IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Stephen Barbour	
U.S. Patent No.:	11/574,372	Attorney Docket No.: 54598-0001PS1
Issue Date:	February 7, 2023	
Appl. Serial No.:	16/484,728	
Filing Date:	January 6, 2020	
Title:	BLOCKCHAIN MINE AT OIL OR GAS FACILITY	

DECLARATION OF MICHAEL NIKOLAOU

I, Michael Nikolaou, declare as follows:

I. ASSIGNMENT

1. I have been retained on behalf of Crusoe Energy Systems, LLC. ("Crusoe" or "Petitioner") to offer technical opinions related to U.S. Patent No. 11/574,372 ("The '372 patent") (EX1001). I understand that Crusoe is requesting the Patent Trial and Appeal Board ("PTAB" or "Board") to institute a post-grant review ("PGR") proceeding of the '372 patent.

2. I have been asked to provide my independent analysis of the '372 patent in light of the prior art cited in this declaration. Crusoe has specifically asked for my analysis from the perspective of a POSITA in the gas and oil industry. To the extent this declaration provides opinions on subject matter related to bitcoin mining, I am relying on the opinions of Mr. Vernon Kasdorf (EX1004). To that end, I am relying on Mr. Kasdorf's review and analysis of CryptoKube, Szmigielski, Kheterpal, and Polivka – which are all identified as prior art herein.

3. I am not and never have been, an employee of Crusoe. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the '372 patent, the prior art cited below, and issues related thereto, and I will not receive any added compensation based on the outcome of this PGR or other proceeding involving the '372 patent.

II. QUALIFICATIONS

4. I am a Professor and Associate Chair of Chemical and Biomolecular Engineering in the Cullen College of Engineering at the University of Houston. I also have a joint appointment in the Petroleum Engineering Department at the University of Houston.

5. I graduated with a Diploma in Chemical Engineering from the National Technical University in Athens, Greece in 1984. I then earned a Ph.D. in Chemical Engineering at the University of California, Los Angeles in 1989. Prior to coming to the University of Houston, I

was an Assistant (and then Associate) Professor at Texas A&M University for eight years. After my promotion to Associate Professor and tenure at Texas A&M, I took a sabbatical leave as a Visiting Scientist at MIT in 1995. I have taught at the University of Houston for over twenty-five years, since 1997.

6. In my role as a Professor at the University of Houston I teach both undergraduate and graduate courses every year. At the undergraduate level, these courses include Analytical Methods for Chemical Engineers, Numerical Methods for Chemical Engineers, Plant Economics, Plant Design, Thermodynamics, Statistical Methods in Chemical Engineering, Statistical Quality Control Methods, and Chemical Process Control. At the graduate level, I teach Mathematical Methods in Chemical Engineering, Advanced Process Control, and Natural Gas Engineering. I also routinely advise both undergraduate and graduate (Master and Ph.D.) students.

7. I have extensive experience in process systems engineering and mathematical modeling. My research interests are in computer-aided systems engineering, i.e., development and use of computer-based methods for the design, optimization, monitoring, and automatic control of various kinds of systems, in a diverse array of industries.

8. In my over 30 years of academic and industrial consulting experience I have worked on problems in several industries, including the oil & gas industry and oil refining & petrochemicals. Much of my work tackles fundamental research issues and is described in a number of publications, as discussed below. A substantial portion of my work is directed to concrete solutions to problems faced by industrial partners and has resulted in specific commercial products (e.g. for Lam Research, https://www.lamresearch.com/), patents, and the formation (by the corresponding project's managers) of a small company that was eventually bought by Schlumberger, a major global oilfield services company

(http://www.slb.com/services/drilling/drilling_services_systems/directional_drilling/slider.aspx).

9. In addition to teaching, I have also served as a consultant for various oil and gas companies over the past twenty-seven years, working with both major companies and smaller, independent companies, both "upstream" (i.e., oil and gas exploration and production) and "downstream" (oil and gas transportation, oil refining, and chemicals). I have consulted on a variety of matters for ENI, Schlumberger, WildHorse / RotoSlide, Synergy Fluid Services, XGas/EPT, IQPC Oil & Gas, Intelligent Agents Corporation, Landmark / Halliburton, ECOPETROL, Lam Research, Shell Global Solutions, Noble Drilling, AspenTech, General Electric, Simulation Sciences, Bryan Research & Engineering, Frito-Lay, Shell Development, and Union Pacific Resources.

10. I have published over 150 peer-reviewed publications in journals and conference proceedings in the area of computer-aided systems engineering. My publications focus on applications to the design, optimization, monitoring, and automatic control of various kinds of systems, in oil & gas, oil refining & petrochemicals, snack food production, semiconductor manufacturing, and development and administration of antibiotics against resistant or persistent infections. Three of my refereed journal publications have been featured on the cover of high-impact journals (AIChE Journal, 2011; IEEE Control Systems Magazine, 2006; PLoS Computational Biology, 2011).

11. I have also presented my work as a speaker at numerous academic conferences, whether in regular sessions, invited sessions, or as a keynote speaker. As an example, I have been invited twice (in 1996 and 2011) to give presentations in the flagship conference on Chemical Process Control, held every five years (CPC-V and CPC-VIII); and was a keynote speaker at the 2017 International Petroleum & Petrochemical Technology Conference (IPPTC) in Beijing, China.

I have also published 5 book chapters on various aspects of computer-aided systems engineering. Finally, I serve regularly as a peer reviewer at several major engineering and scientific journals (including *Automatica, PLoS, AIChE Journal, SPE Journal, Journal of Process Control, Computers & Chemical Engineering*) as well as at federal and international funding agencies, including National Science Foundation (NSF), Petroleum Research Fund (PRF), National Institutes of Health (NIH), and the Qatar National Research Fund (QNRF).

12. I am a member of the American Institute of Chemical Engineers, the Society of Petroleum Engineers, and Omega Chi Epsilon. I serve as a co-organizer or co-chair of several major international conferences, including the AIChE Annual Meeting and the AIChE Spring Meeting.

13. I have received numerous teaching awards from both Texas A&M and University of Houston, including the Dow Excellence in Teaching Award, and the Cullen College of Engineering Teaching Excellence Award. I have also been named a Top Reviewer by *Automatica*, and, in 2007, I received the Computing & Systems Technology (CAST) Directors Award from the American Institute of Chemical Engineering. In 2017, I received the Abraham E. Dukler Distinguished Engineering Faculty Award at the University of Houston, which is given to faculty who have made significant contributions to society and whose accomplishments and careers have brought credit to the University of Houston Cullen College of Engineering. In 2019, I received the Fluor Corp. Faculty Excellence Award in the Cullen College of Engineering. This award is the highest distinction bestowed to faculty of this College.

14. My curriculum vitae, which includes a complete list of my publications, is included as Appendix A.

15. I am being compensated at a rate of $700 per hour for my work in this case. This

compensation is not contingent on the nature of my findings or the outcome of this litigation.

16. I have previously given testimony in the following cases:

a) *Eurecat U.S., Inc. v. Soren Marklund, Douglas Wene, and Chem 32 LLC*, Trial Ct. Cause No. 2012-5700, Harris Cty. Ct. (Tex).

b) *TDE Petroleum Data Solutions, Inc. v. AKM Enterprise, Inc. DBA Moblize, Inc.*, Case No. 4:15-cv-01821 (S.D. Tex. 2015).

c) *Arrona et al. v. Bluestone Natural Resources, LLC*, Case No. 4:15-cv-02680 (S.D. Tex. 2017).

d) *Sunoco Partner Marketing & Terminals L.P. v. Powder Springs Logistics, LLC, et al.,* Case No. 1:17-cv-01390 (D. Del. 2017).

e) *Magellan Midstream Partners L.P. v. Sunoco Partners Marketing & Terminals,* IPR2019-00024 (U.S. Patent No. 9,494,948).

f) *Magellan Midstream Partners L.P. v. Sunoco Partners Marketing & Terminals*, IPR2019-00025 (U.S. Patent No. 9,606,548).

17. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge, of the technologies discussed in this declaration based upon my education, training, or experience with the matters discussed herein.

III. SUMMARY OF CONCLUSIONS FORMED

18. This Declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions:

- **Ground 1:** Based upon my knowledge and experience and my review of the prior art in this declaration, and Mr. Kasdorf's Declaration (EX1004), I believe that claims 1-4, 8, 16-30, and 34 of the '372 patent are rendered obvious by Dickerson and CryptoKube, in view of Szmigielski and Kheterpal.
- **Ground 2**: Based upon my knowledge and experience and my review of the prior

art in this declaration, and Mr. Kasdorf's Declaration (EX1004), I believe that claims 1-4, 8, 10-12, 15-30, 34-37, and 40 of the '372 patent are rendered obvious by Dickerson, CryptoKube, and Belady-989, in view of Szmigielski and Kheterpal.

- **Ground 3**: Based upon my knowledge and experience and my review of the prior art in this declaration, and Mr. Kasdorf's Declaration (EX1004), I believe that claims 1-4, 7-12, 15-30, 34-37, and 40 of the '372 patent are rendered obvious by Dickerson, CryptoKube, Belady-989, and Boot, in view of Szmigielski and Kheterpal.
- **Ground 4**: Based upon my knowledge and experience and my review of the prior art in this declaration, and Mr. Kasdorf's Declaration (EX1004), I believe that claims 1-4, 8, 16-30, and 34 of the '372 patent are rendered obvious by Pioneer Energy's MAGS system and the Polivka miner, in view Szmigielski and Kheterpal.
- **Ground 5**: Based upon my knowledge and experience and my review of the prior art in this declaration, and Mr. Kasdorf's Declaration (EX1004), I believe that claims 1-4, 8, 10-12, 15-30, 34-37, and 40 are rendered obvious by Pioneer Energy's MAGS system, the Polivka miner, and Belady-989, in view of Szmigielski and Kheterpal.

IV. PERSON OF ORDINARY SKILL IN THE ART

19. In my opinion, a person of ordinary skill in the art of the '372 patent In my opinion, a person of ordinary skill in the art of the '372 patent would have a degree in chemical engineering, petroleum engineering, process engineering, mechanical engineering, or a similar field with 1-2 years of experience in designing power generation systems, Bitcoin mining systems, or other comparable hands-on experience. Alternatively, a person having 3-5 years of experience in the

Bitcoin mining industry would also qualify as a POSITA. Additional education could substitute for professional experience, or vice versa.

V. LEGAL PRINCIPLES

20. I am not a lawyer and I will not provide any legal opinions in this PGR. Although I am not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

A. Claim Construction

21. I understand that claim terms are generally given their plain and ordinary meaning in light of the patent's specification and file history as understood by a person of ordinary skill in the art at the time of the purported invention. In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention was made (not today).

B. Obviousness

22. I understand that a patent claim is invalid if the claimed invention would have been obvious to a person of ordinary skill in the field at the time of the purported invention, which is often considered the time the application was filed. Thus, even if all of the claim limitations are not found in a single prior art reference that anticipates the claim, the claim can still be invalid. I also understand that a POSITA is presumed to have been aware of all pertinent prior art at the time of the alleged invention.

23. I understand that to obtain a patent, a claimed invention must have, as of the priority date, been nonobvious in view of the prior art in the field. I understand that an invention is obvious

when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

24. I understand that, to prove that prior art or a combination of prior art renders a patent obvious it is necessary to: (1) identify the particular references that, singly or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain a motivation, teaching, need, market pressure or other legitimate reason that would have inspired a person of ordinary skill in the art to combine prior art references to solve a problem.

25. I also understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious. Such indicia include:

- Commercial success of products covered by the patent claims;
- A long-felt need for the invention;
- Failed attempts by others to make the invention;
- Copying of the invention by others in the field;
- Unexpected results achieved by the invention as compared to the closest prior art;
- Praise of the invention by the infringer or others in the field;
- The taking of licenses under the patent by others;
- Expressions of surprise by experts and those skilled in the art at the making of the invention; and
- The patentee proceeded contrary to the accepted wisdom of the prior art.

26. To the extent these factors have been brought to my attention, if at all, I have taken

them into consideration in rendering my opinions and conclusions. As discussed above and detailed in my curriculum vitae, I was very familiar with power generation systems, equipment, and technologies, and oil and gas facilities (and the industry in general) and was aware of the state of the art as of the earliest claimed priority date of the '372 patent. For the purposes of this declaration, I have been asked to assume that the earliest priority date of the '372 patent is February 8, 2017. I believe that I would qualify as understanding the knowledge and skill of a POSITA as of that date, and I have a sufficient level of knowledge, experience, and expertise to provide an expert opinion in the field of the '372 patent.

VI. MATERIALS CONSIDERED

27. In forming my opinion, I considered the following documents:

EX1001	U.S. Patent No. 11,574,372 to Stephen Barbour et al. ("the '372 Patent")
EX1002	Excerpts from the Prosecution History of the '372 Patent ("the Prosecution History")
EX1004	Declaration and Curriculum Vitae of Vernon Kasdorf.
EX1005	WO2015123257A1 ("Dickerson")
EX1006	CryptoKube brochure from the WaybackMachine dated March 5, 2016 ("CryptoKube brochure")
EX1007	CryptoKube Bitcoin mining Data center tour(CC) ("CryptoKube video-Part1")
EX1008	CryptoKube Bitcoin mining Data center tour transcript
EX1009	Szmigielski, Albert. Bitcoin Essentials. Packt Publishing Ltd, 2016 ("Szmigielski")
EX1010	U.S. Patent Publication No. 2016/0125040 ("Kheterpal")
EX1011	PCT Patent Publication No. 2015/072989 ("Belady-989")
EX1012	U.S. Patent No. 9,394,770 ("Boot")
EX1013	Sanders, Gerald, and Johnson Space Center. "Gas Conversion Systems Reclaim Fuel for Industry." ("Sanders")
EX1014	US Patent Publication No. 2015/0368566 ("Young")
EX1015	Mining Container ~100kW by Polivka GmbH ("Bitcointalk forum post")
EX1016	Mining with free natural gas _ r_Bitcoin ("Reddit")
EX1017	U.S. Patent Publication No. 2014/0096837 ("Belady-837")
EX1018	U.S. Patent Publication No. 2018/0109541 ("Gleifchauf")
EX1019	Polivka Mining Container Setup on Vimeo ("Polivka video")
EX1020	Declaration of June Ann Munford
EX1021	U.S. Patent No. 6,161,386 ("Lokhandwala")

EX1022	"Crypto you can mine from a home computer," Brave New Coin (bravenewcoin.com) (July 18, 2023)
EX1023	CryptoKube Bitcoin mining Data center tour(CC) ("CryptoKube video-Part2")
EX1100	Complaint for Patent Infringement, *Upstream Data Inc. v. Crusoe Energy Systems LLC*, Case No. 1:23-cv-01252 (D. Colo. May 18, 2023)

In addition to the documents and materials cited in this declaration, I also relied on my knowledge, education, skills, experience, and training in forming my opinions.

VII. BACKGROUND – POWER GENERATION USING FLARE GAS

28. The following paragraphs regarding power generation using flare gas are based on prior art to the '372 patent. As stated above, for the purposes of this declaration, I have been asked to assume that the earliest priority date of the '372 patent is February 8, 2017.

29. Flare gas is natural gas to be flared, that is burned on a flare stack, because it is otherwise prohibitively impractical to either use that gas locally (at a hydrocarbon production location) or transport that gas to another location for profitable consumption. Natural gas flaring is an imperfect practical solution. On the one hand, flaring mitigates the problem of releasing that gas into the atmosphere, which would have significant negative impact (e.g., contribute towards the global atmospheric greenhouse effect a lot more than equivalent amounts of carbon dioxide). On the other hand, the products of flaring include carbon dioxide, black soot, and some unburned methane, which pose environmental or health problems. Furthermore, natural gas flaring places a cost on treating an otherwise valuable commodity.

VIII. OVERVIEW OF THE '372 PATENT

30. The '372 patent relates to "operating a blockchain mining device using natural gas produced at a hydrocarbon production, storage, or processing site/facility." EX1001, Abstract. By way of background to its technology, the '372 Patent explains that "[a]t remote oil and gas facilities, excess natural gas is often wasted, for example vented to atmosphere or burned via

flaring." EX1001, 1:11-13. Figures 1 and 2 are schematics illustrating systems for "powering a blockchain [mining device (**12**)] at a remote oil well [**14**]," with a generator (**28**). EX1001, 5:53-62; 8:35-48.

31. Figure 1 (shown below) shows "a generator [**28**] retrofitted to a prime mover [**24**], which operates a drivehead to pump oil up from the reservoir." EX1001, 5:53-56. That is, in this case, the blockchain mining device (**12**) is connected to a generator (**28**), which is retrofitted to a prime mover.

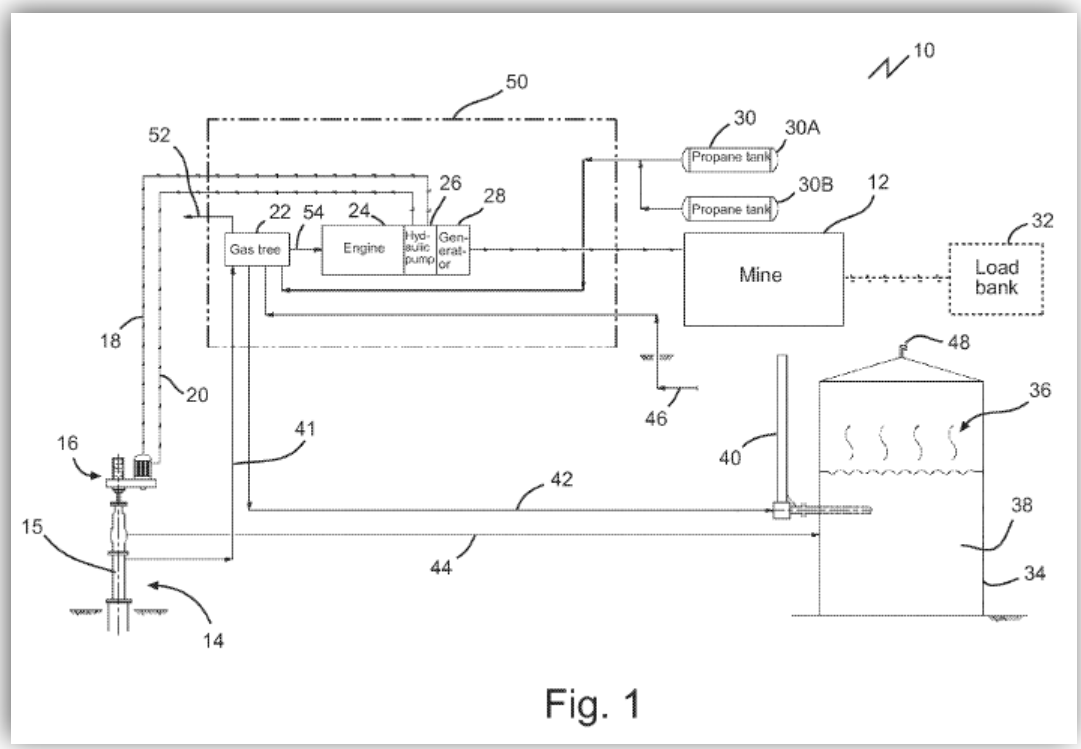


Fig. 1

'372 Patent, EX1001, Fig. 1

32. Figure 2 (shown below) is similar to Figure 1, but this embodiment includes two engines—one that (with a generator) powers the blockchain mining device, and one that operates the drive head. *See* EX1001, 5:57-62.

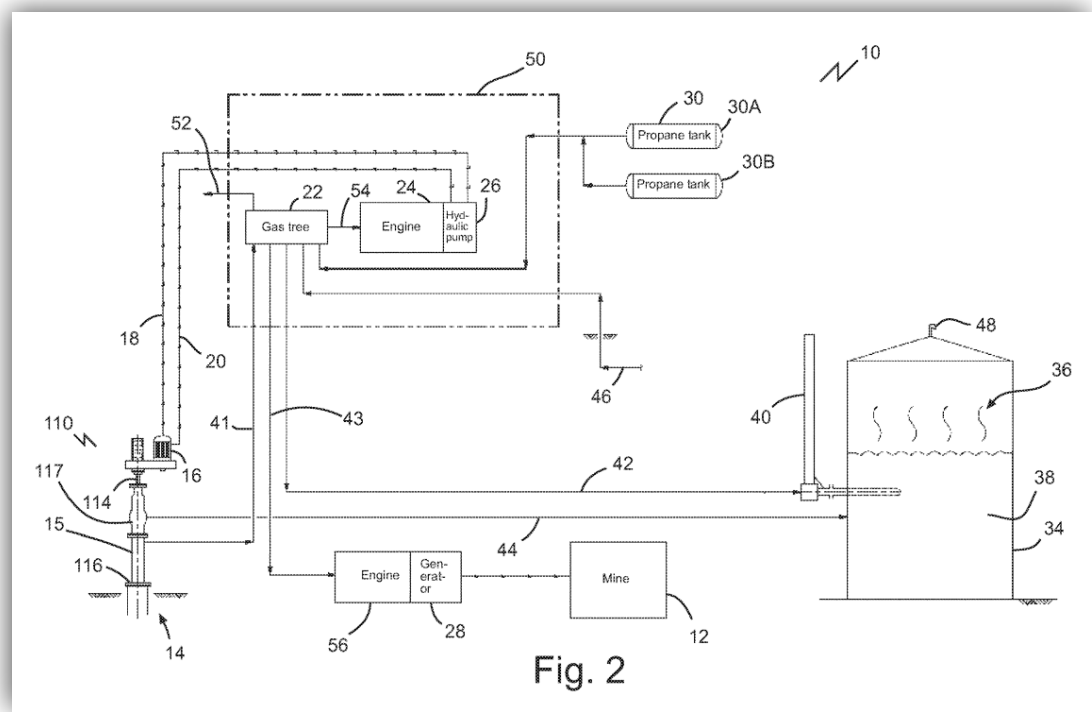


Fig. 2

’372 Patent, EX1001, Fig. 2

33. Figure 3 (shown below) is a schematic illustrating another embodiment of a system for powering a blockchain mine, in which “a generator and engine are connected to be powered by combustible gas taken off of an oil storage unit to power the blockchain main.”

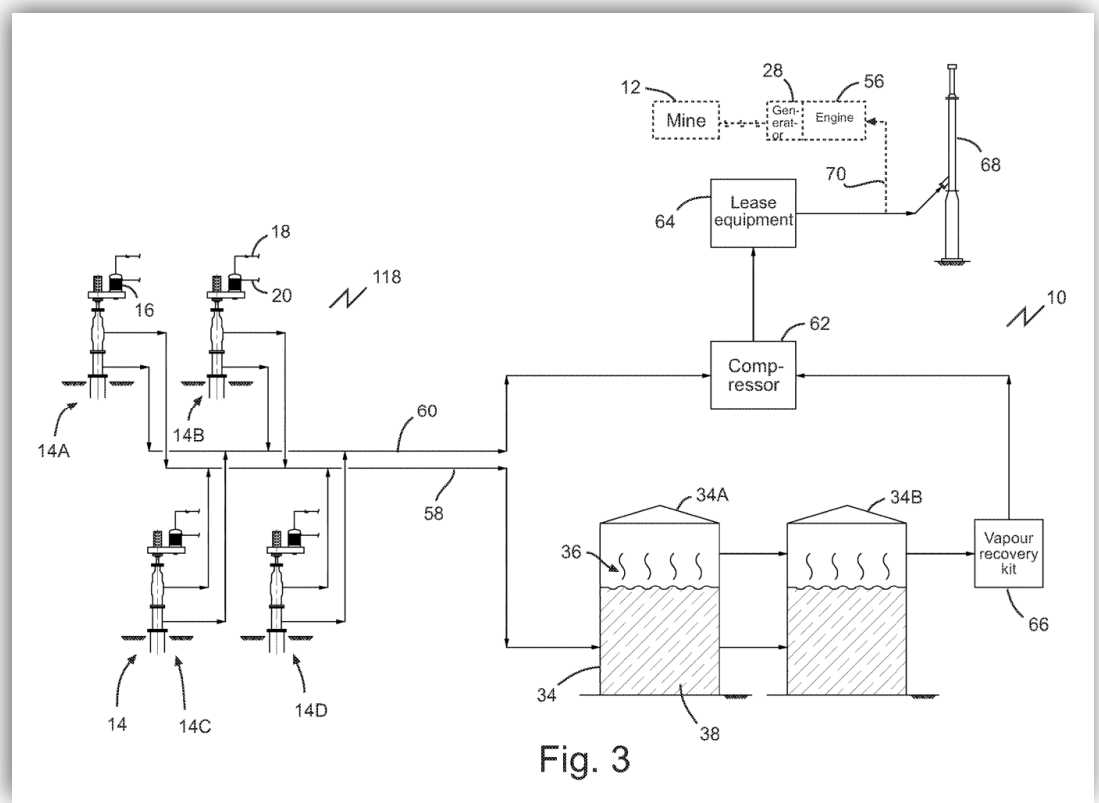


Fig. 3

’372 Patent, EX1001, Fig. 3

34. Common among these three embodiments is that, in each case, a blockchain mining device is connected to a generator that runs on combustible gas – in particular, natural gas at an oil well or oil storage unit.

