles”

- Petitioner's expert: a unitary “truck having at least five axles” would have been obvious

199. Additionally, a “unitary” truck with five axles would have been obvious to a POSITA in view of this disclosure of a three axle semi-trailer intended to be attached to and pulled by a tractor (commonly referred to collectively as a “tractor-trailer truck,” a “semi-trailer truck,” and a “semi-truck”) because a POSITA would have known that the semi-trailer portion could be permanently attached to the tractor portion of the truck instead of as a detachable trailer, as is done with many commercial trucks.

200. Furthermore, a POSITA would have understood that the number of axles used on a vehicle is a simple design choice, with the number of axles to use being determined based on the amount of load that is supported by the axles. I further understand that the Board found a substantially similar claim of the '601 Patent to be disclosed by *Coli*. Ex. 1048 at 43. Accordingly, *Coli* discloses or at least renders obvious claim 13.

Claim 15: An Electric Motor Having “A Maximum Continuous Power Output of About 1750 Brake Horsepower or More”

end. Ex. 1002, ¶139. *Gardner* discloses that the GD-2500Q is a quintuplex pump with a “Stroke Length” of “8.0 inches,” and a “plunger size” (diameter) of “3.75, 4, 4.5, 5, 5.5, 5.75, 6, 6.5, [or] 6.75” inches. Ex. 1011, 14. In addition, *Gardner* discloses that the input power to the pump, which is the same as the output power of the electric motor coupled to the pump, is 2200 or 2500 bhp.” *Id.* *Gardner* also discloses that the pump is rated at 2500 bhp. *Id.*

capable of operating at 2500 hp.”). Because the motor of *Coli* delivers 2500 hp to the pump, a POSITA would have understood that the pump must be rated for at least that amount of delivered power. Ex. 1002, ¶258. Furthermore, *Gardner* expressly discloses that the SWGS-2500 pump is rated at 2500 hp. Ex. 1011 at 14; see Ex. 1001, ¶¶139-146; Ex. 1018. A POSITA would have understood that *Coli* in view of *Gardner* at least renders obvious “wherein the pump is a triplex or a quinteplex pump rated at about 2250 horsepower or more.” Ex. 1002, ¶259; Ex. 1048 at 40.

- Petition Grounds 5A-5B: *Gardner* discloses this element

146. In addition, a POSITA would have understood that *Gardner* discloses a plunger-type quintuplex pump for fracturing operations that includes an 8-inch stroke, 4.5-inch diameter plungers, and is rated at about 2250 (hydraulic) horsepower or more. Relatedly, a POSITA would have understood an electric motor coupled to the *Gardner* pump would be equipped to provide a maximum continuous power output of more than 1750 horsepower.

Claim 15: An Electric Motor Having “A Maximum Continuous Power Output of About 1750 Brake Horsepower or More”

- Coli discloses claim 15

[0049] In the illustrative embodiment of FIG. 3, trailer 10 can house four fracturing modules 20, along with a transformer and drive unit 50. In this particular configuration, each single trailer 10 provides more pumping capacity than four of the traditional diesel powered fracturing trailers 5 of FIG. 1, as parasitic losses are minimal in the electric fracturing system compared to the parasitic losses typical of diesel fueled systems. For example, a conventional diesel powered fluid pump is rated for 2250 hp. However, due to parasitic losses in the transmission, torque converter and cooling systems, diesel fueled systems typically only provide 1800 hp to the pumps. In contrast, the present system can deliver a true 2500 hp directly to each pump 22 because pump 22 is directly coupled to electric motor 21. Further, the nominal weight of a conventional fluid pump is up to 120,000 lbs. In the present operation, each fracturing module 20 weighs approximately 28,000 lbs., thus allowing for placement of four pumps 22 in the same physical dimension (size and weight) as the spacing needed for a single pump in conventional diesel systems, as well as allowing for up to 10,000 hp total to the pumps. In other embodiments, more or fewer fracturing modules 20 may be located on trailer 10 as desired or required for operational purposes.

- Petitioner’s expert: a POSITA would understand Coli’s disclosure as “continuous”

203. *Coli* discloses that the motor “can deliver a true 2500 hp directly to each pump 22 because pump 22 is directly coupled to electric motor 21.” Ex. 1005, [0049]. Accordingly, a POSITA at the time the ’870 Patent was filed would have recognized that *Coli* discloses the “electric motor has a maximum continuous power output of about 1750 horsepower or more.” I further understand that the Board found a substantially similar claim of the ’601 Patent to be disclosed by *Coli*. Ex. 1048 at 41.

Claim 15: An Electric Motor Having “A Maximum Continuous Power Output of About 1750 Brake Horsepower or More”

- Coli discloses claim 15
 - PO: “continuous” requires some period of time
 - PO: “a long period of time” (POR at 52; Ex. 2002 (Nikolaou Decl. ¶112))
 - The duration of the fracturing operation
 - Coli discloses operating at 2500 hp “during fracturing operation”

28. The fracturing module of claim 27, wherein the fracturing module has dimensions of no greater than 136" width×108" length×100" height and the AC permanent magnet motor is capable of operating at 2500 hp during fracturing operations.

Claim 16: An Electric Motor Having a “Maximum Continuous Torque of About 8750 lb-ft or More”

- Coli discloses claim 16
- Petitioner’s expert: a POSITA would understand Coli’s disclosure as “continuous”

[0011] In certain illustrative embodiments, the electric motor can be an AC permanent magnet motor and/or a variable speed motor. The electric motor can be capable of operation in the range of up to 1500 rpms and up to 20,000 ft/lbs of torque. The pump can be a triplex or quintiplex plunger style fluid pump.

27. A fracturing module for use in delivering pressurized fluid to a wellbore, the fracturing module comprising:
an AC permanent magnet motor capable of operation in the range of up to 1500 rpms and up to 20,000 ft/lbs of torque; and
a plunger-style fluid pump coupled to the motor.

204. *Coli* discloses that the “electric motor can be capable of operation in the range of up to 1500 rpms and up to 20,000 ft/lbs of torque.”⁴ Ex. 1005, [0011]. Accordingly, a POSITA at the time the ’870 Patent was filed would have recognized that *Coli* discloses an “electric motor has a maximum continuous torque of about 8750 ft-lb or more.” I further understand that the Board found a substantially similar claim of the ’601 Patent to be disclosed by *Coli*. Ex. 1048 at 41-42.