35. I understand that the ’372 patent lists Stephen Barbour as the inventor, Upstream Data Inc. (“Upstream”) as the applicant and assignee, and has the title: “Blockchain Mine at Oil or Gas Facility.” For purposes of this declaration, I have been asked to assume that February 8, 2017, the filing date of US provisional application No. 62/456,380, is the earliest possible priority date for the ’372 patent.

36. Generally, the ’372 patent discusses systems and methods for using a source combustible gas to power bitcoin mining. I understand that in the related Complaint, Upstream

has relied specifically on claims 1 and 2 of the '372 patent.

IX. OVERVIEW OF THE PROSECUTION HISTORY

37. The application that led to the '372 patent was filed as U.S. Patent Application No. 16/484,728 on February 6, 2018. EX1002.

38. I understand that the '372 patent was filed with 41 claim, two of which were independent claims

> 1. A system comprising:
> a source of combustible gas produced from an oil production, storage, or processing facility;
> a generator connected to the source of combustible gas; and
> a blockchain mining device connected to the generator.
>
> 24. A method comprising using a source of combustible gas produced at a hydrocarbon production well, storage, or processing facility, to produce electricity to operate a blockchain mining device located at the hydrocarbon production well, storage, or processing facility, respectively.

EX1002, 686-691. I further understand that before examination, the claims were amended to "remove all multiple dependencies and reduce excess claim fees." EX1002, 543-550. Claims 1 and 24 were not amended.

39. I understand that on August 9, 2021, before any office actions had been mailed, a third party submission was made to cite a Reddit posting dated July 3, 2016. EX1002, 439-447. According to the third-party submitter, the Reddit posting "discloses a source of combustible gas, a generator that generate (sic) electricity from combustion of the gas, and a blockchain mining device." EX1002, 440.

40. I understand that the Examiner initiated and conducted an interview with the Upstream's representative on April 15, 2022, "to gain insight and a better understand (sic) the claimed invention as well as the oil/natural gas industry as it applies to block chain mining."

EX1002, 348. The Examiner concluded that the third-party submission "reads adequately on the independent claims," and suggested that "[m]oving forward, [] drafting independent claims that clearly unite the combustible gas production elements and the block chain mining elements." EX1002, 348. With respect to the dependent claims, the Examiner indicated that "[a]llowable subject matter may reside in dependent claims 12–18," but that "further searching [would be] required." EX1002, 348. The Examiner's initial search revealed little in the way of qualified prior art, but did reveal Belady-989-FH (US20140096837A1). EX1002, 348.

41. I understand that on April 19, 2022, before Upstream amended the claims, the Examiner mailed an Office Action. EX1002, 329-347. Claims 1 and 24, as well as dependent claims, were rejected for obviousness over Belady-989-FH and Gleifchauf (US20180109541A1). EX1002, 336. No anticipation rejections were made, despite the Examiner having indicated in the April 15 interview that the Reddit Post reads on the independent claims.

42. I understand that, in making the obviousness rejection, the Examiner took the position that Belady-989-FH discloses using a gas generator to power a data center (blockchain mining device), and Gleifchauf discloses using servers for blockchain mining and verification. EX1002, 336-337. According to the Office, it would have been obvious to combine Belady-989-FH and Gleifchauf because Belady-989-FH discloses "data centers are being located in areas where natural resources, from which electrical power can be derived, are abundant and can be obtained inexpensively. For example, natural gas is a byproduct of oil drilling operations and is often considered a waste byproduct since it cannot be economically captured and brought to the market." EX1002, 336-337 (quoting EX1017, [0004]).

43. I understand that subsequent to receiving the obviousness rejection, Upstream amended the independent claims to recite:

1. A system comprising:

a source of combustible gas produced from [[an oil]]a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;

a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and

[[a]] blockchain mining devices connected to the generator;

in which

the blockchain mining devices each have a mining processor and are connected to a network interface;

the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;

the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;

the network is a peer-to-peer network;

the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and

the blockchain database stores transactional information for a digital currency.

24. A method comprising:

Producing electricity using a generator and a source of combustible gas produced at a facility selected from the group consisting of a hydrocarbon production well, storage, or processing facility, ~~to produce electricity to~~ and operating[[e a]] blockchain mining devices located at the ~~hydrocarbon production well, storage, or processing~~ facility, respectively, using the electricity, in which:

the generator is connected to the source of combustible gas, in which the facility is connected to produce a continuous flow of combustible gas to the generator;

the blockchain mining devices [. . .].[1]

44. I understand that, to overcome the obviousness rejection, Upstream argued that its system uses "flare gas" as opposed to "sales gas." EX1002, 222-223. I understand that Upstream also argued that blockchain mining is different from traditional data-processing because it requires more energy. EX1002, 222-223. Upstream argued that its "discovery amounts to a new use for

1 The remainder of the amendments to claim 24, with respect to the block chain mining devices, are identical to those made in claim 1. CRUSOE-1002 209-224.

previously known individual components (a common precursor for patentability), and may provide numerous benefits including the reduction of greenhouse gas emissions and capture of revenue where gas disposal is otherwise a capital loss (for example paragraphs 33, 34, 48, and 73), EX1002, 223.

45. I understand that on August 31, 2022, a notice of allowance was mailed. EX1002, 4-9. In the "Reasons for Allowance," the Examiner indicated that:

> With regard to any rejections under 35 USC § 101 based upon the Alice Corporation Pty. Ltd. v. CLS Bank guidelines, the Examiner finds that the claimed invention amounts to significantly more than a judicial exception or an abstract idea. Also, the claimed invention demonstrates a practical application. The specification clearly teaches and describes blockchain mining at hydrocarbon facility. Any rejections under 35 USC § 101 are hereby withdrawn Additionally, the 2019 PEG defines the phrase "integration into a practical application" to require an additional element(s) or a combination of additional elements in the claim to apply, rely on, or use the judicial exception in a manner that imposes a meaningful limit on the judicial exception, such that it is more than a drafting effort designed to monopolize the exception. See MPEP 2106.04(d). I
>
> With regard to the rejections under 35 USC § 103, the Examiner has carefully reviewed the Applicants responses filed on **07/04/2022**. Based upon the Applicants arguments and assertions, the Examiner is persuaded by and agrees with the Applicant. The assertions and arguments provided by the Applicant credibly declare and make clear that the independent claims and the limitations contained therein are allowable either in part or taken as a whole over the prior art of record. None of the art of record, taken individually or combination, disclose at least the method step or system components contained within the independent claims. Consequently, The prior art of record fails to fully disclose or reasonable teach the independent claims as a whole. See MPEP 1302.14. Moreover, even though the individual references applied in the prior art may teach each individual limitation sufficiently, there does not appear to be sufficient grounds for combining or modifying the prior art of record to adequately arrive at the claimed invention. See MPEP 2143.01.

46. I understand that the '372 patent issued shortly after a Rule 312 amendment (amending claims 15, 16, 18, 31, 37, 38, 40 to recite "hydrocarbon production well, storage, or

processing facility"). EX1002, 20-29.

47. I also understand that neither Dickerson, CryptoKube, Szmigielski, Kheterpal, Boot, Pioneer's MAGS system, nor Polivka miner were considered by the examiner. EX1002.

X. THE CHALLENGED CLAIMS

48. I understand that for purposes of this proceeding, Petitioner is challenging the validity of claims 1-4, 7-12, 15-30, 34-37, and 40 of the '372 patent.

49. Claim 1 of the '372 patent is representative of the challenged claims and is shown below:

> 1. A system comprising:
> a source of combustible gas produced from a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;
> a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and
> blockchain mining devices connected to the generator;
> in which:
> the blockchain mining devices each have a mining processor and are connected to a network interface;
> the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;
> the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;
> the network is a peer-to-peer network;
> the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and
> the blockchain database stores transactional information for a digital currency.

XI. CLAIM CONSTRUCTION

50. I understand that Petitioner reserves the right to assert in litigation that certain claim constructions are proper and that certain terms are indefinite, and I do not concede, by providing my opinions herein, that the challenged claims are of definite scope or properly described.

51. For the purposes of this declaration, no formal claim constructions are presently necessary, besides the specific constructions described below.

52. The term "blockchain mining device" should be construed as "any computing device that is capable of performing blockchain mining without regard to processor speed or power." For this construction, I relied on Mr. Kasdorf.

53. The term "mining processor" should be construed as "any processor that is capable of performing blockchain mining without regard to processor speed or power." For this construction, I relied on Mr. Kasdorf.

54. The term "a continuous flow of combustible gas" should be construed as "a flow of combustible gas that is continuous for at least a time period (e.g., an hour, a day, a week, a month, or longer)." This construction is supported by the '372 patent specification, which states that the load may be limited to a power level producible by the generator "for a period of time of eight, twelve, twenty-four, or more hours." [EX1001, 18:58-67]. A POSITA would have understood that the gas supply from any given oil filed is limited, and will eventually dry up.

55. The term "sales gas line" should be construed as "a pipeline for long-distance transportation of sales gas meeting sales-gas specifications from a hydrocarbon production, storage, or processing facility to a customer connected to the pipeline." This construction is supported by the '372 patent specification, which clearly sets out the meaning of this term: "A sales gas line may be a pipeline of more than ten km of length, in some cases more than fifty, a hundred, or two hundred, kilometers in length, and connecting between an oil and gas site and travelling to an end user, a processing site, or a distribution site.." [EX1001, 7:29-33, 7:1-34].

56. Moreover, "[r]aw natural gas may require processing before it can be sold via a sales gas line." [EX1001, 7:1-2]. Specifically, "gas treating facilities must be designed to convert

a particular raw gas mixture into a sales gas that meets the sales-gas specifications," which "may vary by jurisdiction." [EX1001, 7:20-28].

57. I reserve the right to supplement my opinions if Patent Owner offers a construction of any term in the '372 patent.

XII. SUMMARY OF THE PRIOR ART

A. Dickerson

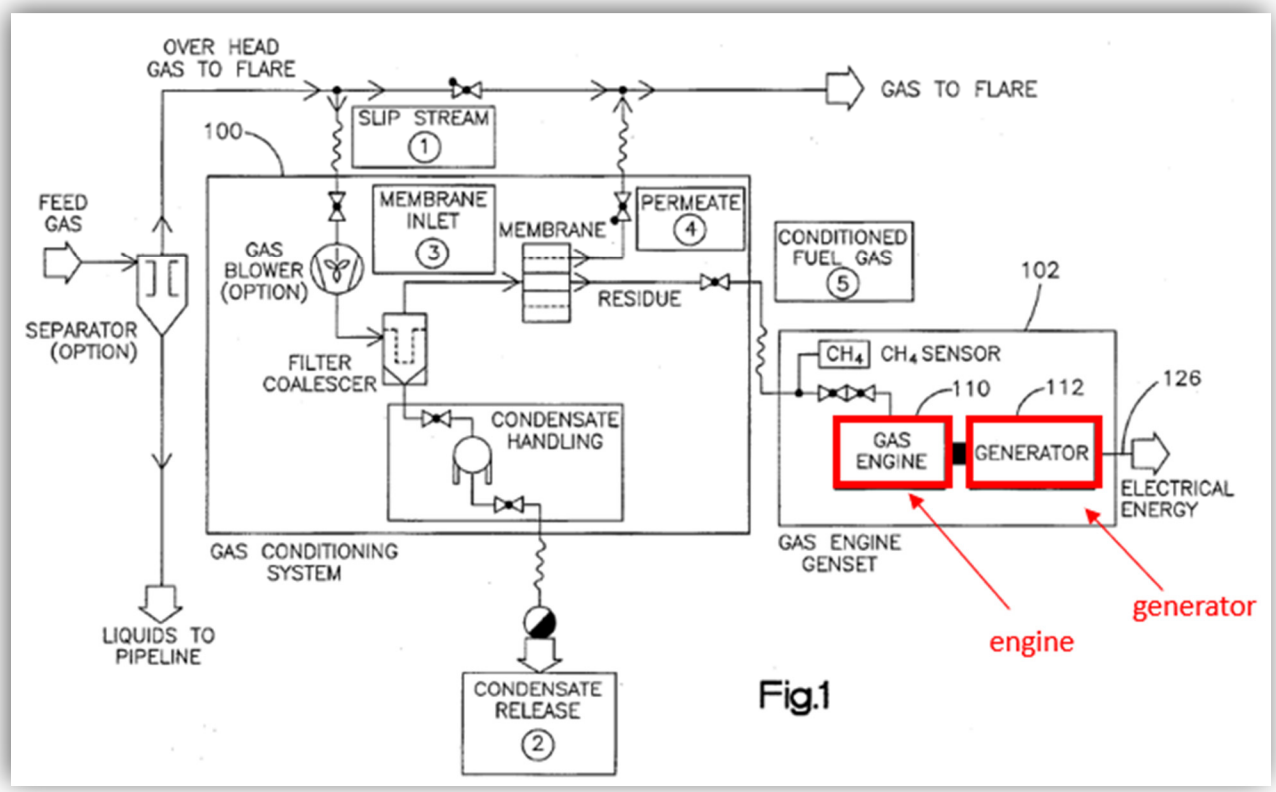
58. PCT Publication No. 2015/123,257 ("Dickerson") has an international publication date of August 20, 2015. [EX1005, Cover].

59. Dickerson "relates generally to a mobile apparatus, system, and method for processing and using raw natural gas that is normally flared at the site of oil and gas field operation facilities." [EX1005, [0002]].

60. Dickerson describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]]. Dickerson explains that "[g]as flared as a byproduct of oil drilling in the Bakken Field releases millions of tons of carbon dioxide into the atmosphere every year, causing considerable environmental concerns" and "a number of oil and gas field facilities where gas is being flared rely on diesel-powered electrical generating units for electricity needed to run the facilities." [EX1005, [0003], [0004]].

61. Dickerson discloses that it seeks to "reduce costs associated with diesel-powered electrical generating units, to eliminate undesirable emissions generated by flaring natural gas, and to reduce emissions from the generation of electricity used to operate oil and gas field facilities, since electricity produced by gas engines results in fewer harmful emissions than electricity produced by diesel-fuel engines." [EX1005, [0010]].

62. Dickerson's system includes (1) one membrane separation unit for separating useful fuel gas from raw natural gas produced at an oil or gas production facility, (2) a gas engine that uses the fuel gas to generate electricity that is returned to the facility, and (3) a control panel for operating the apparatus. [EX1005, [0005]]. FIG. 1 of Dickerson shows one setup of its combined gas conditioning and power generation system. [EX1005, [0008]]. As shown in FIG. 1, gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110. [EX1005, [0026]].



Dickerson, EX1005, FIG. 1 (annotated)

63. Dickerson further discloses that a chiller unit can be included to remove natural gas liquids (NGLs) from the raw natural gas stream, and to further reduce the flaring of raw natural gas. [EX1005, [0022]].

64. Dickerson discloses that its mobile power generation system can be delivered in a 40-foot-long ISO container. [EX1005, [0014]]. Dickerson explains that the container and its contents together define a self-contained, mobile flare gas processing unit that provides a user with electrical power output but requires only feed gas input from the user. [EX1005, [0026]]. Dickerson envisions using the generated electricity for both local consumption and for export. [EX1005, [0039]].

B. CryptoKube

65. I relied on Mr. Kasdorf's review of CryptoKube in forming my opinions.

66. I understand that the CryptoKube system is a commercialized industrial Bitcoin mining system that can be easily shipped to any location that has cheap power and can mine bitcoin. [EX1006, 1-4]. The CryptoKube is built inside an ISO shipping container and is filled with spondooliestech SP31 servers. [EX1006, 4]. The CryptoKube uses fans (fresh air cooling) to move large volumes of air through the data center to cool the servers and remove the hot air exhaust. [EX1006, 1, 4].

67. I understand that, as shown in the CryptoKube video, the CryptoKube is built inside an ISO shipping container with walls, a top, and a base, with an access door formed in the walls. CyptoKube can run inside a large warehouse, outside in a parking lot or in a server pod farm where the power is cheapest. [EX1006, 1-4]; [EX1007, 0:01:08]. I understand that the CryptoKube video and CryptoKube brochure were both published in 2014.

CryptoKube Video, EX1007, 0:01:08.

C. Szmiegielski

68. I relied on Mr. Kasdorf's review of Szmiegielski in forming my opinions.

69. I understand that Szmigielski is a book titled "Bitcoin Essentials," first published in February 2016, where the author reviewed the mining of bitcoin—how new bitcoins are created and how transactions are accepted into the Bitcoin blockchain. [EX1009, 12]. Chapter 1 reviews bitcoin wallets and mining software. Chapters 2-5 cover CPU, GPU, FPGA, and ASIC mining. Chapter 6 talks about solo versus pool mining. Chapter 7 talks about large scale mining, and Chapter 8 discusses the future of bitcoin mining. [EX1009, 13].

70. I understand that the Bitcoin database that stores all the transaction data is called a "block chain." [EX1009, 17]. Mining software coordinates and manages the work of different mining devices. [EX1009, 29]. Electricity is a big part of the cost of mining, and it is very important to set up a mining operation where electricity is cheap or perhaps even free. [EX1009, 86].

71. Industrial miners face almost the same issues as data centers: access to relatively cheap power, good network access, access to latest hardware, and stable political climate. [EX1009, 88]. One of the biggest costs for Bitcoin miners is the cost of electricity. [EX1009, 90]. Electricity is needed in both running the hardware and the associated cooling systems, be it fans or air conditioning. *Id.* Miners, therefore, seek out locations where electricity is fairly priced. *Id.* In North America, the biggest industrial Bitcoin mine is located in eastern Washington state due to the abundance of inexpensive hydroelectric power. *Id.*

D. Kheterpal

72. I relied on Mr. Kasdorf's review of Kheterpal in forming my opinions.

73. I understand that US Patent Publication No. 2016/0125,040 ("Kheterpal") was published on May 5, 2016 and discloses the design and operation of a bitcoin miner chip. [EX1010, Abstract]. FIG. 1 is an illustrative diagram of a peer-to-peer network 100 that may operate according to the Bitcoin protocol. [EX1010, [0030]]. Network 100 includes plural nodes 10 that are coupled to other nodes via paths 12 (e.g., Internet) and nodes 10 may be electronic devices such as desktop computers, laptop computers, cellular telephones, servers, or other electronic devices that implement the Bitcoin protocol. *Id.*

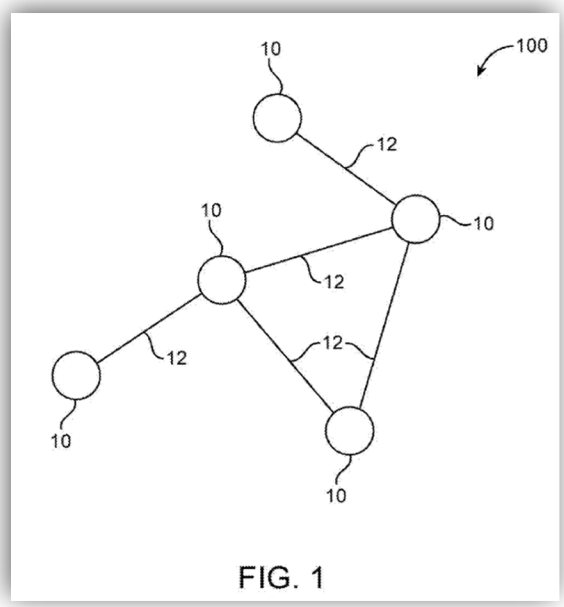


FIG. 1

Kheterpal EX1010, FIG. 1

74. I understand that nodes 10 may communicate to maintain a global ledger (e.g., bitcoin database) of all official transactions, and each node 10 may store a copy of the global ledger (e.g., a complete copy or only a partial copy). [EX1010, [0031]]. Transactions added to the global ledger by each node 10 may be verified by other nodes 10 to help ensure validity of the ledger. *Id.*

75. I understand that the Bitcoin protocol defines a system in which the creation and distribution of the bitcoin cryptocurrency is governed by consensus among a peer-to-peer network. [EX1010, [0004]]. The network maintains a public ledger in which new transactions are verified and recorded by members of the network via cryptography. *Id.* The operations of verifying and recording transactions of cryptocurrencies such as transactions in the bitcoin cryptocurrency are sometimes referred to as mining, because completion of each mining operation typically rewards the miner with newly created cryptocurrency (e.g., bitcoins). *Id.* Verified transactions and newly created bitcoins are recorded in the public ledger. *Id.* The public ledger serves as an official history

of transactions. *Id.* The amount of cryptocurrency owned by any entity may be determined from the public ledger. *Id.*

E. Belady-989

76. PCT Patent Publication No. 2015/072989 ("Belady-989") has an international publication date of May 21, 2015. [EX1011, Cover].

77. Belady-989 describes a gas supply shock absorber (containing a gas storage) that is used to improve a data center system powered by a natural gas generator. [EX1011, Abstract]. If the shock absorber has sufficient gas, a co-located data center utilizes such gas for increased electrical power generation during increased processing activity, which can be requested or generated. [EX1011, Abstract]. Conversely, if the shock absorber has insufficient gas, and a negative pressure spike occurs, the data center throttles down or offloads processing. [EX1011, Abstract]. FIG. 1 illustrates Belady-989's system.

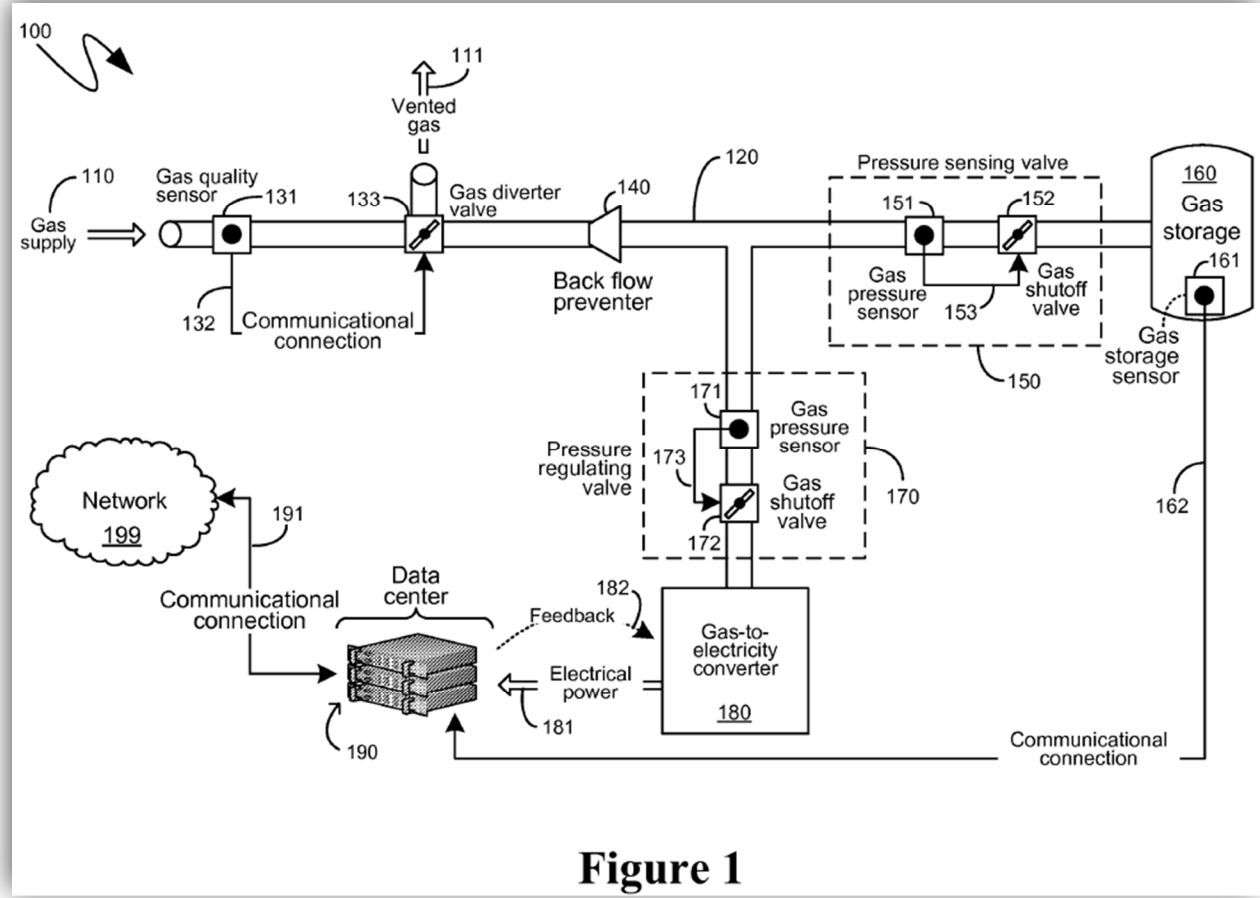


Figure 1

Belady-989, EX1011, FIG. 1

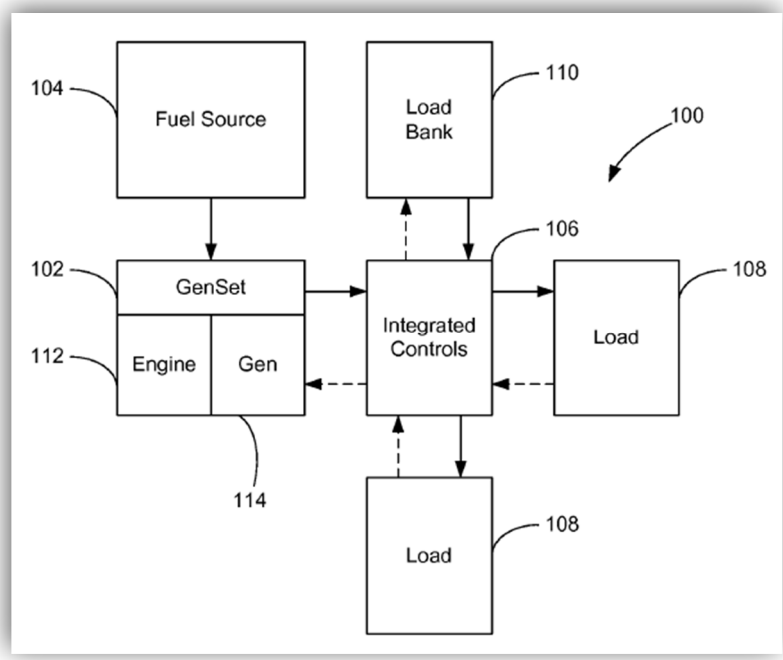
78. As shown in FIG. 1, the data center 190 is connected to network 199, and is powered by a gas-to-electricity converter 180, which can be a gas generator. [EX1011, [0019]]. Belady-989's data center system "can be located in an area where gas supply 110 can be plentiful or otherwise available at a minimal cost, but such a gas supply 110 can also experience pressure spikes." [EX1011, [0019]]. The gas supplied by the gas supply 110 can include natural gas, biogas, methane, propane or other hydrocarbons, hydrogen, or any other fuel that can be accepted by gas-to-electricity converter 180, such as a generator. [EX1011, [0019]].

F. Boot

79. U.S. Patent No. 9,394,770 ("Boot") was issued on July 19, 2016. [EX1012, Cover].

80. Boot describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility that is isolated from a power grid. [EX1012, Abstract, 1:5-10, 4:6-7]. Boot explains that "[t]he driver is preferably an engine that is provided with combustible gases from the petroleum products of the well" and "[i]n the past, such gas have often been vented or flared at the well 118." [EX1012, 1:55-57, 4:6-7].

81. As shown in FIG. 1, Boot's system includes a genset 102, a fuel source 104, an integrated control system 106, a load bank 110, and one or more loads 108. [EX1012, 2:23-28]. The genset 102 includes a driver (engine) 112 coupled to a generator 114. [EX1012: 29-35]. The loads 108 are general references for devices or systems that consume electrical power (e.g., electric motors, computers). [EX1012, 35-41].



Boot, EX1012, FIG. 1

82. Boot explains that the load bank 110 can be activated to take-up any excess power to maintain a minimum load to keep the engine 112 within its preferred operating parameters. [EX1012, 3:8-14]. Boot's system can be positioned on a common platform or skid 130, which is configured to be rolled on and off a conventional lowboy trailer. [EX1012, 4:27-37].

83. In FIG. 2, Boot further discloses that the flare gas can be derived from more than one well heads (well 118). [EX1012, FIG. 2, 3:42-46]. Boot further discloses that the electric submersible pumping system 116 pushes pumped fluids out of the well 118 to surface facilities 120 (e.g., phase separators, storage batteries and gathering lines), which output the flare gas to the genset 102 to generate electricity. [EX1012, 3:37-42].

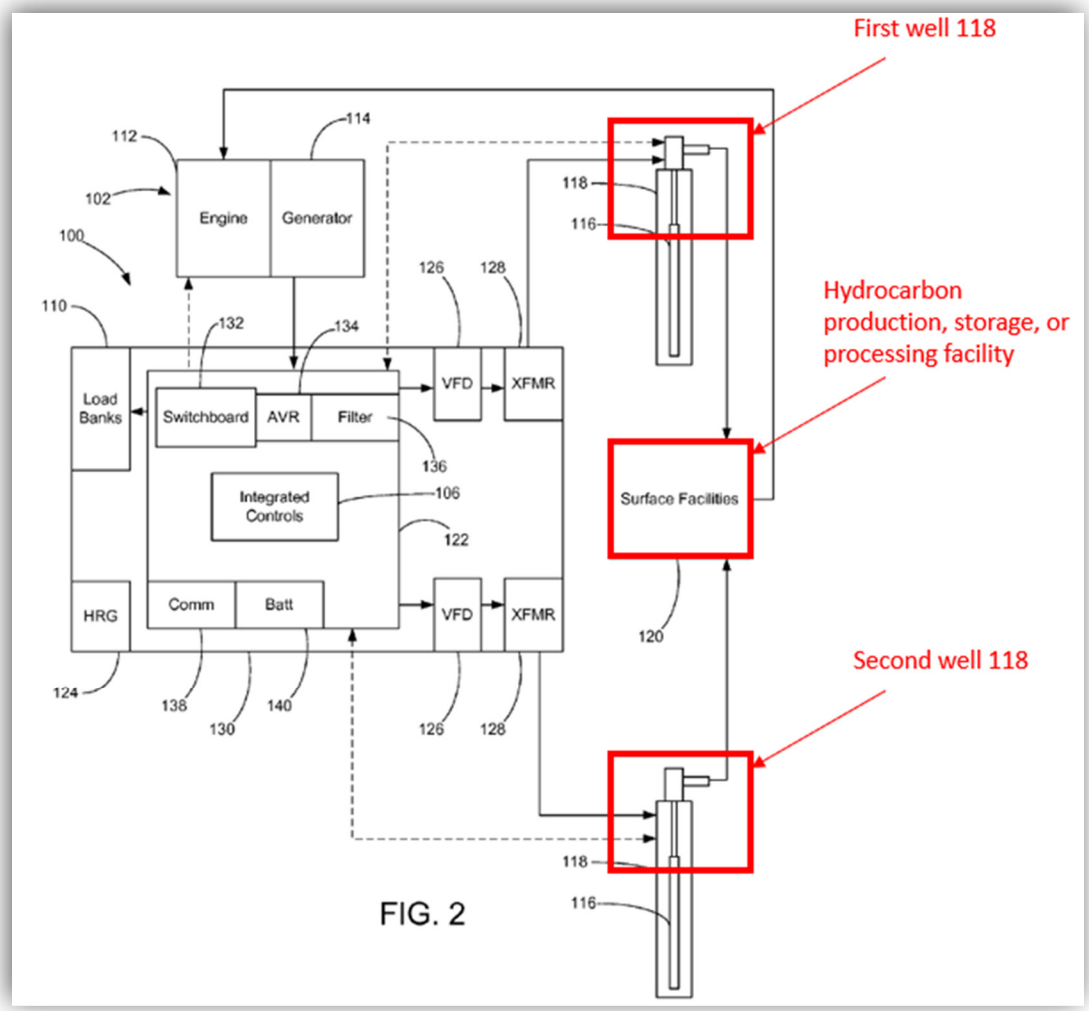


FIG. 2

Boot, EX1012, FIG. 2 (annotated)

G. Pioneer Energy's MAGS System

84. Pioneer Energy's Mobile Alkane Gas Separator (MAGS) system ("MAGS" for short) separates flare gases that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another powers generators that run the drilling operation, and a third powers MAGS itself. [EX1013, 2]. Pioneer sold its first MAGS unit in late 2014 to a company operating in North Dakota, where flare gases are most often simply burned onsite, the gases wasted. [EX1013, 2].

Pioneer Energy's MAGS System, EX1013, 2

85. Some of the engineering details of the MAGS system are described in US Patent Publication No. 2015/0368566 ("Young"). For example, as described in Young, the ethane-enriched B-gas is combusted in an internal engine 719a and the mechanical shaft power is transmitted to a 480 VAC internal generator 719b operating at 60 Hz. [EX1014, [0198]]. Young also discloses that the MAGS system is containerized to fit on a trailer to confer better mobility. [EX1014, [0162], FIG. 4].

H. Polivka miner

86. The Polivka miner is a mobile crypto-currency miner. It is described in a Bitcointalk forum post thread that was kept in a May 11, 2015 WayBackMachine snapshot ("the Bitcointalk forum post"). [EX1015]. The Polivka miner is also depicted in a Youtube video dated February 9, 2015 ("Polivka video"). [EX1019].

87. As shown in the Bitcointalk forum post, the Polivka miner ("Polivka" for short) is adapted from a standard intermodal shipping container, and can be easily transported to remote well sites. [EX1015, 1-10]; [EX1019, 0:00:08]. For example, the Bitcointalk forum post explains that "the container can be loaded and unloaded without crane using the pictured pillars and an air-suspended truck only. (Almost all of the trucks in Europe have air suspension)." [EX1015, 10].

Polivka, EX1015, 1

88. As shown in the below figure, the Polivka miner contains a cooling fan, multiple bitcoin miners on a rack, and a power distribution box on the left side.

Polivka, EX1015, 31

89. As explained in the Bitcointalk forum post, the Polivka miner can carry various miners including Spondoolies-Tech SP31 and Bitmain Antminer S19. [EX1015, 17]. The Bitcointalk forum post also explains that cheap electricity is desired and required. [EX1015, 15, 21]. The Bitcointalk forum post also envisions powering the Polivka miner by gas using a combustion engine. [EX1015, 18].

XIII. ANALYSIS OF DICKERSON AND CRYPTOKUBE (GROUND 1)

90. For the reasons articulated in detail below, and based on my review of the '372 patent, the file history, the prior art cited here, Mr. Kasdorf's declaration, and my years of experience in the oil and gas industry, a POSITA would have readily understood that claims 1-4, 8, 16-30, and 34 are obvious over the combination of Dickerson and CryptoKube, in view of Szmigielski and Kheterpal.

A. It Would Have Been Obvious to a POSITA to Combine Dickerson and

CryptoKube, in view of Szmigielski and Kheterpal.

91. A POSITA would have found it obvious to combine the Dickerson's mobile power generation system with CyptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator, in view of Szmigielski and Kheterpal.

92. Dickerson discloses a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]]. Dickerson discloses that the power generated may be more than the power required on an oil field pumping site, and that its system can provide power for both local consumption and also for export to the grid at the same time if utility power lines are accessible. [EX1005, [0039]]. Dickerson also discloses that oil and gas production facilities are typically located in remote areas where no utility power is available. [EX1005, [0024]].

93. Thus, a POSITA would have understood that Dickerson's system can generate free or cheap excess electricity that cannot be exported to the grid (because no utility power lines are accessible).

94. Smigielski discloses that one of the biggest costs for Bitcoin miners is the cost of electricity and access to cheap power is desired. [EX1009, 90].

95. A POSITA would have been motivated to couple a bitcoin miner to Dickerson's system to utilize the free excess electricity.

96. CryptoKube discloses a mobile bitcoin miner that can be easily transported to a remote oil and gas production facility. [EX1006, 1-4].

97. Thus, a POSITA would have found it obvious to couple the CryptoKube system with Dickerson's system to utilize the free excess electricity.

98. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4]. Thus, it is easy to combine the two by simply combining two ISO shipping containers into one.

99. In the Dickerson-CryptoKube combination, the combined device would have (1) Dickerson's mobile power generation system; and (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator.

B. The Combination of Dickerson and CryptoKube Renders Claims 1-4, 8, 16-30, and 34 Obvious.

100. As I explain below, the combination of Dickerson and CryptoKube renders obvious all limitations of claims 1-4, 8, 16-30, and 34. As stated above, I relied on Mr. Kasdorf's opinions and explanations related to CryptoKube, Szmigielski, and Kheterpal for the purposes of this Declaration.

a. Independent Claim 1

i. Limitation [1pre]

"A system comprising:"

101. To the extent the preamble is limiting, the Dickerson-CryptoKube combination renders [1pre] obvious. For example, Dickerson describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]]. And, per Mr. Kasdorf's review, CryptoKube also discloses a bitcoin miner system. [EX1006, 1-4].

ii. Limitation [1a]

"a source of combustible gas produced from a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;"

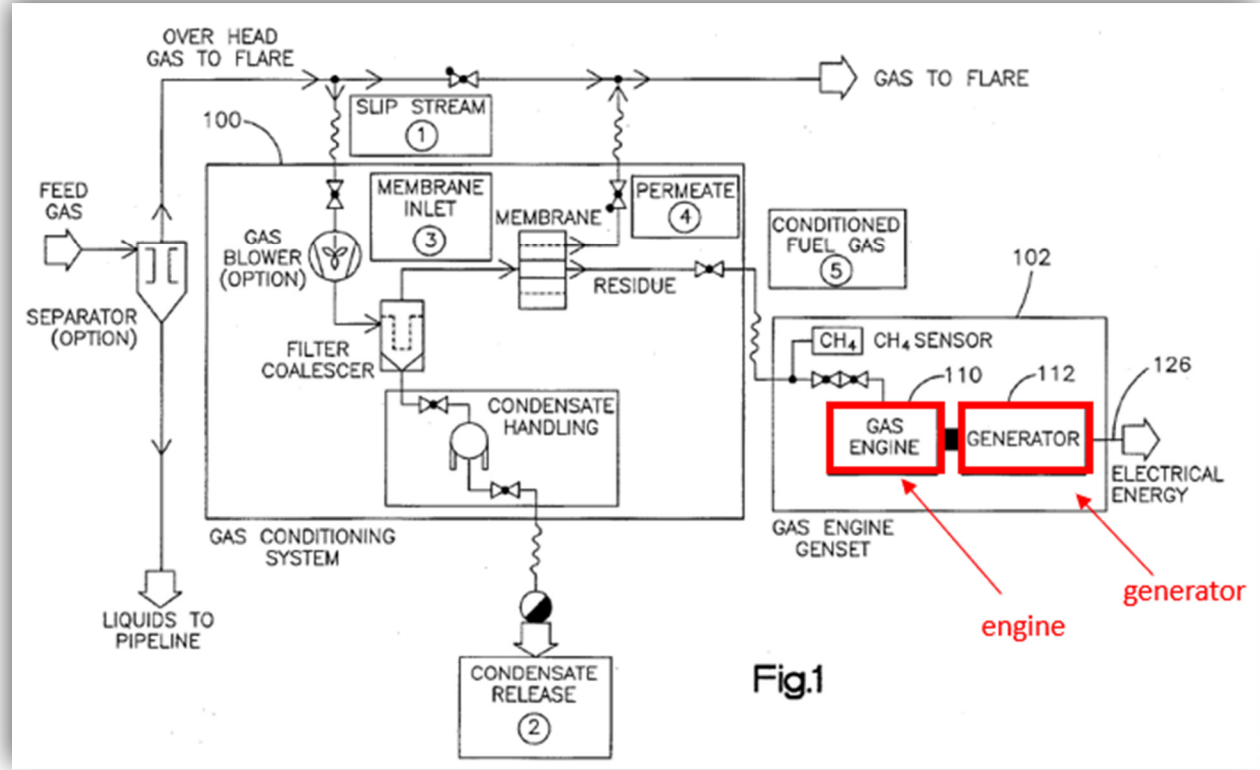
102. Dickerson discloses a mobile system "for processing and using raw natural gas that is normally flared at the site of oil and gas field operation facilities." [EX1005, [0002].] Specifically, Dickerson discloses a membrane separation unit for separating useful fuel gas from raw natural gas produced at an oil or gas production facility, and a gas engine that uses the fuel gas to generate electricity. [EX1005, [0006]].

103. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

iii. Limitation [1b]

> "a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and"

104. Dickerson discloses that the "gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110." [EX1005, [0026]]. As shown in FIG. 1, the generator 112 is connected (via the gas conditioning system 100) to the source of combustible gas to receive a continuous flow of combustible gas to power the generator.



Dickerson, EX1005, FIG.1 (annotated)

105. To the extent that one argues that the generator needs to be "directly" connected to the source of combustible gas, Dickerson also discloses that "the gas may be of sufficient quality to burn directly out of the well without any membrane treatment." [EX1005, [0039]].

106. Dickerson further discloses a continuous flow of combustible gas (e.g., natural gas) because it discloses that "[i]n an application where the facility operator contemplates times when raw natural gas flow will be interrupted, a stand-by diesel generator is provided." [EX1005, [0021]].

107. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

iv. Limitation [1c]

"blockchain mining devices connected to the generator; in which:"

108. As discussed above, in the Dickerson-CryptoKube combination, the combined device would have (1) Dickerson's mobile power generation system; and (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator.

109. For these reasons, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that the Dickerson-CryptoKube combination discloses this limitation.

v. Limitation [1c_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

110. *See* Mr. Kasdorf's declaration on Limitation [1c_i].

vi. Limitation [1c_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

111. *See* Mr. Kasdorf's declaration on Limitation [1c_ii].

vii. Limitation [1c_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

112. *See* Mr. Kasdorf's declaration on Limitation [1c_iii].

viii. Limitation [1c_iv]

"the network is a peer-to-peer network;"

113. *See* Mr. Kasdorf's declaration on Limitation [1c_iv].

ix. Limitation [1c_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

114. *See* Mr. Kasdorf's declaration on Limitation [1c_v].

x. Limitation [1c_vi]

"the blockchain database stores transactional information for a digital currency."

115. *See* Mr. Kasdorf's declaration on Limitation [1c_vi].

b. Dependent Claim 2

"The system of claim 1 isolated from a sales gas line and an external electrical power grid."

116. Dickerson discloses a mobile system "for processing and using raw natural gas that is normally flared at the site of oil and gas field operation facilities." [EX1005, [0002]]. Dickerson explains that the gas needs to be flared "because of the lack of gas pipeline takeaway capacity." [EX1005, [0003]]. Dickerson also discloses that its system allows "utilizing field gas directly and avoids to move the gas from a remote float/station to a processing field line before utilizing." [EX1005, [0036]]. Thus, Dickerson discloses that the system is isolated from a sales gas line.

117. Dickerson also discloses that "the system can provide power for both local consumption and also for export to the grid at the same time **if the power lines are accessible from the site**." [EX1005, [0039]]. Dickerson also discloses that oil and gas production facilities are typically located in remote areas where no utility power is available. [EX1005, [0024]]. Dickerson also discloses that the "generated electricity powers either a **local grid (island operation)** or will be fed into the main grid." [EX1005, claim 4]. Thus, Dickerson discloses the situation that the system is isolated from an external electrical power grid.

118. For these reasons, I believe a POSITA would have understood that Dickerson discloses limitation 2.0.

c. Dependent Claim 3

"The system of claim 1 in which: the source of combustible gas and the facility comprise a remote well selected from a group consisting of a remote oil or gas well; and the remote well is connected to produce the continuous flow of combustible gas to power the generator."

119. Dickerson describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]]. Dickerson explains that oil and gas production facilities are typically located in **remote** areas where no utility power is available. [EX1005, [0024]]. Dickerson discloses that one or more containers can be moved as an operator expands or contracts its drilling sites to different or additional **remote** locations. [EX1005, [0024]].

120. Dickerson further discloses that the gas engine genset is compact, containerized/skid mounted, and mobile which makes the system particularly suitable for **remote** sites. [EX1005, [0027]]. Dickerson discloses that its system allows "utilizing field gas directly and avoids to move the gas from a **remote float/station** to a processing field line before utilizing." [EX1005, [0036]].

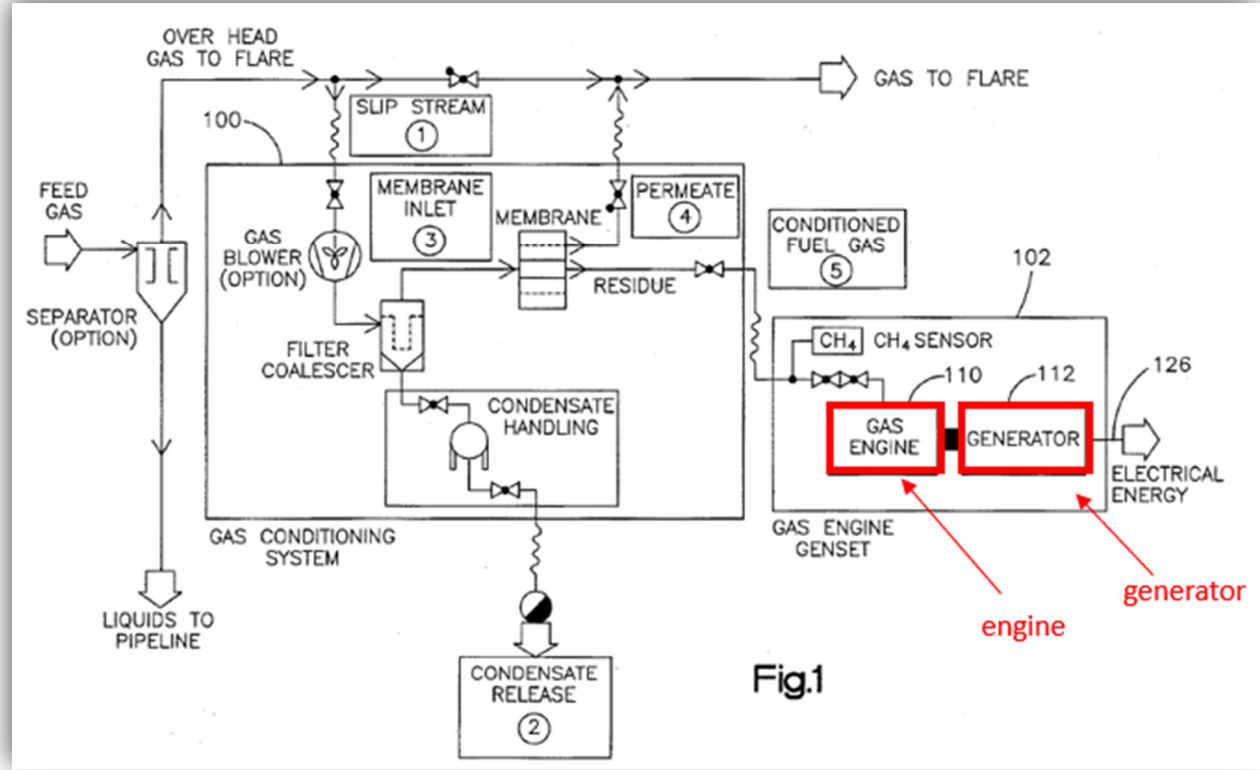
121. Dickerson further discloses a continuous flow of combustible gas (e.g., natural gas) because it discloses that "[i]n an application where the facility operator contemplates times when raw natural gas flow will be interrupted, a stand-by diesel generator is provided." [EX1005, [0021]].

122. For these reasons, I believe a POSITA would have understood that Dickerson discloses limitation 3.0.

d. <u>Dependent Claim 4</u>

> "The system of claim 3 further comprising a combustion engine connected to the source of combustible gas and connected to drive the generator."

123. Dickerson discloses that the "gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110." [EX1005, [0026]]. As shown in FIG. 1, the generator 112 is connected (via the gas conditioning system 100) to the source of combustible gas to receive a continuous flow of combustible gas to power the generator.



Dickerson, EX1005, FIG. 1 (annotated)

124. To the extent that one argues that the generator needs to be "directly" connected to the source of combustible gas, Dickerson also discloses that "the gas may be of sufficient quality to burn directly out of the well without any membrane treatment." [EX1005, [0039]].

125. Dickerson discloses that examples of suitable gas engines are illustrated in U.S. Patent 6,161,386 (depicting a **combustor**, turbine, and electricity generator). [EX1005, [0021]]. Thus, Dickerson discloses a combustion engine (gas engine 110) connected to the source of combustible gas and connected to drive the generator (generator 112).

126. For these reasons, I believe a POSITA would have understood that Dickerson discloses limitation 4.0.

e. Dependent Claim 8

> "The system of claim 1 in which the generator and blockchain mining devices are located adjacent to the facility."

127. A POSITA would understand that the '372 patent discloses that the generator and blockchain mining device may be located adjacent to the remote oil well, for example within one hundred meters. [The '372 patent, 9:17-19].

128. As discussed above, in the Dickerson-CryptoKube combination, the combined device would have (1) Dickerson's mobile power generation system; and (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4].

129. Dickerson discloses that the gas engine genset is compact, containerized/skid mounted, and mobile which makes the system particularly suitable for remote sites. [EX1005, [0027]]. Dickerson discloses that its system allows "utilizing field gas directly and avoids to move the gas from a remote float/station to a processing field line before utilizing." [EX1005, [0036]].

130. Per Mr. Kasdorf's Declaration, the CryptoKube video shows that the CryptoKube is built inside an ISO shipping container that is easy to relocate and CyptoKube can run inside a large warehouse, outside in a parking lot or in a server pod farm where the power is cheapest. [EX1006, 1-4].

131. Thus, the combined device is mobile, and in order to save infrastructure costs and to avoid transporting the flare gas over a long distance, a POSITA would have found it obvious that the generator and blockchain mining devices are located adjacent to the facility (e.g., within one hundred meters).

132. For these reasons, I believe a POSITA would have understood that the Dickerson-CryptoKube combination discloses limitation 8.0.

f. Dependent Claim 16

"The system of claim 1 in which a controller is connected to operate a cooling system to maintain the blockchain mining devices within a predetermined operating range of temperature."

133. *See* Mr. Kasdorf's declaration on Limitation [16].

g. Dependent Claim 17

"The system of claim 1 in which the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer."

134. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4]. Thus, a POSITA would understand that it is easy to combine the two by simply combining two ISO shipping containers into one. A POSITA would have been motivated to do so because it will save transportation costs. Dickerson discloses that the gas engine genset is compact, **containerized/skid mounted**, and mobile which makes the system particularly suitable for remote sites. [EX1005, [0027]]. Dickerson discloses that the mobile platform (container) is a part of a vehicle trailer. [EX1005, claim 3]. Per Mr. Kasdorf's declaration, the CryptoKube video shows that the CryptoKube is built inside an ISO shipping container that is easy to relocate. [EX1006, 1-4].

CryptoKube video, EX1007, 0:01:08

135. Thus, in the combined device, the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer.

136. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

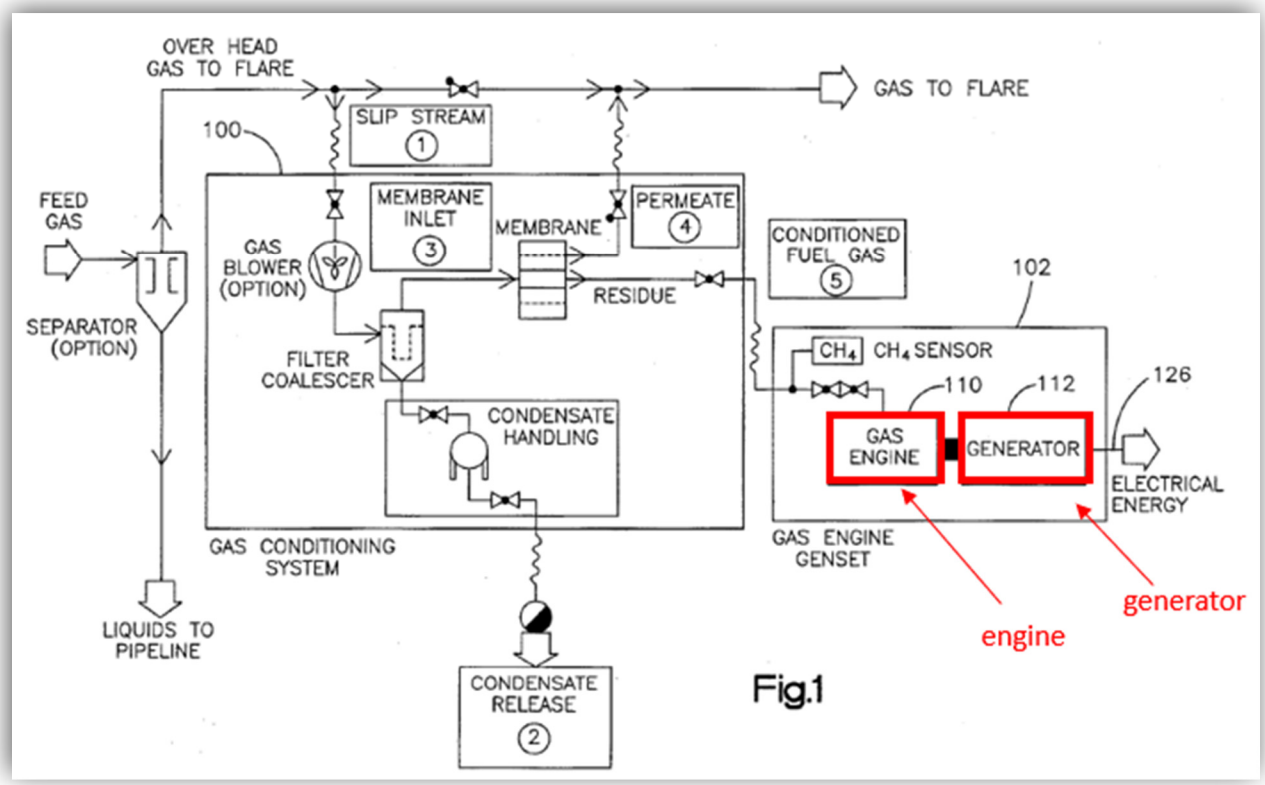
h. Dependent Claim 18

"The system of claim 17 in which the portable enclosure comprises a generator driven by an engine, which is connected to the source of combustible gas."

137. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4]. Thus, it is easy to combine the two by simply combining two ISO shipping containers into one. A POSITA would have been motivated to do so because it will save transportation costs. Dickerson

discloses that the gas engine genset is compact, **containerized/skid mounted**, and mobile which makes the system particularly suitable for remote sites. [EX1005, [0027]]. Dickerson discloses that the mobile platform (container) is a part of a vehicle trailer. [EX1005, claim 3].

138. Dickerson's system includes (1) one membrane separation unit for separating useful fuel gas from raw natural gas produced at an oil or gas production facility, (2) a gas engine that uses the fuel gas to generate electricity that is returned to the facility, and (3) a control panel for operating the apparatus. [EX1005, [0005]]. FIG. 1 of Dickerson shows one setup of its combined gas conditioning and power generation system. [EX1005, [0008]]. As shown in FIG. 1, gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110. [EX1005, [0026]].



Dickerson, EX1005, FIG. 1 (annotated)

139. Thus, in the combined device, the portable enclosure (ISO container) comprises a generator driven by an engine, which is connected to the source of combustible gas.

140. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

i. Dependent Claim 19

"The system of any claim 18 in which the engine comprises a turbine."

141. Dickerson discloses that examples of suitable gas engines are illustrated in U.S. Patent 6,161,386 (depicting a combustor, **turbine**, and electricity generator). [EX1005, [0021]]. Thus, Dickerson discloses a combustion engine (gas engine 110) connected to the source of combustible gas and connected to drive the generator (generator 112).

142. Thus, Dickerson discloses that the engine comprises a turbine.

143. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

j. Dependent Claim 20

"The system of claim 17 in which the portable enclosure comprises an intermodal transport container."

144. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4]. Dickerson discloses that the gas engine genset is compact, containerized/skid mounted, and mobile which makes the system particularly suitable for remote sites. [EX1005, [0027]]. Per Mr. Kasdorf's Declaration, the CryptoKube video shows that the CryptoKube is built inside an ISO shipping container with walls, a top, and a base, with an access door formed in the walls.

CryptoKube video, EX1007, 0:01:08

145. Thus, in the combined device, the portable enclosure comprises an intermodal transport container (an ISO container).

146. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

k. Dependent Claim 21

"The system of claim 17 in which the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls."

147. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4]. Dickerson discloses that the gas engine genset is compact, containerized/skid mounted, and mobile which makes the system particularly suitable for remote sites. [EX1005, [0027]]. Per Mr.

Kasdorf's Declaration, the CryptoKube video shows that the CryptoKube is built inside an ISO shipping container with walls, a top, and a base, with an access door formed in the walls.

CryptoKube video, EX1007, 0:01:08

148. Thus, in the combined device, the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls.

149. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

l. Dependent Claim 22

> "The system of claim 1 further comprising a combustible gas disposal device, at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas."

150. A POSITA would understand that the ’372 patent discloses examples of a gas disposal device including a flare, a vent to the atmosphere, an incinerator, a burner, and other suitable devices. [The ’372 patent, 11:41-44].

151. Dickerson discloses this limitation. Dickerson’s system includes such a gas disposal device at least because it includes a flare. [EX1005, [0028]]. FIG. 1 of Dickerson shows one setup of its combined gas conditioning and power generation system. [EX1005, [0008]]. As shown in FIG. 1, the inlet gas enters the filter coalesce which removes any liquid condensates/aerosols (#2) formed and the overhead gas next enters the membrane vessels, which split the inlet (#3) into two streams—the membranes preferentially permeate the heavy hydrocarbons, CO2, water and H2S, and the resulting permeate stream (#4) is flared. [EX1005, [0028]].

152. Thus, Dickerson discloses a combustible gas disposal device (a flare), at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas.

153. Dickerson further discloses that a chiller unit can be included to remove natural gas liquids (NGLs) from the raw natural gas stream, and to further reduce the flaring of raw natural gas. [EX1005, [0022]].

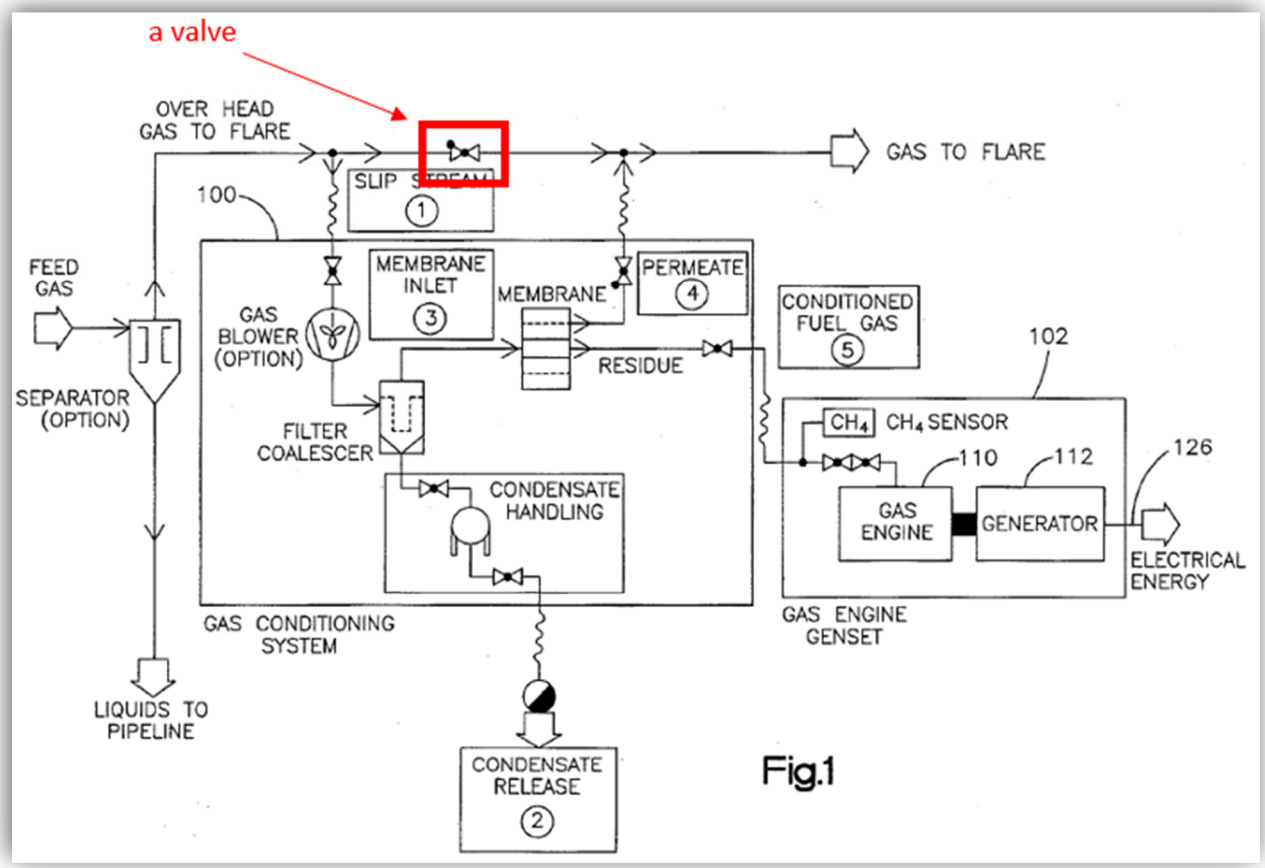
154. Thus, Dickerson discloses another combustible gas disposal device (a chiller), at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas.

155. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

m. <u>Dependent Claim 23</u>

"The system of claim 22 further comprising a valve connected upstream of the generator to receive the continuous flow of gas from the source of combustible gas, and selectively supply the continuous flow of gas to the generator, the combustible gas disposal device, or both the generator and the combustible gas disposal device, to selectively divert the continuous flow of gas to the combustible gas disposal device, the generator, or both the generator and the combustible gas disposal device, respectively."

156. Dickerson discloses this limitation. FIG. 1 of Dickerson shows one setup of its combined gas conditioning and power generation system. [EX1005, [0008]]. As shown in FIG. 1, a valve is connected upstream of the generator, and can selectively supply the over head gas to flare either (1) to the flare, or (2) to the gas conditioning system 100.



Dickerson, EX1005, FIG. 1

157. Thus, Dickerson discloses a valve connected upstream of the generator to receive the continuous flow of gas from the source of combustible gas, and selectively supply the continuous flow of gas to the generator (genset 102), the combustible gas disposal device (the flare), or both the generator and the combustible gas disposal device, to selectively divert the continuous flow of gas to the combustible gas disposal device, the generator, or both the generator and the combustible gas disposal device, respectively. By adjusting this valve, Dickerson can selectively supply and selectively divert the continuous flow of gas to either one or both of the flare and the generator.

158. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

n. <u>Independent Claim 24</u>

i. Limitation [24pre]

"A method comprising:"

159. To the extent the preamble is limiting, the Dickerson-CryptoKube combination renders [24pre] obvious. For example, Dickerson describes a method to generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]].

ii. Limitation [24a]

> "producing electricity using a generator and a source of combustible gas produced at a facility selected from the group consisting of a hydrocarbon production well, storage, or processing facility, and"

160. Dickerson describes a method to generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]]. Dickerson discloses that the gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110. [EX1005, [0026]].

161. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

iii. Limitation [24b]

> "operating blockchain mining devices located at the facility, respectively, using the electricity, in which:"

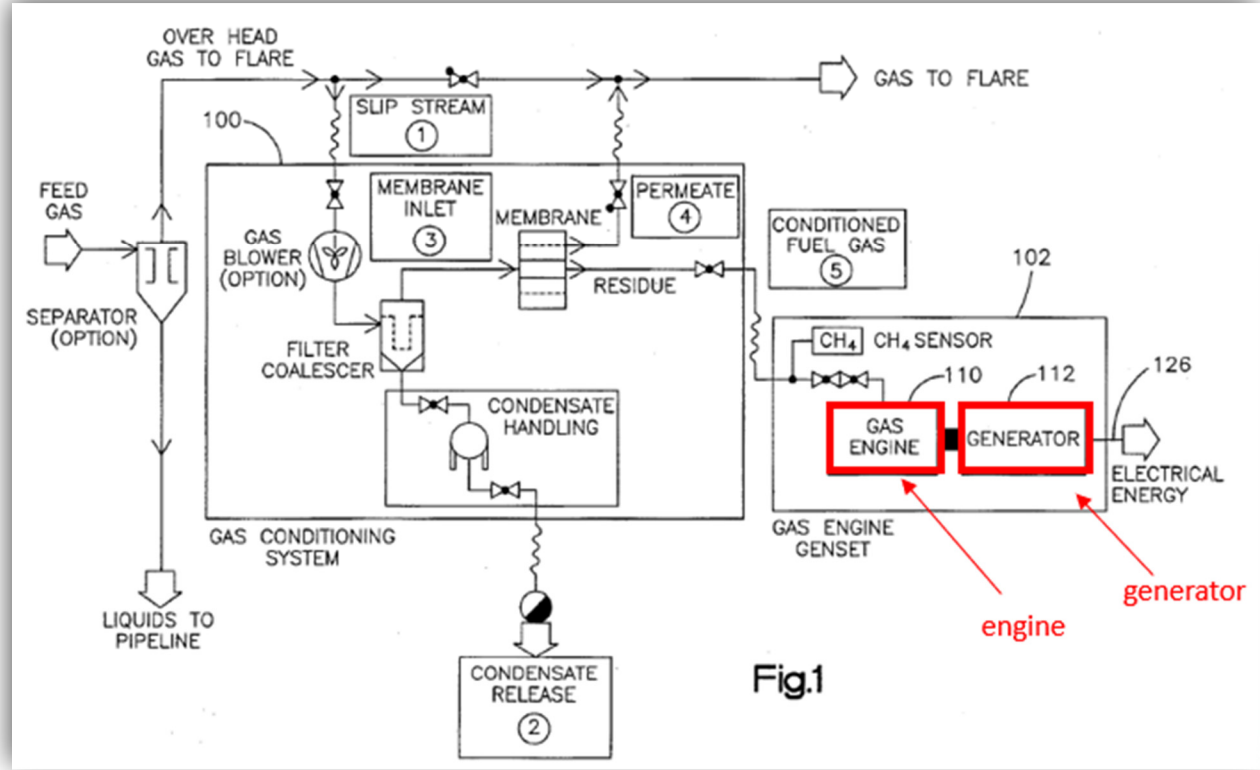
162. As discussed above, in the Dickerson-CryptoKube combination, the combined device would have (1) Dickerson's mobile power generation system; and (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator.

163. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

iv. Limitation [24c]

> "the generator is connected to the source of combustible gas, in which the facility is connected to produce a continuous flow of combustible gas to power the generator;"

164. Dickerson discloses that the "gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110." [EX1005, [0026]]. As shown in FIG. 1, the generator 112 is connected (via the gas conditioning system 100) to the source of combustible gas to receive a continuous flow of combustible gas to power the generator.



Dickerson, EX1005, FIG. 1 (annotated)

165. To the extent that one argues that the generator needs to be "directly" connected to the source of combustible gas, Dickerson also discloses that "the gas may be of sufficient quality to burn directly out of the well without any membrane treatment." [EX1005, [0039]].

166. Dickerson further discloses a continuous flow of combustible gas (e.g., natural gas) because it discloses that "[i]n an application where the facility operator contemplates times when raw natural gas flow will be interrupted, a stand-by diesel generator is provided." [EX1005, [0021]].

167. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

v. Limitation [24d_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

168. *See* Mr. Kasdorf's Declaration on Limitation [1c_i].

vi. Limitation [24d_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

169. See Mr. Kasdorf's Declaration on Limitation [1c_ii].

vii. Limitation [24d_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

170. *See* Mr. Kasdorf's Declaration on Limitation [1c_iii].

viii. Limitation [24d_iv]

"the network is a peer-to-peer network;"

171. *See* Mr. Kasdorf's Declaration on Limitation [1c_iv].

ix. Limitation [24d_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

172. *See* Mr. Kasdorf's Declaration on Limitation [1c_v].

x. Limitation [24d_vi]

"the blockchain database stores transactional information for a digital currency."

173. *See* Mr. Kasdorf's Declaration on Limitation [1c_vi].

o. <u>Dependent Claim 25</u>

The method of claim 24 further comprising, prior to using the source of combustible gas: one or both disconnecting or diverting the source of combustible gas from a combustible gas disposal device at the facility; and connecting the source of combustible gas to operate the blockchain mining devices.

174. Dickerson describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1005, Abstract, [0002]]. Dickerson discloses "delivering the apparatus to an oil or gas production facility, connecting and operating the apparatus while the facility is generating raw natural gas, and disconnecting and removing the apparatus from the site when raw natural gas is no longer being generated." [EX1005, Abstract]. A POSITA would have understood that prior to using the source of combustible gas, the source of combustible gas needs to be disconnected or diverted from a combustible gas disposal device (a flare) to operate the Dickerson's system and to operate the blockchain mining devices in the CryptoKube miner.

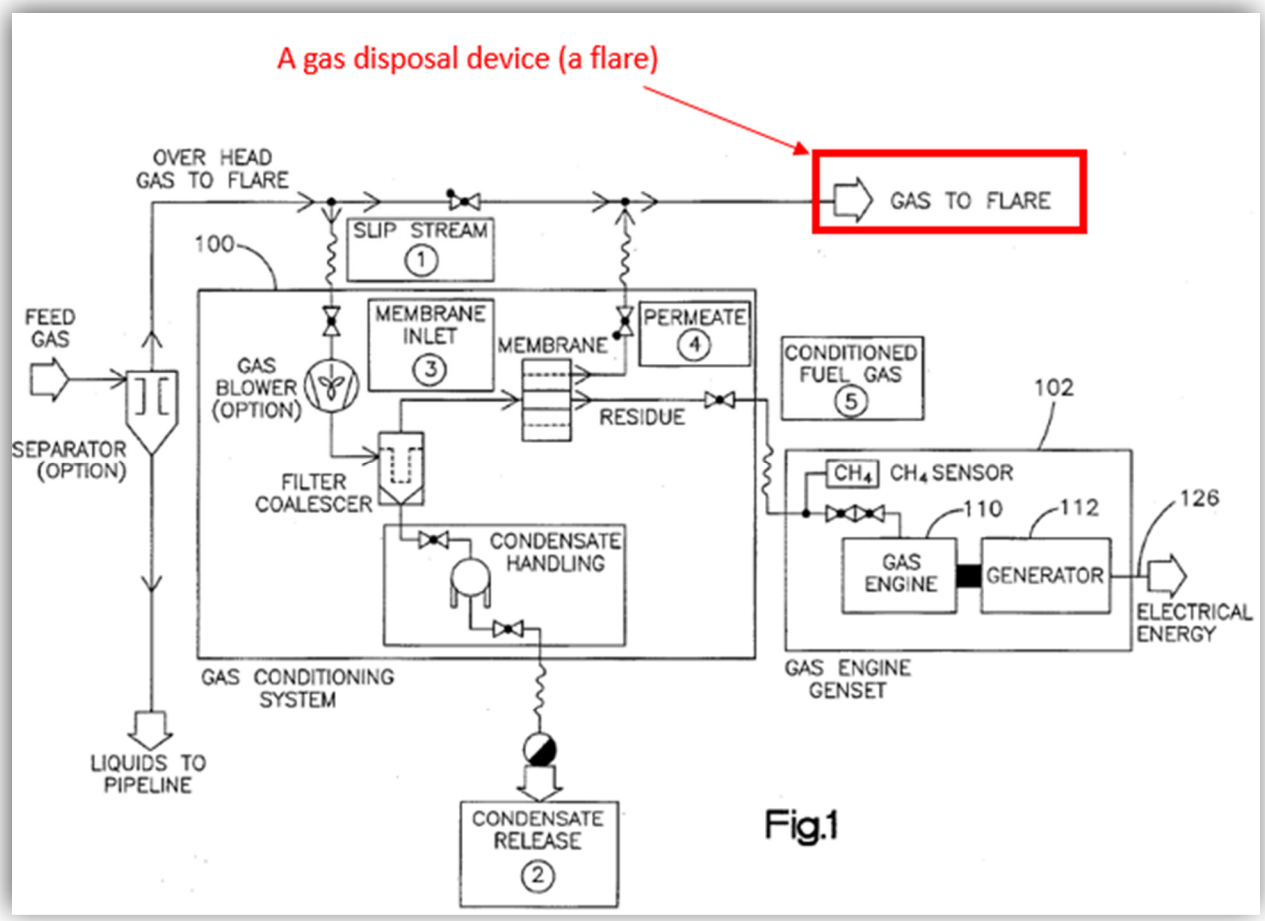
175. For these reasons, Dickerson renders this limitation obvious.

p. <u>Dependent Claim 26</u>

> "The method of claim 25 in which the combustible gas disposal device comprises one or more of a flare, a vent to the atmosphere, an incinerator, or a burner."

176. Dickerson's system includes a gas disposal device in the form of a flare. [EX1005, [0028]]. FIG. 1 of Dickerson shows one setup of its combined gas conditioning and power generation system. [EX1005, [0008]]. As shown in FIG. 1, the inlet gas enters the filter coalesce which removes any liquid condensates/aerosols (#2) formed and the overhead gas next enters the membrane vessels, which split the inlet (#3) into two streams—the membranes preferentially permeate the heavy hydrocarbons, CO2, water and H2S, and the resulting permeate stream (#4) is flared. [EX1005, [0028]].

177. Thus, Dickerson discloses a gas disposal device in the form of a flare.



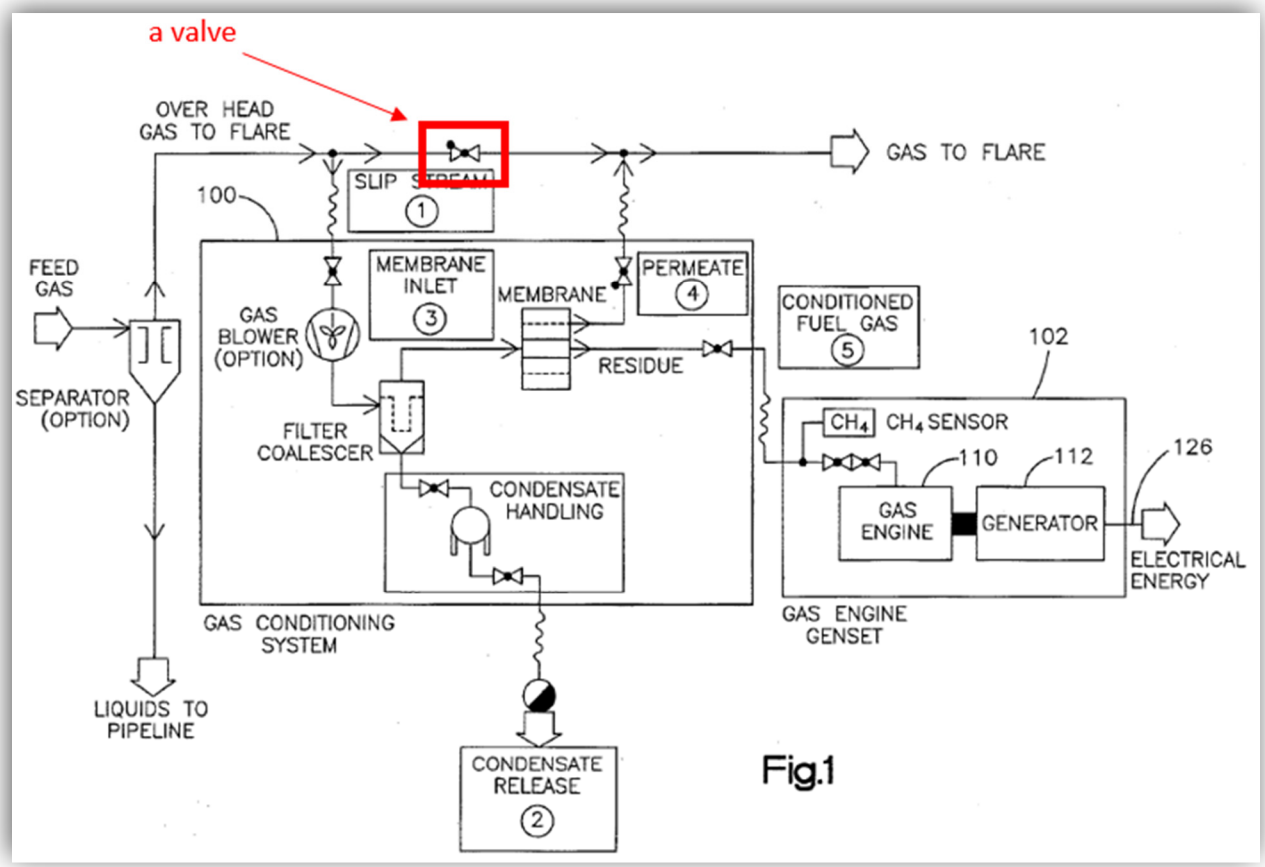
Dickerson, EX1005, FIG. 1 (annotated)

178. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

q. Dependent Claim 27

"The method of claim 24 further comprising: connecting the source of combustible gas to operate the blockchain mining devices; and diverting gas from a combustible gas disposal device to operate the blockchain mining devices."

179. FIG. 1 of Dickerson shows one setup of its combined gas conditioning and power generation system. [EX1005, [0008]]. As shown in FIG. 1, a valve is connected upstream of the generator, and can selectively supply the over head gas to flare either (1) to the flare, or (2) to the gas conditioning system 100 and the gas genset 102.



Dickerson, EX1005, Fig. 1 (annotated)

180. Thus, Dickerson discloses connecting the source of combustible gas to operate the blockchain mining devices; and diverting gas from a combustible gas disposal device (a flare) to operate the blockchain mining devices.

181. For these reasons, I believe a POSITA would have understood that Dickerson discloses this limitation.

r. Dependent Claim 28

"The method of claim 24 in which the facility is selected from a group consisting of an oil or gas well that is isolated from a sales gas line and an external electrical power grid."

182. Dickerson discloses this limitation for the same reasons that I explained with respect to limitation [2.0] above.

s. Dependent Claim 29

"The method of claim 24 in which the source of combustible gas is a remote well selected from a group consisting of a remote oil or gas well."

183. Dickerson discloses this limitation for the same reasons that I explained with respect to limitation [3.0] above.

t. Dependent Claim 30

"The method of claim 24 in which producing further comprises supplying combustible gas to a combustion engine that is connected to drive the generator."

184. Dickerson discloses this limitation for the same reasons that I explained with respect to limitation [4.0] above.

u. Dependent Claim 34

"The method of claim 29 further comprising operating the blockchain mining devices to: mine transactions with the blockchain mining devices; and communicate wirelessly through the internet to communicate with a blockchain database."

185. *See* Mr. Kasdorf's Declaration on Limitation [34].

XIV. ANALYSIS OF DICKERSON, CRYPTOKUBE, AND BELADY-989 (GROUND 2)

186. For the reasons articulated in detail below, and based on my review of the '372 patent, the file history, the prior art cited here, Mr. Kasdorf's Declaration, and my years of experience in the oil and gas industry, a POSITA would have readily understood that claims 1-4, 8, 10-12, 15-30, 34-37, and 40 are obvious over the combination of Dickerson, CryptoKube, and Belady-989, in view of Szmigielski and Kheterpal.

A. It Would Have Been Obvious to a POSITA to Combine Dickerson, CryptoKube, and Belady-989 in view of Szmigielski and Kheterpal.

187. A POSITA would have found it obvious to combine Dickerson's mobile power generation system, CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator, and Belady-989's gas supply shock absorbers, in view of Szmigielski and Kheterpal.

188. As discussed above, Dickerson's system generates free excess electricity and Smigielski discloses that one of the biggest costs for Bitcoin miners is the cost of electricity and access to cheap power is desired. [EX1009, 90].

189. Thus, a POSITA would have found it obvious to couple the CryptoKube mobile bitcoin miner with Dickerson's system to utilize the free excess electricity.

190. Both the Dickerson system and the CryptoKube system are containerized and built inside an ISO shipping container to confer better mobility. [EX1005, [0014]]; [EX1006, 1-4]. Thus, it is easy to combine the two by simply combining two ISO shipping containers into one.

191. In the Dickerson-CryptoKube combination, the combined device would have (1) Dickerson's mobile power generation system; and (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator.

192. Belady-989 describes a gas supply shock absorber (containing a gas storage) that is used to improve a data center system powered by a natural gas generator. [EX1011, Abstract]. If the shock absorber has sufficient gas, a co-located data center utilizes such gas for increased electrical power generation during increased processing activity, which can be requested or generated. [EX1011, Abstract]. Conversely, if the shock absorber has insufficient gas, and a negative pressure spike occurs, the data center throttles down or offloads processing. [EX1011, Abstract].

193. Dickerson discloses that "auxiliary means for providing electricity is provided when there will likely be periods when the production facility will require electricity but will be generating no or low levels of raw natural gas." [EX1005, [0021]]. A POSITA would have understood that the flow of raw natural gas from the oil and gas facility may fluctuate and would

have been motivated to further improve the Dickerson-CryptoKube combination by employing Belady-989's gas supply shock absorber because doing so will improve the energy usage efficiency. Indeed, Belady-989 discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Szmigielski also discloses that "[i]ndustrial miners face almost the same issues as data centers: access to relatively cheap power, good network access…" [EX1009, 103].

194. Thus, a POSITA would have been motivated to combine Dickerson, CryptoKube and Belady-989, to use Belady-989's gas supply shock absorber to improve energy usage efficiency.

195. In the Dickerson-CryptoKube-Belady-989 combination, the combined device would have (1) Dickerson's mobile power generation system; (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator; and (3) Belady-989's gas supply shock absorber.

B. The Combination of Dickerson, CryptoKube, and Belady-989 Renders Claims 1-4, 8, 10-12, 15-30, 34-37, and 40 Obvious.

196. As I explain below, the combination of Dickerson, Crypto, and Belady-989 renders obvious all limitations of claims 1-4, 8, 10-12, 15-30, 34-37, and 40. As stated above, I relied on Mr. Kasdorf's opinions and explanations related to CryptoKube, Szmigielski, and Kheterpal for the purposes of this Declaration.

a. <u>Independent Claim 1</u>

i. Limitation [1pre]

"A system comprising:"

197. As I explained above in Ground 1, to the extent the preamble is limiting, combining Dickerson and CryptoKube renders [1pre] obvious. *See* discussion in Ground 1.

ii. Limitation [1a]

> "a source of combustible gas produced from a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;"

198. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

199. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

200. For these reasons, to the extent that one argues that limitation [1a] is not rendered obvious by Dickerson, limitation [1a] would be rendered obvious by combining Dickerson and Belady-989.

iii. Limitation [1b]

> "a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and"

201. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

202. Belady-989 further discloses that gas-to-electricity converter 180 can be a generator. [EX1011, [0019]].

203. For these reasons, to the extent that one argues that limitation [1b] is not rendered obvious by Dickerson, limitation [1b] would be rendered obvious by combining Dickerson and Belady-989.

iv. Limitation [1c]

"blockchain mining devices connected to the generator; in which:"

204. As I explained above in Ground 1, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that combining Dickerson and CryptoKube discloses this limitation.

v. Limitation [1c_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

205. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_i].

206. Further, Belady-989 discloses that "the data center 190 can comprise a communication connection 191 to a network 199." [EX1011, [0029]].

vi. Limitation [1c_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

207. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_ii].

vii. Limitation [1c_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

208. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_iii].

viii. Limitation [1c_iv]

"the network is a peer-to-peer network;"

209. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_iv].

ix. Limitation [1c_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

210. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_v].

x. Limitation [1c_vi]

"the blockchain database stores transactional information for a digital currency."

211. *See* Mr. Kasdorf's declaration on Ground, 1 Limitation [1c_vi].

b. <u>Dependent Claim 2</u>

"The system of claim 1 isolated from a sales gas line and an external electrical power grid."

212. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses limitation 2.0.

213. Belady-989 further discloses data centers often consume large quantities of electrical power and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Specifically, Belady-989 explains that "natural gas is a byproduct of oil drilling operations and is often considered a waste byproduct since it cannot be economically captured and brought to market." Id. Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

214. For these reasons, to the extent that one argues that limitation [2.0] is not rendered obvious by Dickerson, limitation [2.0] would be rendered obvious by combining Dickerson and Belady-989.

c. <u>Dependent Claim 3</u>

"The system of claim 1 in which: the source of combustible gas and the facility comprise a remote well selected from a group consisting of a remote oil or gas well; and the remote well is connected to produce the continuous flow of combustible gas to power the generator."

215. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses limitation 3.0.

216. Belady-989 further discloses that it has become more practical to perform digital data processing at a location remote from the location where such data is initially generated, and where the processed data will be consumed. [EX1011, [0002]].

217. For these reasons, to the extent that one argues that limitation [3.0] is not rendered obvious by Dickerson, limitation [3.0] would be rendered obvious by combining Dickerson and Belady-989.

d. Dependent Claim 4

> "The system of claim 3 further comprising a combustion engine connected to the source of combustible gas and connected to drive the generator."

218. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses limitation 4.0.

e. Dependent Claim 8

> "The system of claim 1 in which the generator and blockchain mining devices are located adjacent to the facility."

219. As I explained above in Ground 1, I believe a POSITA would have understood that the Dickerson-CryptoKube combination discloses limitation 8.0.

f. Dependent Claim 10

> "The system of claim 1 in which the system is configured to modulate a power load level exerted by the blockchain mining devices on the generator, by increasing or decreasing the mining activity of the mining processor."

220. As discussed above, in the Dickerson-CryptoKube-Belady-989 combination, the combined device would have (1) Dickerson's mobile power generation system; (2) CryptoKube's mobile bitcoin miner, wherein the bitcoin mining devices (spondooliestech SP31 servers) are connected to and powered by Dickerson's generator; and (3) Belady-989's gas supply shock absorber.

221. Belady-989 describes a gas supply shock absorber (containing a gas storage) that is used to improve a data center system powered by a natural gas generator. [EX1011, Abstract]. If the shock absorber has sufficient gas, a co-located data center utilizes such gas for increased electrical power generation during increased processing activity, which can be requested or generated. [EX1011, Abstract]. Conversely, if the shock absorber has insufficient gas, and a negative pressure spike occurs, the data center throttles down or offloads processing. [EX1011, Abstract]. Per Mr. Kasdorf's Declaration, CryptoKube discloses a monitoring server running a DCIM software that can be customized to monitor and control the individual miners. [EX1023, 0:00:08]. In his Declaration, Mr. Kasdorf explained that POSITA would have found it obvious to adapt CryptoKube's DCIM software to adjust the mining activity of the mining processors (e.g., by turning off a certain number of mining processors) based on input from Belady-989's tank pressure sensor.

222. Thus, in the Dickerson-CryptoKube-Belady-989 combination, the system is configured to modulate a power load level exerted by the blockchain mining devices on the generator, by increasing or decreasing the mining activity of the mining processor.

223. For these reasons, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that the combined device discloses this limitation.

g. <u>Dependent Claim 11</u>

> "The system of claim 10 in which the system is configured to modulate the power load level by selecting one or more actions from a group of actions consisting of increasing or decreasing a maximum number of mining processors that are engaged in mining transactions."

224. As I stated above with regard to Limitation [10.0], Mr. Kasdorf explained in his Declaration that a POSITA would have found it obvious to adapt CryptoKube's DCIM software to adjust the mining activity of the mining processors (e.g., by turning off a certain number of

mining processors) based on input from Belady-989's tank pressure sensor. For example, a POSITA would have found it obvious to adjust the mining activity of the mining processors by increasing or decreasing a maximum number of mining processors that are engaged in mining transactions.

225. For these reasons, I believe a POSITA would have understood that Belady-989 discloses this limitation.

h. <u>Dependent Claim 12</u>

> "The system of claim 10 in which the system is configured to modulate the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility."

226. As I stated above with regard to Limitation [10.0], Mr. Kasdorf explained in his Declaration that a POSITA would have found it obvious to adapt CryptoKube's DCIM software to adjust the mining activity of the mining processors (e.g., by turning off a certain number of mining processors) based on input from Belady-989's tank pressure sensor.

227. Belady-989 discloses that its gas supply shock absorber comprises pressure sensing valves and pressure regulating valves, which can detect positive pressure spikes in the gas supply and enable such overly pressurized gas to charge the gas storage, and which can also detect negative pressure spikes in the gas supply and, in response, make available the gas stored in the gas storage to compensate for such negative pressure spikes. [EX1011, [0015]]. Belady-989 further discloses that if the gas storage has a sufficient quantity of gas stored therein, the data center can utilize such gas to provide increased electrical power during periods of increased processing activity and workload. [EX1011, [0015]]. Conversely, if the gas storage has an insufficient quantity of gas stored therein, and the gas supply experiences a negative pressure spike, the computing devices of the data center can be throttled down to consume less electrical power. [EX1011, [0015]]. A POSITA would have found it obvious that Belady-989's gas pressure sensor

regulates the power load level of the bitcoin miners (e.g., by turning off a certain number of mining processors) based on input from Belady-989's tank pressure sensor in response to variations in a production rate of combustible gas.

228. Thus, in the Dickerson-CryptoKube-Belady-989 combination, the system is configured to modulate the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility.

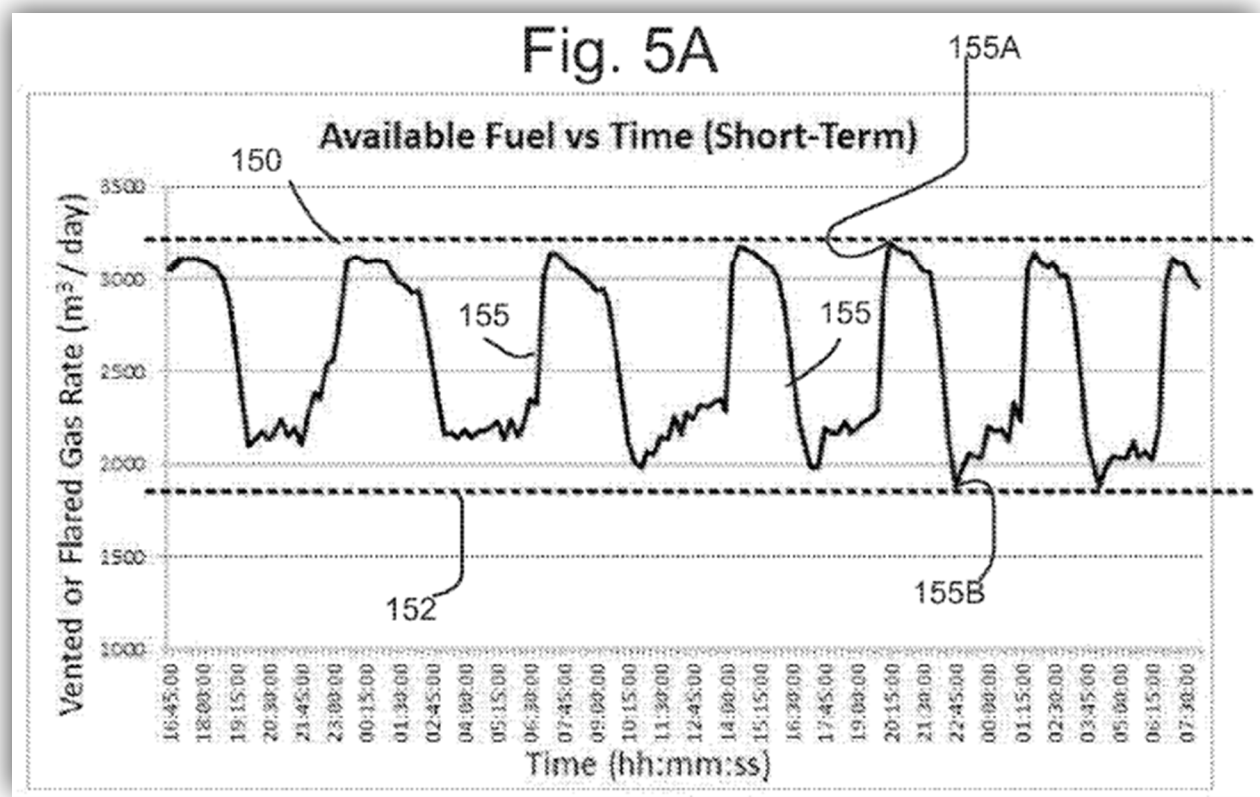
229. For these reasons, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that the combined device discloses this limitation.

i. Dependent Claim 15

> "The system of claim 10 in which: a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate; the controller is set to limit the power load level to above a power level producible by the generator when the production rate is at the daily minimum production rate; and a backup source, selected from a group consisting of fuel or electricity, is connected make up a shortfall in fuel or electricity, respectively, required to supply the blockchain mining devices with the power load level."

230. As I stated above with regard to Limitation [10.0], Mr. Kasdorf explained in his Declaration that a POSITA would have found it obvious to adapt CryptoKube's DCIM software to adjust the mining activity of the mining processors (e.g., by turning off a certain number of mining processors) based on input from Belady-989's tank pressure sensor.

231. Further, Belady-989 discloses "**positive gas pressure spikes** can occur with an average frequency such as, for example, occurring, on average, once every couple of hours or once every couple of days" [EX1011 [0036]]. This corresponds to the available fuel spikes in FIG. 5A in the '372 patent.



'372 patent, EX1001, FIG. 5A

232. Thus, Belady-989 discloses that, in the Dickerson-CryptoKube-Belady-989 combination, a production rate (positive gas pressure) of combustible gas from the hydrocarbon production well, storage, or processing facility **varies between a daily minimum production rate and a daily maximum production rate**.

233. Belady-989 further discloses that such historical data (of positive gas pressure spikes) can be taken into account to control the power load level of the data center. [EX1011, [0036]]. For example, if there is no anticipated positive gas pressure spike, one or more individual processing units can be throttled down, to reduce the overall energy consumption of the data center. [EX1011, [0036]]. When there are anticipated positive gas pressure spikes, a POSITA would have found it obvious to limit the power load level to above a power level producible by the generator

when the production rate is at the daily minimum production rate, to fully make use of the generated electricity.

234. Belady-989 discloses a backup source of fuel in the form of gas storage 160. Specifically, Belady-989 discloses that "**[s]hould the gas supply 110 subsequently experience a negative gas pressure spike**, such that the pressure of the gas supplied by the gas supply 110 decreases, in one embodiment, the gas pressure sensor 151 of the pressure sensing valve 150 can detect such a decrease in the gas pressure and can cause the gas shutoff valve 152 to open to enable gas from the gas storage 160 to flow into the piping 120, thereby increasing the gas pressure in the piping 120 and **providing the gas-to-electricity converter 180 with a sufficient pressure to continue to provide sufficient electrical power 181 to the data center**." [EX1011, [0025]].

235. Thus, Belady-989 discloses a backup source is connected make up a shortfall in fuel required to supply the blockchain mining devices with the power load level.

236. For these reasons, I believe a POSITA would have understood that Belady-989 discloses this limitation.

j. Dependent Claim 16

"The system of claim 1 in which a controller is connected to operate a cooling system to maintain the blockchain mining devices within a predetermined operating range of temperature."

237. *See* Mr. Kasdorf's Declaration on Ground 1, Limitation [16].

k. Dependent Claim 17

"The system of claim 1 in which the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer."

238. As I explained above in Ground 1, I believe a POSITA would have understood that the combination of Dickerson and CryptoKube discloses this limitation.

l. Dependent Claim 18

"The system of claim 17 in which the portable enclosure comprises a generator driven by an engine, which is connected to the source of combustible gas."

239. As I explained above in Ground 1, I believe a POSITA would have understood that the combination of Dickerson and CryptoKube discloses this limitation.

m. Dependent Claim 19

"The system of any claim 18 in which the engine comprises a turbine."

240. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

n. Dependent Claim 20

"The system of claim 17 in which the portable enclosure comprises an intermodal transport container."

241. As I explained above in Ground 1, I believe a POSITA would have understood that the combination of Dickerson and CryptoKube discloses this limitation.

o. Dependent Claim 21

"The system of claim 17 in which the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls."

242. As I explained above in Ground 1, I believe a POSITA would have understood that the combined device discloses this limitation.

p. Dependent Claim 22

"The system of claim 1 further comprising a combustible gas disposal device, at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas."

243. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

244. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

245. For these reasons, to the extent that one argues that limitation [22.0] is not rendered obvious by Dickerson, limitation [22.0] would be rendered obvious by combining Dickerson and Belady-989.

q. Dependent Claim 23

> "The system of claim 22 further comprising a valve connected upstream of the generator to receive the continuous flow of gas from the source of combustible gas, and selectively supply the continuous flow of gas to the generator, the combustible gas disposal device, or both the generator and the combustible gas disposal device, to selectively divert the continuous flow of gas to the combustible gas disposal device, the generator, or both the generator and the combustible gas disposal device, respectively."

246. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

247. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

248. For these reasons, to the extent that one argues that limitation [23.0] is not rendered obvious by Dickerson, limitation [23.0] would be rendered obvious by combining Dickerson and Belady-989.

r. Independent Claim 24

i. Limitation [24pre]

> "A method comprising:"

249. As I explained in above in Ground 1, to the extent the preamble is limiting, combining Dickerson and CryptoKube renders [24pre] obvious. *See* discussion in Ground 1.

ii. Limitation [24a]

> "producing electricity using a generator and a source of combustible gas produced at a facility selected from the group consisting of a hydrocarbon production well, storage, or processing facility, and"

250. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

251. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Belady-989 further discloses that gas-to-electricity converter 180 can be a generator. [EX1011, [0019]]. Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

252. For these reasons, to the extent that one argues that limitation [24a] is not rendered obvious by Dickerson, limitation [24a] would be rendered obvious by combining Dickerson and Belady-989.

iii. Limitation [24b]

> "operating blockchain mining devices located at the facility, respectively, using the electricity, in which:"

253. As I explained above in Ground 1, I believe a POSITA would have understood that combining Dickerson and CryptoKube discloses this limitation.

iv. Limitation [24c]

> "the generator is connected to the source of combustible gas, in which the facility is connected to produce a continuous flow of combustible gas to power the generator;"

254. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

v. Limitation [24d_i]

> "the blockchain mining devices each have a mining processor and are connected to a network interface;"

255. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_i].

256. Further, Belady-989 discloses that "the data center 190 can comprise a communication connection 191 to a network 199." [EX1011, [0029]].

vi. Limitation [24d_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

257. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_ii].

vii. Limitation [24d_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

258. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_iii].

viii. Limitation [24d_iv]

"the network is a peer-to-peer network;"

259. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_iv].

ix. Limitation [24d_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

260. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_v].

x. Limitation [24d_vi]

"the blockchain database stores transactional information for a digital currency."

261. *See* Mr. Kasdorf's declaration on Ground 1, Limitation [1c_vi].

s. <u>Dependent Claim 25</u>

"The method of claim 24 further comprising, prior to using the source of combustible gas: one or both disconnecting or diverting the source of combustible gas from a combustible gas disposal device at the facility; and connecting the source of combustible gas to operate the blockchain mining devices."

262. As I explained above in Ground 1, Dickerson renders this limitation obvious.

t. <u>Dependent Claim 26</u>

"The method of claim 25 in which the combustible gas disposal device comprises one or more of a flare, a vent to the atmosphere, an incinerator, or a burner."

263. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

264. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

265. For these reasons, to the extent that one argues that limitation [26] is not rendered obvious by Dickerson, limitation [26] would be rendered obvious by combining Dickerson and Belady-989.

u. Dependent Claim 27

"The method of claim 24 further comprising: connecting the source of combustible gas to operate the blockchain mining devices; and diverting gas from a combustible gas disposal device to operate the blockchain mining devices."

266. As I explained above in Ground 1, I believe a POSITA would have understood that Dickerson discloses this limitation.

267. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

268. For these reasons, to the extent that one argues that limitation [27] is not rendered obvious by Dickerson, limitation [27] would be rendered obvious by combining Dickerson and Belady-989.

v. Dependent Claim 28

"The method of claim 24 in which the facility is selected from a group consisting of an oil or gas well that is isolated from a sales gas line and an external electrical power grid."

269. Dickerson discloses this limitation for the same reasons that I explained with respect to limitation [2.0] above in Ground 1.

270. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Specifically, Belady-989 explains that "natural gas is a byproduct of oil drilling operations and is often considered a waste byproduct since it cannot be economically captured and brought to market." *Id.* Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

271. For these reasons, to the extent that one argues that limitation [28] is not rendered obvious by Dickerson, limitation [28] would be rendered obvious by combining Dickerson and Belady-989.

w. <u>Dependent Claim 29</u>

"The method of claim 24 in which the source of combustible gas is a remote well selected from a group consisting of a remote oil or gas well."

272. Dickerson discloses this limitation for the same reasons that I explained with respect to limitation [3.0] above in Ground 1.

273. Belady-989 further discloses that it has become more practical to perform digital data processing at a location remote from the location where such data is initially generated, and where the processed data will be consumed. [EX1011, [0002]].

274. For these reasons, to the extent that one argues that limitation [29] is not rendered obvious by Dickerson, limitation [29] would be rendered obvious by combining Dickerson and Belady-989.

x. <u>Dependent Claim 30</u>

"The method of claim 24 in which producing further comprises supplying combustible gas to a combustion engine that is connected to drive the generator."

275. Dickerson discloses this limitation for the same reasons that I explained with respect to limitation [4.0] above in Ground 1.

y. Dependent Claim 34

"The method of claim 29 further comprising operating the blockchain mining devices to: mine transactions with the blockchain mining devices; and communicate wirelessly through the internet to communicate with a blockchain database."

276. *See* Mr. Kasdorf's Declaration (EX1004) on Ground 1, Limitation [34].

z. Dependent Claim 35

"The method of claim 34 further comprising modulating a power load level exerted by the blockchain mining devices on the generator, by selecting an action from a group of actions consisting of increasing or decreasing, a mining activity of the blockchain mining devices."

277. The Dickerson-CryptoKube-Belady-989 combination discloses this limitation for the same reasons that I explained with respect to limitation [10.0] above in Ground 2.

aa. Dependent Claim 36

"The method of claim 35 in which: modulating comprises modulating the power load level by increasing or decreasing a maximum number of mining processors that are engaged in mining transactions."

278. Belady-989 discloses this limitation for the same reasons that I explained with respect to limitation [11.0] above in Ground 2.

bb. Dependent Claim 37

"The method of claim 36 in which modulating comprises modulating the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility."

279. The Dickerson-CryptoKube-Belady-989 combination discloses this limitation for the same reasons that I explained with respect to limitation [12.0] above in Ground 2.

cc. Dependent Claim 40

"The method of claim 35 in which: a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate; modulating comprises

limiting the power load level to above a power level produced by the generator when the production rate is at the daily minimum production rate; and supplying from a backup source, which is selected from a group consisting of a backup fuel or electricity source a shortfall in fuel or electricity, respectively, required to supply the blockchain mining devices with the power load level."

280. Belady-989 discloses this limitation for the same reasons I explained with respect to limitation [15.0] above in Ground 2.

XV. ANALYSIS OF DICKERSON, CRYPTOKUBE, BELADY-989, AND BOOT (GROUND 3)

281. For the reasons articulated in detail below, and based on my review of the '372 patent, the file history, the prior art cited here, Mr. Kasdorf's declaration, and my years of experience in the oil and gas industry, a POSITA would have readily understood that claims 1-4, 7-12, 15-30, 34-37, and 40 are obvious over the combination of Dickerson, CryptoKube, Belady-989, and Boot, in view of Szmigielski and Kheterpal.

A. It Would Have Been Obvious to a POSITA to Combine Dickerson, CryptoKube, Belady-989, and Boot in view of Szmigielski and Kheterpal.

282. A POSITA would have found it obvious to improve the Dickerson-CryptoKube-Belady-989 combination by further including Boot's teachings, including using Boot's load bank to absorb excess power, and gathering oil and gas from multiple wells on a multi-well, and in view of Szmigielski and Kheterpal.

283. Similar to Dickerson, Boot discloses a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility that is isolated from a power grid. [EX1012, Abstract, 1:5-10, 4:6-7]. Boot discloses that the power generated may be more than the power required on an oil field pumping site, and that the excess power can be dissipated as heat in a load bank 110. [EX1012, 3:8-14]. Boot further discloses in FIG. 2 that the flare gas can be derived from more than one oil pumps or more than one well heads. [EX1012, FIG. 2, 3:42-46].

284. A POSITA would have found it obvious to improve the Dickerson-CryptoKube-Belady-989 combination by further including Boot's teachings including using Boot's load bank to absorb excess power, and gathering oil and gas from multiple wells on a multi-well pad.

285. A POSITA would have been motivated to include Boot's load bank because Boot teaches that the load bank can help keep the engine within its preferred operating parameters (for instance not running at too low a speed and hence too low a temperature). [EX1012, 3:8-14].

286. A POSITA would have been motivated to gather oil and gas from multiple wells on a multi-well pad because doing so can increase gas supply and increase the amount of electricity generated.

B. The Combination of Dickerson, CryptoKube, Belady-989, and Boot Renders Claims 1-4, 7-12, 15-30, 34-37, and 40 Obvious.

287. As I explain below, the combination of Dickerson, Crypto, and Belady-989 renders obvious all limitations of claims 1-4, 7-12, 15-30, 34-37, and 40. As stated above, I relied on Mr. Kasdorf's opinions and explanations related to CryptoKube, Szmigielski, and Kheterpal for the purposes of this Declaration.

a. Independent Claim 1

i. Limitation [1pre]

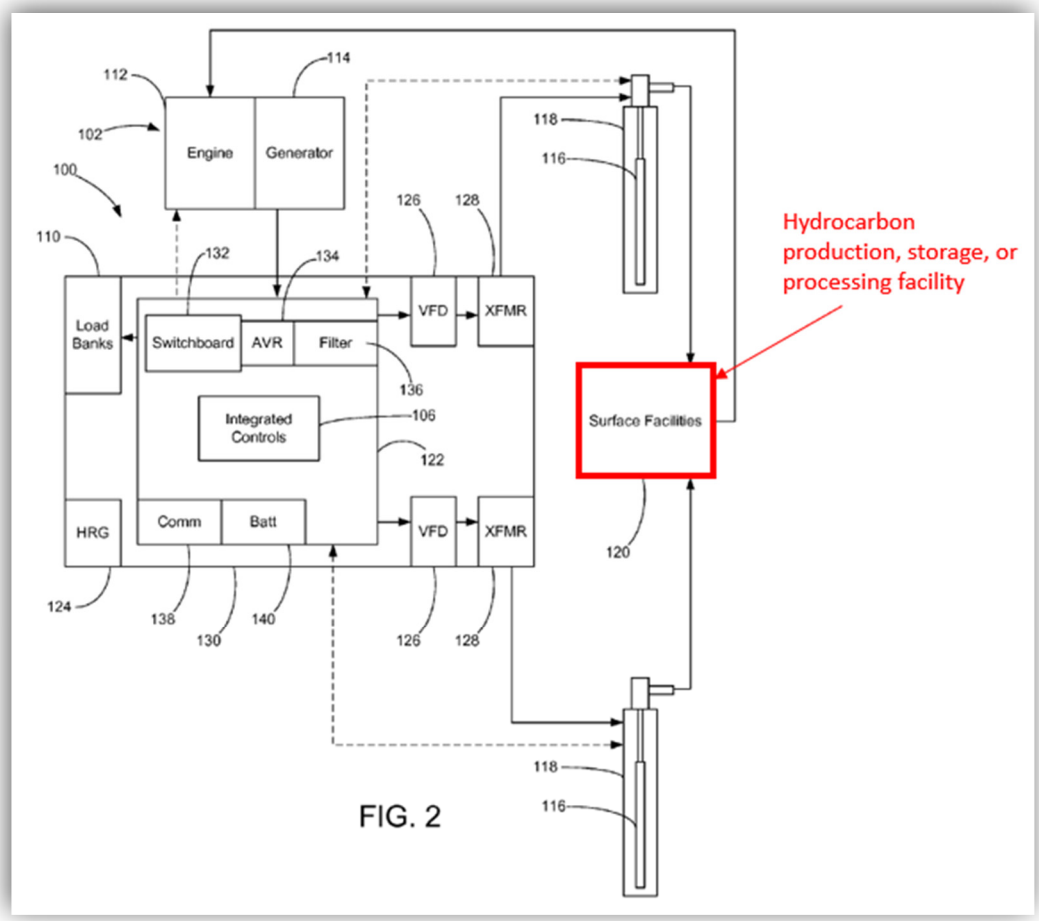
"A system comprising:"

288. To the extent the preamble is limiting, the Dickerson-CryptoKube-Belady-989-Boot combination renders [1pre] obvious. For example, Boot describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1012, Abstract, 1:5-10, 4:6-7]. CryptoKube also discloses a bitcoin miner system. [EX1006, 1-4].

ii. Limitation [1a]

"a source of combustible gas produced from a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;"

289. As shown in FIG. 2, Boot discloses that the electric submersible pumping system 116 pushes pumped fluids out of the well 118 to surface facilities 120 (e.g., phase separators, storage batteries and gathering lines). [EX1012, 3:37-42]. Boot discloses that the engine 112 operates on methane, ethane or other gases produced in the surface facilities 120 (e.g., phase separators), scavenged from the well 118. [EX1012, 3:62-4:2]. Boot explains that its system "will find particular utility in providing power to electric submersible pumping systems disposed in wells drilled in remote locations for the production of petroleum products." [EX1012, 3:25-31]. A POSITA would have understood that Boot's system discloses a source of combustible gas produced from a hydrocarbon production, storage, or processing facility in the form of surface facilities 120.



Boot, EX1012, FIG. 2 (annotated)

290. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

iii. Limitation [1b]

"a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and"

291. Boot discloses that the genset 102 includes a driver (engine) 112 coupled to a generator 114. [EX1012, 2: 29-30]. As discussed above, Boot further discloses that the engine 112 operates on methane, ethane or other gases produced in the surface facilities 120 (e.g., phase separators), scavenged from the well 118. [EX1012, 3:62-4:2].

292. Boot further discloses adjusting the output of the generator to accommodate the demand of the electrical loads. [EX1012, 3:4-7, 5:36-42, claim 1]. A POSITA would have found this requires a continuous flow of combustible gas to power the generator.

293. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

iv. Limitation [1c]

"blockchain mining devices connected to the generator; in which:"

294. *See* Ground 2 above.

v. Limitation [1c_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

295. *See* Ground 2 above.

vi. Limitation [1c_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

296. *See* Ground 2 above.

vii. Limitation [1c_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

297. *See* Ground 2 above.

viii. Limitation [1c_iv]

"the network is a peer-to-peer network;"

298. *See* Ground 2 above.

ix. Limitation [1c_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

299. *See* Ground 2 above.

x. Limitation [1c_vi]

"the blockchain database stores transactional information for a digital currency."

300. *See* Ground 2 above.

b. <u>Dependent Claim 2</u>

"The system of claim 1 isolated from a sales gas line and an external electrical power grid."

301. Boot discloses that its system is adapted for providing power to electric submersible pumping systems and associated auxiliary systems installed in locations without access to an established power grid. [EX1012, 1:5-10].

302. Boot further discloses that "[t]he driver is preferably an engine that is provided with combustible gases from the petroleum products of the well" and "[i]n the past, such gas have often been vented or flared at the well 118." [EX1012, 1:55-57, 4:6-7].

303. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

c. <u>Dependent Claim 3</u>

"The system of claim 1 in which: the source of combustible gas and the facility comprise a remote well selected from a group consisting of a remote oil or gas well; and the remote well is connected to produce the continuous flow of combustible gas to power the generator."

304. Boot describes a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility that is isolated from a power grid. [EX1012, Abstract, 1:5-10, 4:6-7]. Boot explains that its system "will find particular utility in providing power to electric submersible pumping systems disposed in wells drilled in remote locations for the production of petroleum products." [EX1012, 3:25-31].

305. Boot further discloses adjusting the output of the generator to accommodate the demand of the electrical loads. [EX1012, 3:4-7, 5:36-42, claim 1]. A POSITA would have found this requires a continuous flow of combustible gas to power the generator.

306. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

d. Dependent Claim 4

> "The system of claim 3 further comprising a combustion engine connected to the source of combustible gas and connected to drive the generator."

307. Boot discloses that the genset 102 includes a driver (engine) 112 coupled to a generator 114, where the engine produces mechanical power to drive the generator. [EX1012, 2: 29-35]. As discussed above, Boot further discloses that the engine 112 operates on methane, ethane or other gases produced in the surface facilities 120 (e.g., phase separators), scavenged from the well 118. [EX1012, 3:62-4:2]. Boot explains that "[t]hrough use of emission catalysts within the engine 112, the exhaust gases generated by combustion within the engine 112 present a significant environmental benefit." [EX1012, 4:8-11]. Thus, Boot discloses a combustion engine (engine 112) connected to the source of combustible gas (surface facilities 120) and connected to drive the generator (generator 114).

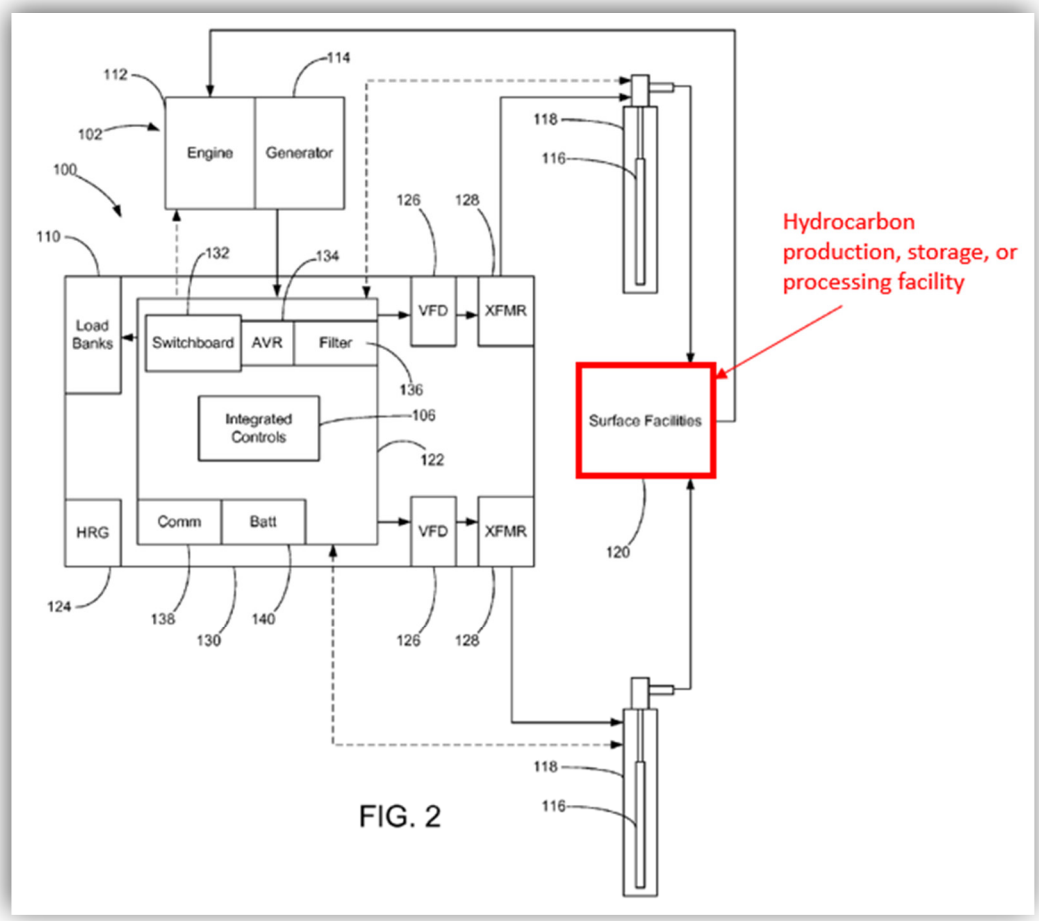
308. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

e. Dependent Claim 7

> "The system of claim 1 in which: the facility comprises a unit selected from a group consisting of an oil storage or processing unit; the source of combustible gas comprises the unit, which has a gas outlet connected to supply combustible gas to operate the generator; and the unit is connected to receive oil produced from a remote oil well."

309. As shown in FIG. 2, Boot discloses that the electric submersible pumping system 116 pushes pumped fluids out of the well 118 to surface facilities 120 (e.g., phase separators,

storage batteries and gathering lines). [EX1012, 3:37-42]. Boot discloses that the engine 112 operates on methane, ethane or other gases produced in the surface facilities 120 (e.g., phase separators), scavenged from the well 118. [EX1012, 3:62-4:2]. Thus, a POSITA would have understood that Boot's facility comprises an oil processing unit (surface facilities 120); the source of combustible gas comprises the unit, which has a gas outlet connected to supply combustible gas to operate the generator (generator 114); and the unit is connected to receive oil produced from a remote oil well (well 118).



Boot, EX1012, FIG. 2 (annotated)

310. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

f. Dependent Claim 8

"The system of claim 1 in which the generator and blockchain mining devices are located adjacent to the facility."

311. *See* Ground 2 above.

g. Dependent Claim 9

"The system of claim 1 in which the facility comprises a plurality of remote wells selected from a group consisting of remote oil or gas wells, and one or both of the following conditions are satisfied: the plurality of remote wells are located on a multi-well pad; or the plurality of remote wells include a satellite well."

312. Boot discloses that "[a]lthough two electric submersible pumping system 116 are depicted in FIG. 2, it will be appreciated that **fewer or greater numbers of electric submersible pumping systems 116** may be connected to a single independent power system 100." [EX1012, 3:42-46]. A POSITA would have understood that Boot's system comprises a plurality of remote oil wells, which can be located on a multi-well pad.

313. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

h. Dependent Claim 10

"The system of claim 1 in which the system is configured to modulate a power load level exerted by the blockchain mining devices on the generator, by increasing or decreasing the mining activity of the mining processor."

314. *See* Ground 2 above.

i. Dependent Claim 11

"The system of claim 10 in which the system is configured to modulate the power load level by selecting one or more actions from a group of actions consisting of increasing or decreasing a maximum number of mining processors that are engaged in mining transactions."

315. *See* Ground 2 above.

j. Dependent Claim 12

"The system of claim 10 in which the system is configured to modulate the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility."

316. *See* Ground 2 above.

k. Dependent Claim 15

"The system of claim 10 in which: a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate; the controller is set to limit the power load level to above a power level producible by the generator when the production rate is at the daily minimum production rate; and a backup source, selected from a group consisting of fuel or electricity, is connected make up a shortfall in fuel or electricity, respectively, required to supply the blockchain mining devices with the power load level."

317. *See* Ground 2 above.

l. Dependent Claim 16

"The system of claim 1 in which a controller is connected to operate a cooling system to maintain the blockchain mining devices within a predetermined operating range of temperature."

318. *See* Ground 2 above.

m. Dependent Claim 17

"The system of claim 1 in which the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer."

319. *See* Ground 2 above.

n. Dependent Claim 18

"The system of claim 17 in which the portable enclosure comprises a generator driven by an engine, which is connected to the source of combustible gas."

320. See Ground 2 above.

o. Dependent Claim 19

"The system of any claim 18 in which the engine comprises a turbine."

321. Boot discloses that the engine 112 can be a turbine engine, which can be from General Electric Company and can be configured to operate on a variety of fuels. [EX1012, 4:22-26].

322. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

p. Dependent Claim 20

"The system of claim 17 in which the portable enclosure comprises an intermodal transport container."

323. *See* Ground 2 above.

q. Dependent Claim 21

"The system of claim 17 in which the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls."

324. *See* Ground 2 above.

r. Dependent Claim 22

"The system of claim 1 further comprising a combustible gas disposal device, at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas."

325. *See* Ground 2 above.

s. Dependent Claim 23

"The system of claim 22 further comprising a valve connected upstream of the generator to receive the continuous flow of gas from the source of combustible gas, and selectively supply the continuous flow of gas to the generator, the combustible gas disposal device, or both the generator and the combustible gas disposal device, to selectively divert the continuous flow of gas to the combustible gas disposal device, the generator, or both the generator and the combustible gas disposal device, respectively."

326. *See* Ground 2 above.

t. Independent Claim 24

i. Limitation [24pre]

"A method comprising:"

327. *See* Ground 2 above.

ii. Limitation [24a]

"producing electricity using a generator and a source of combustible gas produced at a facility selected from the group consisting of a hydrocarbon production well, storage, or processing facility, and"

328. Boot describes a method to generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1012, Abstract, 1:5-10, 4:6-7, claim 1].

329. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

iii. Limitation [24b]

"operating blockchain mining devices located at the facility, respectively, using the electricity, in which:"

330. *See* Ground 2 above.

iv. Limitation [24c]

"the generator is connected to the source of combustible gas, in which the facility is connected to produce a continuous flow of combustible gas to power the generator;"

331. Boot discloses that the genset 102 includes a driver (engine) 112 coupled to a generator 114. [EX1012, 2: 29-30]. Boot further discloses that the engine 112 operates on methane, ethane or other gases produced in the surface facilities 120 (e.g., phase separators), scavenged from the well 118. [EX1012, 3:62-4:2].

332. Boot further discloses adjusting the output of the generator to accommodate the demand of the electrical loads. [EX1012, 3:4-7, 5:36-42, claim 1]. A POSITA would have found this requires a continuous flow of combustible gas to power the generator.

333. For these reasons, I believe a POSITA would have understood that Boot discloses this limitation.

v. Limitation [24d_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

334. *See* Ground 2 above.

335. Further, Belady-989 discloses that "the data center 190 can comprise a communication connection 191 to a network 199." [EX1011, [0029]].

vi. Limitation [24d_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

336. *See* Ground 2 above.

vii. Limitation [24d_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

337. *See* Ground 2 above.

viii. Limitation [24d_iv]

"the network is a peer-to-peer network;"

338. *See* Ground 2 above.

ix. Limitation [24d_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

339. *See* Ground 2 above.

x. Limitation [24d_vi]

"the blockchain database stores transactional information for a digital currency."

340. *See* Ground 2 above.

u. Dependent Claim 25

"The method of claim 24 further comprising, prior to using the source of combustible gas: one or both disconnecting or diverting the source of combustible gas from a combustible gas disposal device at the facility; and connecting the source of combustible gas to operate the blockchain mining devices."

341. *See* Ground 2 above.

v. Dependent Claim 26

"The method of claim 25 in which the combustible gas disposal device comprises one or more of a flare, a vent to the atmosphere, an incinerator, or a burner."

342. *See* Ground 2 above.

w. Dependent Claim 27

"The method of claim 24 further comprising: connecting the source of combustible gas to operate the blockchain mining devices; and diverting gas from a combustible gas disposal device to operate the blockchain mining devices."

343. *See* Ground 2 above.

x. Dependent Claim 28

"The method of claim 24 in which the facility is selected from a group consisting of an oil or gas well that is isolated from a sales gas line and an external electrical power grid."

344. Boot discloses this limitation for the same reasons that I explained with respect to limitation [2.0].

y. Dependent Claim 29

"The method of claim 24 in which the source of combustible gas is a remote well selected from a group consisting of a remote oil or gas well."

345. Boot discloses this limitation for the same reasons that I explained with respect to limitation [3.0].

z. Dependent Claim 30

"The method of claim 24 in which producing further comprises supplying combustible gas to a combustion engine that is connected to drive the generator."

346. Boot discloses this limitation for the same reasons that I explained with respect to limitation [4.0].

aa. Dependent Claim 34

"The method of claim 29 further comprising operating the blockchain mining devices to: mine transactions with the blockchain mining devices; and communicate wirelessly through the internet to communicate with a blockchain database."

347. *See* Ground 2 above.

bb. Dependent Claim 35

"The method of claim 34 further comprising modulating a power load level exerted by the blockchain mining devices on the generator, by selecting an action from a group of actions consisting of increasing or decreasing, a mining activity of the blockchain mining devices."

348. *See* discussion above regarding limitation [10.0].

cc. Dependent Claim 36

"The method of claim 35 in which: modulating comprises modulating the power load level by increasing or decreasing a maximum number of mining processors that are engaged in mining transactions."

349. *See* discussion above regarding limitation [11.0].

dd. Dependent Claim 37

"The method of claim 36 in which modulating comprises modulating the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility."

350. *See* discussion above regarding limitation [12.0].

ee. Dependent Claim 40

"The method of claim 35 in which: a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate; modulating comprises limiting the power load level to above a power level produced by the generator when the production rate is at the daily minimum production rate; and supplying from a backup source, which is selected from a group consisting of a backup fuel or electricity source a shortfall in fuel or electricity, respectively, required to supply the blockchain mining devices with the power load level."

351. *See* discussion above regarding limitation [15.0].

XVI. ANALYSIS OF PIONEER ENERGY'S MAGS SYSTEM AND THE POLIVKA MINER (GROUND 4)

352. For the reasons articulated in detail below, and based on my review of the '372 patent, the file history, the prior art cited here, Mr. Kasdorf's declaration, and my years of experience in the oil and gas industry, a POSITA would have readily understood that claims 1-4, 8, 8, 16-30, and 34 are obvious over the combination of Pioneer Energy's MAGS System and the Polivka miner, in view of Szmigielski and Kheterpal.

A. It Would Have Been Obvious to a POSITA to Combine Pioneer Energy's MAGS System and the Polivka Miner in view of Szmigielski and Kheterpal.

353. A POSITA would have found it obvious to combine the MAGS mobile power generation system and the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS mobile power generation system, and in view of Szmigielski and Kheterpal.

354. Pioneer Energy's Mobile Alkane Gas Separator (MAGS) system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2].

355. Thus, a POSITA would have understood that MAGS can produce cheap or free electricity using flare gases that would be otherwise flared at the well site.

356. Smigielski discloses that one of the biggest costs for Bitcoin miners is the cost of electricity and access to cheap power is desired. [EX1009, 90]. The Bitcointalk forum post also explains that cheap electricity is desired and even required to run the bitcoin miner. [EX1015, 15, 21].

357. Thus, a POSITA would have been motivated to couple a bitcoin miner to MAGS to utilize the cheap or free electricity generated from flare gas.

358. Polivka discloses a mobile bitcoin miner that can be easily transported to a remote oil and gas production facility. [EX1015, 1-10]. The Bitcointalk forum post also envisions powering the Polivka miner by gas using a combustion engine. [EX1015, 18].

359. Thus, a POSITA would have found it obvious to couple the Polivka system with the MAGS system to utilize the cheap/free electricity.

360. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. Thus, it is easy to combine the two by simply combining two containerized mobile systems into one. A POSITA would have had a reasonable expectation of success in the combination at least because "the first MAGS field unit was tested in the spring of 2014 and units were sent to North Dakota later that fall." [EX1013, 3].

361. In the MAGS-Polivka combination, the combined device would have (1) the MAGS mobile power generation system; and (2) the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS mobile power generation system.

B. The Combination of Pioneer Energy's MAGS System and the Polivka Miner Renders Claims 1-4, 8, 16-30, and 34 Obvious.

362. As I explain below, the combination of Pioneer Energy's MAGS System and the Polivka miner renders obvious all limitations of claims 1-4, 16-30, and 34. I relied on Mr. Kasdorf's opinions and explanations related to the Polivka miner, Smigielski, and Kheterpal.

a. Independent Claim 1

i. Limitation [1pre]

"A system comprising:"

363. To the extent the preamble is limiting, the MAGS-Polivka combination renders [1pre] obvious. For example, MAGS is a mobile power generation system that can generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1013, 2]. And, per Mr. Kasdorf's review, Polivka also discloses a bitcoin miner system. [EX1015, 1-10].

ii. Limitation [1a]

> "a source of combustible gas produced from a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;"

364. Pioneer Energy's Mobile Alkane Gas Separator (MAGS) system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2].

365. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

iii. Limitation [1b]

> "a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and"

366. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2].

367. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

iv. Limitation [1c]

> "blockchain mining devices connected to the generator; in which:"

368. As discussed above, in the MAGS-Polivka combination, the combined device would have (1) the MAGS mobile power generation system; and (2) the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS mobile power generation system.

369. For these reasons, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that the MAGS-Polivka combination discloses this limitation.

v. Limitation [1c_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

370. *See* Mr. Kasdorf's Declaration on Limitation [1c_i].

vi. Limitation [1c_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

371. *See* Mr. Kasdorf's Declaration on Limitation [1c_ii].

vii. Limitation [1c_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

372. *See* Mr. Kasdorf's Declaration on Limitation [1c_iii].

viii. Limitation [1c_iv]

"the network is a peer-to-peer network;"

373. *See* Mr. Kasdorf's Declaration on Limitation [1c_iv].

ix. Limitation [1c_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

374. *See* Mr. Kasdorf's Declaration on Limitation [1c_v].

x. Limitation [1c_vi]

"the blockchain database stores transactional information for a digital currency."

375. *See* Mr. Kasdorf's Declaration on Limitation [1c_vi].

b. Dependent Claim 2

"The system of claim 1 isolated from a sales gas line and an external electrical power grid."

376. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2]. Pioneer sold its first MAGS unit in late 2014 to a company operating in North Dakota, where flare gases are most often simply burned onsite, the gases wasted. [EX1013, 2]. The MAGS system utilizes flare gas that is flared because natural gas pipelines are not in place when the oil well is drilled. [EX1014, [0084], EX1013, 2]. Thus, a POSITA would have understood that the system is isolated from a sales gas line.

377. In remote drilling sites isolated from an external power grid, the MAGS system is designed to replace the diesel generators powering the oil drilling rig. [EX1013, 3, Young, [0006], [0133], [0146]]. A POSITA would have understood that diesel-powered generators are needed because the system is isolated from an external electrical power grid.

378. For these reasons, I believe a POSITA would have understood that the MAGS system discloses limitation 2.0.

c. Dependent Claim 3

"The system of claim 1 in which: the source of combustible gas and the facility comprise a remote well selected from a group consisting of a remote oil or gas well; and the remote well is connected to produce the continuous flow of combustible gas to power the generator."

379. The MAGS system utilizes flare gas that is flared because natural gas pipelines are not in place when the oil well is drilled. [EX1014, [0084], EX1013, 2]. Young explains that often

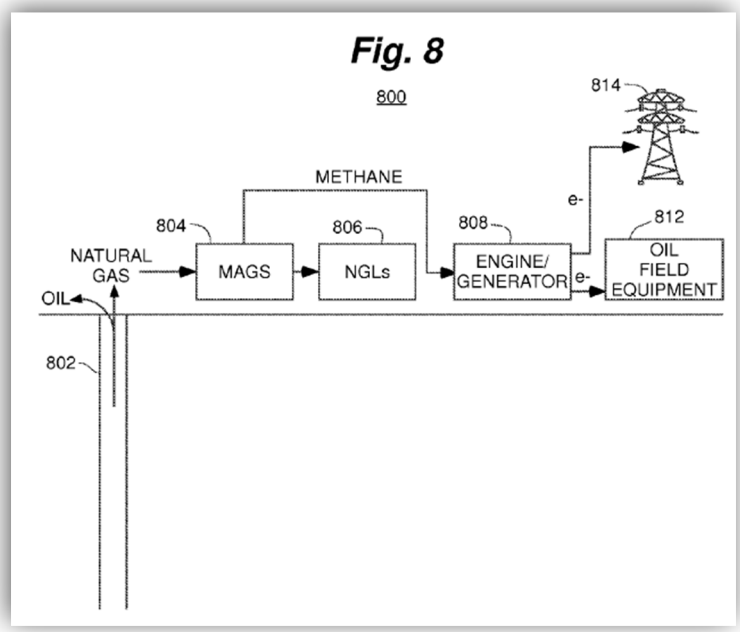
the locations of such flares are remote and far from human operations. [EX1014, [0010]]. Thus, the MAGS system is deployed at an oil and gas field system, to utilize the flare gas produced from a remote well. [EX1014, [0011]-[0012], [0056]]. Indeed, Young explains that "[t]he MAGS is designed to receive the wellhead natural gas 701 from a remote field location." [EX1014, [0188]].

380. For these reasons, I believe a POSITA would have understood that the MAGS system discloses limitation 3.0.

d. <u>Dependent Claim 4</u>

"The system of claim 3 further comprising a combustion engine connected to the source of combustible gas and connected to drive the generator."

381. The MAGS system uses methane to run a generator to replace the diesel generators powering the oil drilling rig. [EX1013, 3]. As shown in FIG. 8 of Young, the MAGS system comprises a combustion engine connected to drive the generator. [EX1014, [0323]].



<u>Young, EX1014, FIG. 8</u>

382. For these reasons, I believe a POSITA would have understood that the MAGS system discloses limitation [4.0].

e. Dependent Claim 8

"The system of claim 1 in which the generator and blockchain mining devices are located adjacent to the facility."

383. A POSITA would understand that the '372 patent discloses that the generator and blockchain mining device may be located adjacent to the remote oil well, for example within one hundred meters. [The '372 patent, 9:17-19].

384. As discussed above, in the MAGS-Polivka combination, the combined device would have (1) the MAGS mobile power generation system; and (2) the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS mobile power generation system.

385. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. Thus, it is easy to combine the two by simply combining two containerized mobile systems. Thus, since the combined device is mobile, in order to save infrastructure costs and to avoid transporting the flare gas over a long distance, a POSITA would have found it obvious that the generator and blockchain mining devices are located adjacent to the facility (e.g., within one hundred meters).

386. For these reasons, I believe a POSITA would have understood that the MAGS-Polivka combination discloses limitation 8.0.

f. Dependent Claim 16

"The system of claim 1 in which a controller is connected to operate a cooling system to maintain the blockchain mining devices within a predetermined operating range of temperature."

387. *See* Mr. Kasdorf's declaration on Limitation [16].

g. <u>Dependent Claim 17</u>

"The system of claim 1 in which the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer."

388. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. As shown in the Bitcointalk forum post, and per Mr. Kasdorf's declaration, the Polivka miner is adapted from a standard intermodal shipping container, and can be easily transported to remote well sites. [EX1015, 1-10]; [EX1019, 0:00:08]. For example, the Bitcointalk forum post explains that "the container can be loaded and unloaded without crane using the pictured pillars and an air-suspended truck only. (Almost all of the trucks in Europe have air suspension)." [EX1015, 10].

<u>EX1015, 1</u>

389. A related video also shows that the Polivka system is mounted on a trailer. [EX1019, 0:00:08].

390. Thus, in the combined device, the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer.

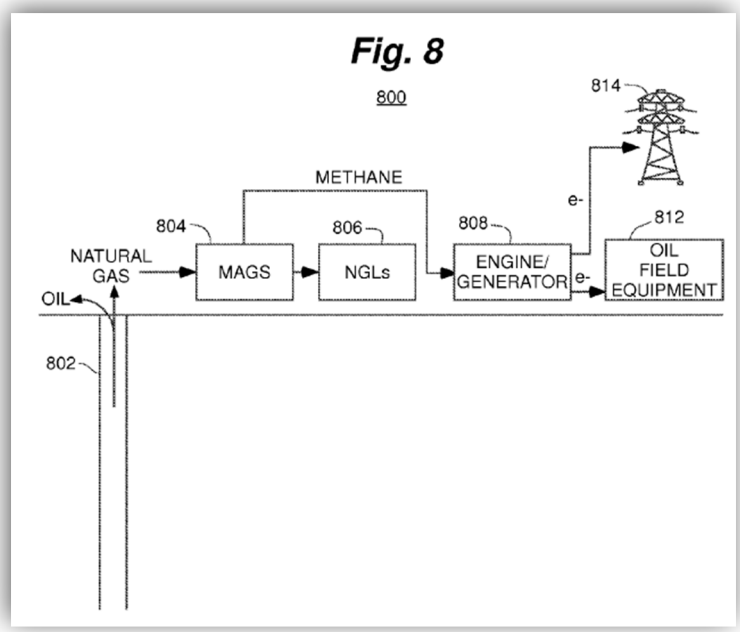
391. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

h. <u>Dependent Claim 18</u>

> "The system of claim 17 in which the portable enclosure comprises a generator driven by an engine, which is connected to the source of combustible gas."

392. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. Thus, it is easy to combine the two by simply combining two containerized mobile systems into one container. A POSITA would have been motivated to do so because it will further save transportation costs.

393. The MAGS system uses methane to run a generator to replace the diesel generators powering the oil drilling rig. [EX1013, 3]. As shown in FIG. 8 of Young, the MAGS system comprises a combustion engine connected to drive the generator. [EX1014, [0323]].



Young, EX1014, FIG. 8

394. Thus, a POSITA would have found it obvious that the portable enclosure (container) comprises a generator driven by an engine, which is connected to the source of combustible gas.

395. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

i. Dependent Claim 19

"The system of any claim 18 in which the engine comprises a turbine."

396. The MAGS system uses methane to run a generator to replace the diesel generators powering the oil drilling rig. [EX1013, 3]. As shown in FIG. 8 of Young, the MAGS system comprises a combustion engine connected to drive the generator. [EX1014, [0323]]. A POSITA would have found it obvious that the onsite power generator is driven by an engine that comprises a turbine.

397. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

j. Dependent Claim 20

"The system of claim 17 in which the portable enclosure comprises an intermodal transport container."

398. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. Per Mr. Kasdorf's Declaration, Bitcointalk forum post shows that the Polivka miner is adapted from a standard intermodal shipping container, and can be easily transported to remote well sites. [EX1015, 1-10]; [EX1019, 0:00:08]. For example, the Bitcointalk forum post explains that "the container can be loaded and unloaded without crane using the pictured pillars and an air-suspended truck only. (Almost all of the trucks in Europe have air suspension)." [EX1015, 10].

Bitcointalk forum post, EX1015, 1

399. A related video also shows that the Polivka system is mounted on a trailer. [EX1019, 0:00:08].

400. Thus, a POSITA would have found it obvious that the portable enclosure comprises an intermodal transport container.

k. Dependent Claim 21

"The system of claim 17 in which the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls."

401. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. Per Mr. Kasdorf's Declaration, Bitcointalk forum post shows that the Polivka miner is adapted from a standard intermodal shipping container, and can be easily transported to remote well sites. [EX1015, 1-10]; [EX1019, 0:00:08]. For example, the Bitcointalk forum post explains that "the container can be loaded and unloaded without crane using the pictured pillars and an air-suspended truck only. (Almost all of the trucks in Europe have air suspension)." [EX1015, 10].

Bitcointalk forum post, EX1015, 1

402. As shown in a related video, the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls.

Polivka Video, EX1019, 0:00:08

403. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

l. Dependent Claim 22

> The system of claim 1 further comprising a combustible gas disposal device, at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas.

404. A POSITA would understand that he '372 patent discloses examples of a gas disposal device including a flare, a vent to the atmosphere, an incinerator, a burner, and other suitable devices. [The '372 patent, 11:41-44].

405. The MAGS system discloses this limitation. The MAGS system separates flare gases that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another powers generators that run the drilling operation, and a third powers

MAGS itself. [EX1013, 2]. Thus, MAGS includes combustible gas disposal devices (e.g., compressor 908, CNG storage cylinders 910), which are connected to receive combustible gas from the source. [EX1014, [0274], FIG. 9]. MAGS also discloses a gas disposal device in the form of a flare—"the remaining ethane-rich gas that is not needed for power generation may be flared." [EX1014, [0142]].

406. Further, a POSITA would have found it obvious that the drilling site may produce an amount of flare gas that exceeds the capacity of the MAGS system, and would have found it obvious to have kept the existing flare at the site.

407. For these reasons, I believe a POSITA would have understood that the MAGS System discloses this limitation.

m. <u>Independent Claim 24</u>

i. Limitation [24pre]

"A method comprising:"

408. To the extent the preamble is limiting, the MAGS-Polivka combination renders [24pre] obvious. For example, MAGS provides a method to generate electricity using flare gas (raw natural gas that is to be flared) at an oil and gas production facility. [EX1013, 2].

ii. Limitation [24a]

> "producing electricity using a generator and a source of combustible gas produced at a facility selected from the group consisting of a hydrocarbon production well, storage, or processing facility, and"

409. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2]. The MAGS system is deployed at an oil and gas field system, to utilize the flare gas produced from a remote well. [EX1014, [0011]-[0012], [0056]].

410. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

iii. Limitation [24b]

"operating blockchain mining devices located at the facility, respectively, using the electricity, in which:"

411. As discussed above, in the MAGS-Polivka combination, the combined device would have (1) the MAGS mobile power generation system; and (2) the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS mobile power generation system.

412. For these reasons, I believe a POSITA would have understood that the combined device discloses this limitation.

iv. Limitation [24c]

"the generator is connected to the source of combustible gas, in which the facility is connected to produce a continuous flow of combustible gas to power the generator;"

413. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2].

414. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

v. Limitation [24d_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

415. See discussion above regarding [1c_i].

vi. Limitation [24d_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

416. See discussion above regarding [1c_ii].

vii. Limitation [24d_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

417. See discussion above regarding [1c_iii].

viii. Limitation [24d_iv]

"the network is a peer-to-peer network;"

418. See discussion above regarding [1c_iv].

ix. Limitation [24d_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

419. See discussion above regarding [1c_v].

x. Limitation [24d_vi]

"the blockchain database stores transactional information for a digital currency."

420. See discussion above regarding [1c_vi].

n. <u>Dependent Claim 25</u>

"The method of claim 24 further comprising, prior to using the source of combustible gas: one or both disconnecting or diverting the source of combustible gas from a combustible gas disposal device at the facility; and connecting the source of combustible gas to operate the blockchain mining devices."

421. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2]. The MAGS system containerized to fit in a trailer to confer better mobility. [EX1014, [0162], FIG. 4]. A POSITA would have understood that prior to using the source of combustible gas, the source of combustible

gas needs to be diverted from a combustible gas disposal device (a flare) to the MAGS system, and to operate the blockchain mining devices in the Polivka miner.

422. For these reasons, the MAGS system renders this limitation obvious.

o. Dependent Claim 26

"The method of claim 25 in which the combustible gas disposal device comprises one or more of a flare, a vent to the atmosphere, an incinerator, or a burner."

423. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one that can be captured in tanks and shipped off for sale, another to fuel **powers generators** that run the drilling operation, and a third to power the MAGS itself. [EX1013, 2]. A POSITA would have found it obvious that the drilling site may produce an amount of flare gas that exceeds the capacity of the MAGS system, and would have found it obvious to have kept the existing flare at the site.

424. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

p. Dependent Claim 27

"The method of claim 24 further comprising: connecting the source of combustible gas to operate the blockchain mining devices; and diverting gas from a combustible gas disposal device to operate the blockchain mining devices."

425. The MAGS system separates **flare gases** that naturally occur at drilling sites into three streams: one can be captured in tanks and shipped off for sale, another **powers generators** that run the drilling operation, and a third powers MAGS itself. [EX1013, 2]. MAGS discloses a gas disposal device in the form of a flare—"the remaining ethane-rich gas that is not needed for power generation may be flared." [EX1014, [0142]]. A POSITA would have found it obvious that the drilling site may produce an amount of flare gas that exceeds the capacity of the MAGS system,

and would have found it obvious to have kept the existing flare at the site and only divert a portion of the gas to operate the MAGS system and the blockchain mining devices in the Polivka miner.

426. For these reasons, I believe a POSITA would have understood that the MAGS system discloses this limitation.

q. Dependent Claim 28

"The method of claim 24 in which the facility is selected from a group consisting of an oil or gas well that is isolated from a sales gas line and an external electrical power grid."

427. The MAGS system discloses this limitation for the same reasons that I explained with respect to limitation [2.0] above.

r. Dependent Claim 29

"The method of claim 24 in which the source of combustible gas is a remote well selected from a group consisting of a remote oil or gas well."

428. The MAGS system discloses this limitation for the same reasons that I explained with respect to limitation [3.0] above.

s. Dependent Claim 30

The method of claim 24 in which producing further comprises supplying combustible gas to a combustion engine that is connected to drive the generator.

429. The MAGS system discloses this limitation for the same reasons that I explained with respect to limitation [4.0] above.

t. Dependent Claim 34

"The method of claim 29 further comprising operating the blockchain mining devices to: mine transactions with the blockchain mining devices; and communicate wirelessly through the internet to communicate with a blockchain database."

430. *See* Mr. Kasdorf's Declaration on Limitation [34].

XVII. ANALYSIS OF PIONEER ENERGY'S MAGS SYSTEM, THE POLIVKA MINER, AND BELADY-989 (GROUND 5)

431. For the reasons articulated in detail below, and based on my review of the '372 patent, the file history, the prior art cited here, Mr. Kasdorf's declaration, and my years of experience in the oil and gas industry, a POSITA would have readily understood that claims 1-4, 8, 10-12, 15-30, 34-37, and 40 are obvious over the combination of Pioneer Energy's MAGS System, the Polivka miner, and Belady-989, in view of Szmigielski and Kheterpal.

A. It Would Have Been Obvious to a POSITA to Combine Pioneer Energy's MAGS System, the Polivka Miner, and Belady-989 in view of Szmigielski and Kheterpal.

432. A POSITA would have found it obvious to combine the MAGS mobile generation system, the Polivka mobile miner, wherein the bitcoin mining devices (e.g., spondooliestch SP31 servers) are connected to and powered by the MAGS system; and Belady-989's gas supply shock absorber.

433. As discussed above, the MAGS system generates free excess electricity and Smigielski discloses that one of the biggest costs for Bitcoin miners is the cost of electricity and access to cheap power is desired. [EX1009, 90].

434. Thus, a POSITA would have found it obvious to couple the Polivka mobile bitcoin miner with the MAGS system to utilize the free excess electricity.

435. Both the MAGS system and the Polivka system are containerized to confer better mobility. [EX1014, [0162], FIG. 4]; [EX1015, 1-10]. Thus, it is easy to combine the two by simply combining two containerized mobile systems into one. A POSITA would have had a reasonable expectation of success in the combination at least because "the first MAGS field unit was tested in the spring of 2014 and units were sent to North Dakota later that fall." [EX1013, 3].

436. In the MAGS-Polivka combination, the combined device would have (1) the MAGS mobile power generation system; and (2) the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS mobile power generation system.

437. Belady-989 describes a gas supply shock absorber (containing a gas storage) that is used to improve a data center system powered by a natural gas generator. [EX1011, Abstract]. If the shock absorber has sufficient gas, a co-located data center utilizes such gas for increased electrical power generation during increased processing activity, which can be requested or generated. [EX1011, Abstract]. Conversely, if the shock absorber has insufficient gas, and a negative pressure spike occurs, the data center throttles down or offloads processing. [EX1011, Abstract].

438. A POSITA would have understood that the flow of raw natural gas from the oil and gas facility may fluctuate and would have been motivated to further improve the MAGS-Polivka combination by employing Belady-989's gas supply shock absorber because doing so will improve the energy usage efficiency. Indeed, Belady-989 discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Szmigielski also discloses that "[i]ndustrial miners face almost the same issues as data centers: access to relatively cheap power, good network access…" [EX1009, 103]. Thus, a POSITA would have been motivated to combine MAGS, Polivka and Belady-989, to use Belady-989's gas supply shock absorber to improve energy usage efficiency.

439. In the MAGS-Polivka-Belady-989 combination, the combined device would have (1) the MAGS mobile power generation system; (2) the Polivka mobile bitcoin miner, wherein the

bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS system; and (3) Belady-989's gas supply shock absorber.

B. The Combination of Pioneer Energy's MAGS System, the Polivka Miner, and Belady-989 Renders Claims 1-4, 8, 10-12, 15-30, 34-37, and 40 Obvious.

440. As I explain below, the combination of Pioneer Energy's MAGS System, the Polivka miner, and Belady-989 renders obvious all limitations of claims 1-4, 8, 10-12, 15-30, 34-37, and 40. As stated above, I relied on Mr. Kasdorf's opinions and explanations related to the Polivka miner, Szmigielski, and Kheterpal for the purposes of this Declaration.

a. Independent Claim 1

i. Limitation [1pre]

"A system comprising:"

441. See discussion above in Ground 4.

ii. Limitation [1a]

"a source of combustible gas produced from a facility selected from a group consisting of a hydrocarbon production, storage, or processing facility;"

442. See discussion above in Ground 4.

443. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

444. For these reasons, to the extent that one argues that limitation [1a] is not rendered obvious by the MAGS system, limitation [1a] would be rendered obvious by combining the MAGS system and Belady-989.

iii. Limitation [1b]

"a generator connected to the source of combustible gas to receive a continuous flow of combustible gas to power the generator; and"

445. See discussion above in Ground 4.

446. Belady-989 further discloses that gas-to-electricity converter 180 can be a generator. [EX1011, [0019]].

447. For these reasons, to the extent that one argues that limitation [1b] is not rendered obvious by the MAGS system, limitation [1b] would be rendered obvious by combing the MAGS system and Belady-989.

iv. Limitation [1c]

"blockchain mining devices connected to the generator; in which:"

448. See discussion above in Ground 4.

v. Limitation [1c_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

449. See discussion above in Ground 4.

450. Further, Belady-989 discloses that "the data center 190 can comprise a communication connection 191 to a network 199." [EX1011, [0029]].

vi. Limitation [1c_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

451. See discussion above in Ground 4.

vii. Limitation [1c_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

452. See discussion above in Ground 4.

viii. Limitation [1c_iv]

"the network is a peer-to-peer network;"

453. See discussion above in Ground 4.

ix. Limitation [1c_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

454. See discussion above in Ground 4.

x. Limitation [1c_vi]

"the blockchain database stores transactional information for a digital currency."

455. See discussion above in Ground 4.

b. <u>Dependent Claim 2</u>

"The system of claim 1 isolated from a sales gas line and an external electrical power grid."

456. See discussion above in Ground 4.

457. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Specifically, Belady-989 explains that "natural gas is a byproduct of oil drilling operations and is often considered a waste byproduct since it cannot be economically captured and brought to market." *Id.* Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

458. For these reasons, to the extent that one argues that limitation [2.0] is not rendered obvious by the MAGS system, limitation [2.0] would be rendered obvious by combining the MAGS system and Belady-989.

c. <u>Dependent Claim 3</u>

"The system of claim 1 in which: the source of combustible gas and the facility comprise a remote well selected from a group consisting of a remote oil or gas well;

and the remote well is connected to produce the continuous flow of combustible gas to power the generator."

459. See discussion above in Ground 4.

460. Belady-989 further discloses that it has become more practical to perform digital data processing at a location remote from the location where such data is initially generated, and where the processed data will be consumed. [EX1011, [0002]].

461. For these reasons, to the extent that one argues that limitation [3.0] is not rendered obvious by the MAGS system, limitation [3.0] would be rendered obvious by combining the MAGS system and Belady-989.

d. Dependent Claim 4

"The system of claim 3 further comprising a combustion engine connected to the source of combustible gas and connected to drive the generator."

462. See discussion above in Ground 4.

e. Dependent Claim 8

"The system of claim 1 in which the generator and blockchain mining devices are located adjacent to the facility."

463. See discussion above in Ground 4.

f. Dependent Claim 10

"The system of claim 1 in which the system is configured to modulate a power load level exerted by the blockchain mining devices on the generator, by increasing or decreasing the mining activity of the mining processor."

464. As discussed above, in the MAGS-Polivka-Belady-989 combination, the combined device would have (1) the MAGS mobile power generation system; (2) the Polivka mobile bitcoin miner, wherein the bitcoin mining devices (e.g., spondooliestech SP31 servers) are connected to and powered by the MAGS system; and (3) Belady-989's gas supply shock absorber.

465. Belady-989 describes a gas supply shock absorber (containing a gas storage) that is used to improve a data center system powered by a natural gas generator. [EX1011, Abstract]. If the shock absorber has sufficient gas, a co-located data center utilizes such gas for increased electrical power generation during increased processing activity, which can be requested or generated. [EX1011, Abstract]. Conversely, if the shock absorber has insufficient gas, and a negative pressure spike occurs, the data center throttles down or offloads processing. [EX1011, Abstract]. A POSITA would have found it obvious to control power load level of the Polivka miner (e.g., by turning off a certain number of mining processors) using Belady-989's method based on input from Belady-989's tank pressure sensor to increase energy usage efficiency.

466. Thus, in the MAGS-Polivka-Belady-989 combination, the system is configured to modulate a power load level exerted by the blockchain mining devices on the generator, by increasing or decreasing the mining activity of the mining processor.

467. For these reasons, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that the combined device discloses this limitation.

g. <u>Dependent Claim 11</u>

> "The system of claim 10 in which the system is configured to modulate the power load level by selecting one or more actions from a group of actions consisting of increasing or decreasing a maximum number of mining processors that are engaged in mining transactions."

468. As discussed above with regard to Limitation [10.0], Mr. Kasdorf explained in his Declaration that a POSITA would have found it obvious to control power load level of the Polivka miner (e.g., by turning off a certain number of mining processors) using Belady-989's method based on input from Belady-989's tank pressure sensor to increase energy usage efficiency. For example, a POSITA would have found it obvious to adjust the mining activity of the mining

processors by increasing or decreasing a maximum number of mining processors that are engaged in mining transactions.

469. For these reasons, I believe a POSITA would have understood that Belady-989 discloses this limitation.

h. Dependent Claim 12

> "The system of claim 10 in which the system is configured to modulate the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility."

470. As discussed above with regard to Limitation [10.0], Mr. Kasdorf explained in his Declaration that a POSITA would have found it obvious to control power load level of the Polivka miner (e.g., by turning off a certain number of mining processors) using Belady-989's method based on input from Belady-989's tank pressure sensor to increase energy usage efficiency.

471. Belady-989 discloses that its gas supply shock absorber comprises pressure sensing valves and pressure regulating valves, which can detect positive pressure spikes in the gas supply and enable such overly pressurized gas to charge the gas storage, and which can also detect negative pressure spikes in the gas supply and, in response, make available the gas stored in the gas storage to compensate for such negative pressure spikes. [EX1011, [0015]]. Belady-989 further discloses that if the gas storage has a sufficient quantity of gas stored therein, the data center can utilize such gas to provide increased electrical power during periods of increased processing activity and workload. [EX1011, [0015]]. Conversely, if the gas storage has an insufficient quantity of gas stored therein, and the gas supply experiences a negative pressure spike, the computing devices of the data center can be throttled down to consume less electrical power. [EX1011, [0015]]. A POSITA would have found it obvious that Belady-989's gas pressure sensor regulates the power load level of the bitcoin miners (e.g., by turning off a certain number of mining

processors) based on input from Belady-989's tank pressure sensor in response to variations in a production rate of combustible gas.

472. For these reasons, and for the reasons provided by Mr. Kasdorf, I believe a POSITA would have understood that the combined device discloses this limitation.

i. Dependent Claim 15

> "The system of claim 10 in which: a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate; the controller is set to limit the power load level to above a power level producible by the generator when the production rate is at the daily minimum production rate; and a backup source, selected from a group consisting of fuel or electricity, is connected make up a shortfall in fuel or electricity, respectively, required to supply the blockchain mining devices with the power load level."

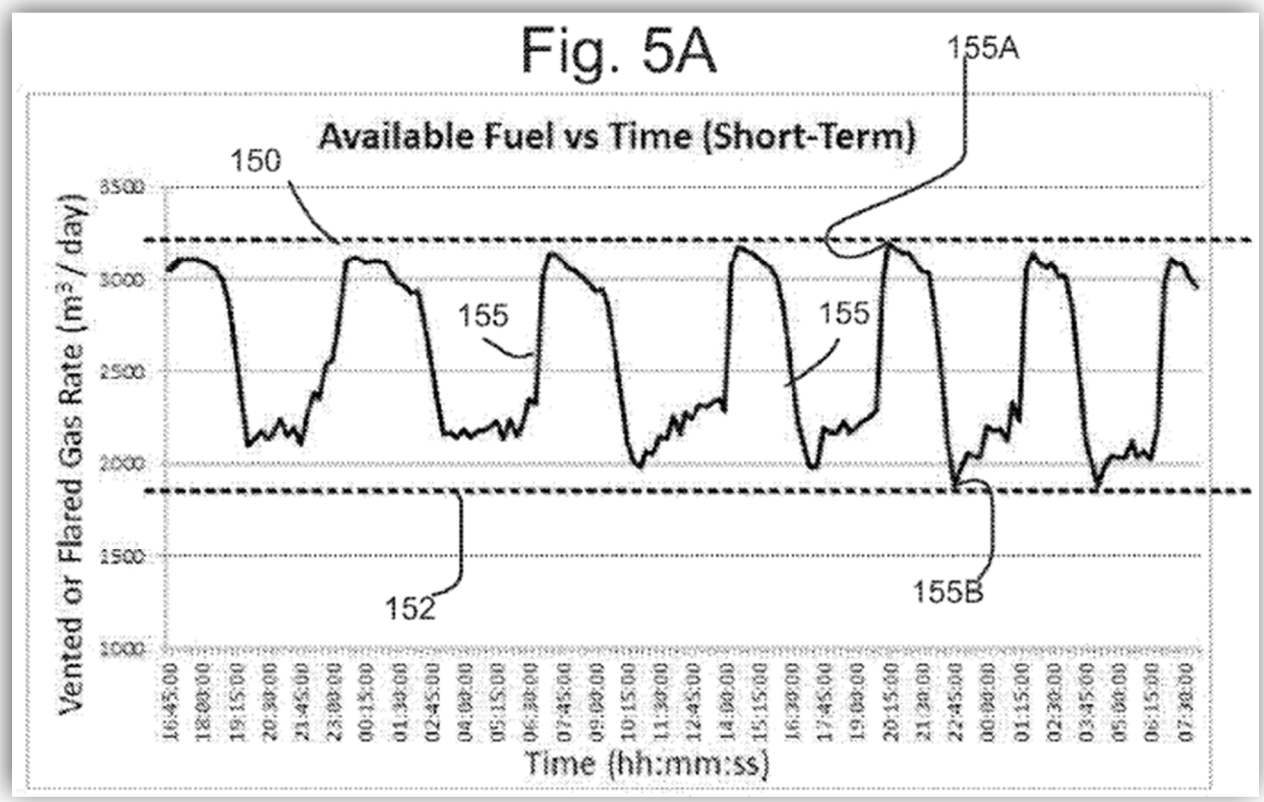
473. As discussed above with regard to Limitation [10.0], Mr. Kasdorf explained in his Declaration that a POSITA would have found it obvious to control power load level of the Polivka miner (e.g., by turning off a certain number of mining processors) using Belady-989's method based on input from Belady-989's tank pressure sensor to increase energy usage efficiency.

474. Further, Belady-989 discloses "positive gas pressure spikes can occur with an average frequency such as, for example, occurring, on average, once every couple of hours or once every couple of days" [EX1011 [0036]]. This corresponds to the available fuel spikes in FIG. 5A in the '372 patent.

'372 patent, EX1001, FIG. 5A

Thus, Belady-989 discloses that a production rate (positive gas pressure) of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate.

475. Belady-989 further discloses that such historical data (of positive gas pressure spikes) can be taken into account to control the power load level of the data center. [EX1011, [0036]]. For example, if there is no anticipated positive gas pressure spike, one or more individual



processing units can be throttled down, to reduce the overall energy consumption of the data center. [EX1011, [0036]]. When there are anticipated positive gas pressure spikes, a POSITA would have found it obvious to limit the power load level to above a power level producible by the generator when the production rate is at the daily minimum production rate, to fully make use of the generated electricity.

476. Belady-989 discloses a backup source of fuel in the form of gas storage 160. Specifically, Belady-989 discloses that "[s]hould the gas supply 110 subsequently experience a negative gas pressure spike, such that the pressure of the gas supplied by the gas supply 110 decreases, in one embodiment, the gas pressure sensor 151 of the pressure sensing valve 150 can detect such a decrease in the gas pressure and can cause the gas shutoff valve 152 to open to enable gas from the gas storage 160 to flow into the piping 120, thereby increasing the gas pressure in the piping 120 and providing the gas-to-electricity converter 180 with a sufficient pressure to continue to provide sufficient electrical power 181 to the data center." [EX1011, [0025]].

477. Thus, Belady-989 discloses a backup source is connected make up a shortfall in fuel required to supply the blockchain mining devices with the power load level.

478. For these reasons, I believe a POSITA would have understood that Belady-989 discloses this limitation.

j. <u>Dependent Claim 16</u>

"The system of claim 1 in which a controller is connected to operate a cooling system to maintain the blockchain mining devices within a predetermined operating range of temperature."

479. See discussion above in Ground 4.

k. <u>Dependent Claim 17</u>

"The system of claim 1 in which the blockchain mining devices are housed in a portable enclosure that is structured to one or more of form a skid or be mounted on a trailer."

See discussion above in Ground 4.

l. Dependent Claim 18

"The system of claim 17 in which the portable enclosure comprises a generator driven by an engine, which is connected to the source of combustible gas."

480. See discussion above in Ground 4.

m. Dependent Claim 19

"The system of any claim 18 in which the engine comprises a turbine."

481. See discussion above in Ground 4.

n. Dependent Claim 20

"The system of claim 17 in which the portable enclosure comprises an intermodal transport container."

482. See discussion above in Ground 4.

o. Dependent Claim 21

"The system of claim 17 in which the portable enclosure has the form of a box with walls, a top, and a base, with one or more access doors formed in the walls."

483. See discussion above in Ground 4.

p. Dependent Claim 22

"The system of claim 1 further comprising a combustible gas disposal device, at the facility, the combustible gas disposal device being connected to receive combustible gas from the source of combustible gas."

484. See discussion above in Ground 4.

485. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

486. For these reasons, to the extent that one argues that limitation [22.0] is not rendered obvious by the MAGS system, limitation [22.0] would be rendered obvious by combining the MAGS system and Belady-989.

q. Dependent Claim 23

"The system of claim 22 further comprising a valve connected upstream of the generator to receive the continuous flow of gas from the source of combustible gas, and selectively supply the continuous flow of gas to the generator, the combustible gas disposal device, or both the generator and the combustible gas disposal device, to selectively divert the continuous flow of gas to the combustible gas disposal device, the generator, or both the generator and the combustible gas disposal device, respectively."

487. See discussion above in Ground 4.

488. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

489. For these reasons, to the extent that one argues that limitation [23.0] is not rendered obvious by the MAGS system, limitation [23.0] would be rendered obvious by combining the MAGS system and Belady-989.

r. <u>Independent Claim 24</u>

i. Limitation [24pre]

"A method comprising:"See discussion above in Ground 4.

490. See discussion above in Ground 4.

ii. Limitation [24a]

"producing electricity using a generator and a source of combustible gas produced at a facility selected from the group consisting of a hydrocarbon production well, storage, or processing facility, and"

491. See discussion above in Ground 4.

492. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Belady-989 further discloses that gas-to-electricity converter 180 can be a generator. [EX1011, [0019]]. Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

493. For these reasons, to the extent that one argues that limitation [24a] is not rendered obvious by the MAGS system, limitation [24a] would be rendered obvious by combining the MAGS system and Belady-989.

iii. Limitation [24b]

"operating blockchain mining devices located at the facility, respectively, using the electricity, in which:"

494. See discussion above in Ground 4.

iv. Limitation [24c]

"the generator is connected to the source of combustible gas, in which the facility is connected to produce a continuous flow of combustible gas to power the generator;"

495. See discussion above in Ground 4.

v. Limitation [24d_i]

"the blockchain mining devices each have a mining processor and are connected to a network interface;"

496. See discussion above in Ground 4.

497. Further, Belady-989 discloses that "the data center 190 can comprise a communication connection 191 to a network 199." [EX1011, [0029]].

vi. Limitation [24d_ii]

"the network interface is connected to receive and transmit data through the internet to a network that stores or has access to a blockchain database;"

498. See discussion above in Ground 4.

vii. Limitation [24d_iii]

"the mining processors are connected to the network interface and adapted to mine transactions associated with the blockchain database and to communicate with the blockchain database;"

499. See discussion above in Ground 4.

viii. Limitation [24d_iv]

"the network is a peer-to-peer network;"

500. See discussion above in Ground 4.

ix. Limitation [24d_v]

"the blockchain database is a distributed database stored on plural nodes in the peer-to-peer network; and"

501. See discussion above in Ground 4.

x. Limitation [24d_vi]

"the blockchain database stores transactional information for a digital currency."

502. See discussion above in Ground 4.

s. <u>Dependent Claim 25</u>

"The method of claim 24 further comprising, prior to using the source of combustible gas: one or both disconnecting or diverting the source of combustible gas from a combustible gas disposal device at the facility; and connecting the source of combustible gas to operate the blockchain mining devices."

503. See discussion above in Ground 4.

t. <u>Dependent Claim 26</u>

"The method of claim 25 in which the combustible gas disposal device comprises one or more of a flare, a vent to the atmosphere, an incinerator, or a burner."

504. See discussion above in Ground 4.

505. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

506. For these reasons, to the extent that one argues that limitation [26] is not rendered obvious by the MAGS system, limitation [26] would be rendered obvious by combining the MAGS system and Belady-989.

u. <u>Dependent Claim 27</u>

"The method of claim 24 further comprising: connecting the source of combustible gas to operate the blockchain mining devices; and diverting gas from a combustible gas disposal device to operate the blockchain mining devices."

507. See discussion above in Ground 4.

508. Belady-989 further discloses that the gas diverter valve 133 can be triggered and the gas provided by the gas supply 110 can be vented as vented gas 111. [EX1011, FIG. 1, [0028]].

509. For these reasons, to the extent that one argues that limitation [27] is not rendered obvious by the MAGS system, limitation [27] would be rendered obvious by combining the MAGS system and Belady-989.

v. <u>Dependent Claim 28</u>

> "The method of claim 24 in which the facility is selected from a group consisting of an oil or gas well that is isolated from a sales gas line and an external electrical power grid."

510. See discussion above in Ground 4.

511. Belady-989 further discloses data centers often consume large quantities of electrical power, and should be located in areas where natural resources (e.g., flare gas), from which electrical power can be derived, are abundant and can be obtained inexpensively. [EX1011, [0004]]. Specifically, Belady-989 explains that "natural gas is a byproduct of oil drilling operations and is often considered a waste byproduct since it cannot be economically captured and brought to market." *Id.* Belady-989 further discloses that gas supply 110 can be from gas produced as a waste product of oil drilling. [EX1011, [0028]].

512. For these reasons, to the extent that one argues that limitation [28] is not rendered obvious by the MAGS system, limitation [28] would be rendered obvious by combining the MAGS system and Belady-989.

w. <u>Dependent Claim 29</u>

> "The method of claim 24 in which the source of combustible gas is a remote well selected from a group consisting of a remote oil or gas well."

513. See discussion above in Ground 4.

514. Belady-989 further discloses that it has become more practical to perform digital data processing at a location remote from the location where such data is initially generated, and where the processed data will be consumed. [EX1011, [0002]].

515. For these reasons, to the extent that one argues that limitation [29] is not rendered obvious by the MAGS system, limitation [29] would be rendered obvious by combining the MAGS system and Belady-989.

x. Dependent Claim 30

"The method of claim 24 in which producing further comprises supplying combustible gas to a combustion engine that is connected to drive the generator."

516. See discussion above in Ground 4.

y. Dependent Claim 34

"The method of claim 29 further comprising operating the blockchain mining devices to: mine transactions with the blockchain mining devices; and communicate wirelessly through the internet to communicate with a blockchain database."

517. See discussion above in Ground 4.

z. Dependent Claim 35

"The method of claim 34 further comprising modulating a power load level exerted by the blockchain mining devices on the generator, by selecting an action from a group of actions consisting of increasing or decreasing, a mining activity of the blockchain mining devices."

518. See discussion above regarding [10.0].

aa. Dependent Claim 36

"The method of claim 35 in which: modulating comprises modulating the power load level by increasing or decreasing a maximum number of mining processors that are engaged in mining transactions."

519. See discussion above regarding [11.0].

bb. Dependent Claim 37

"The method of claim 36 in which modulating comprises modulating the power load level in response to variations in a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility."

520. See discussion above regarding [12.0].

cc. Dependent Claim 40

"The method of claim 35 in which: a production rate of combustible gas from the hydrocarbon production well, storage, or processing facility varies between a daily minimum production rate and a daily maximum production rate; modulating comprises limiting the power load level to above a power level produced by the generator when the production rate is at the daily minimum production rate; and supplying from a backup source, which is selected from a group consisting of a backup fuel or electricity source a shortfall in fuel or electricity, respectively, required to supply the blockchain mining devices with the power load level."

521. See discussion above regarding [15.0].

XVIII. THE CHALLENGED CLAIMS ARE UNPATENTABLE UNDER 35 U.S.C § 101

A. The '372 Patent Claims an Abstract Idea

522. The '372 Patent, makes itself clear that its focus is that it claims the abstract idea of using natural gas to power a blockchain mine. [CRUSOE-1001, Abstract]. The claims only recite common equipment and methods for using the equipment to power a blockchain mine with natural gas. This is consistent with the Patent's explanation of current state of the art within the oil and gas mining industry. CRUSOE-1001, 6:56-58, 10:27-29 (detailing how well operators already use gas to power on-site equipment). The only discernable innovation is that the patent claims to have discovered that at blockchain mine can be plugged in to power equipment at a hydrocarbon facility.

523. The language of Claim 1 shows this combination of generic machinery operating as intended to achieve to accomplish the goal of powering a blockchain mine. The generator in Claim 1 is generically described; further, the specification states that existing on-site unmodified generators are capable of performing the task. [CRUSOE-1001, 10:27-29, 11:11-14, 16:44-49].

Meanwhile, the claimed blockchain mine, operates indistinguishably from how the existing blockchain mines operate. [CRUSOE-1004 [440]; compare CRUSOE-1001, Cl. 1 (claiming a blockchain mine), with CRUSOE-1001, 11:55-57, 11:67-12:4, 13:5-7, 13:15-19, 13:22-27, 13:49-52, 15:22-59 (describing the composition and operation of standard blockchain mining devices)].

524. Claim 1 is also not even limited to natural gas as it broadly claims a source of "combustible gas" from either a hydrocarbon production, storage or processing facility. [CRUSOE-1001, 1:17-19, 2:47-48]. Claim 1 claims all power generation means using combustible gas and any means of blockchain mining are also claimed. [CRUSOE-1004 [440]; CRUSOE-1001, 9:66-10:8, 15:22-40].

B. The '372 Patent Does Not Add Any New Technological Features to the Underlying Technology

525. The '372 Patent only recites common equipment used conventionally to power blockchain mining with hydrocarbon facility gas. It is has been a long common practice for well operators to use well gas at mining facilities for power needs. [CRUSOE-1005, [0024]; CRUSOE-1013, 2].

526. The only discernable innovation the Patent appears to claim is proximally positioning an energy intensive computing process by low-cost energy. There are no identifiable improvements or innovations made to the claimed equipment or methods.

C. Claim 1 Is Representative of the Entire '372 Patent.

527. Claim 1 of the '372 Patent accurately represents the entire patent.

528. Claim 24 is nearly a mirror of Claim 1 reciting indistinguishable limitations and performing the same abstract idea.

529. Claims 2-9, 17-23, and 25-34 add no technological change to any part of Claim 1 or 24. They merely claim various iterations of where or how Claims 1 and 24 can be implemented.

530. Claims 10-15 and 35-41 only claim more abstract ideas targeting the modulation of the blockchain device's power consumption based on available energy. These claims are directed to common and routine industry practices.

D. Analysis of the Claims of the '372 patent

531. Based on my knowledge and experience and my reading of the claims and patent and review of Mr. Kasdorf's Declaration (EX1004), I believe that all the claims of the '372 patent are directed to the abstract idea of powering a cryptocurrency mine with gas from a hydrocarbon facility and do not recite anything more than conventional equipment.

532. For independent Claims 1 and 24, the recited limitations related to a source of combustible gas and a generator recite nothing more than generic industry used equipment and materials commonly found at hydrocarbon production, storage, or processing facilities. And, as per Mr. Kasdorf's review, the claimed blockchain mining device recites nothing more than common computer elements operating as expected in any blockchain mining device. [EX1004]. Furthermore, Claims 1 and 24 recite nothing that changes or effects the way the underlying technology would normally operate.

533. Claims 2, 3, 7-9, and 27-29 recite little more than selecting particular, yet common, hydrocarbon facilities as locations for a blockchain mine.

534. Claims 4-6, 19, and 30-33 recite little more than common iterations of conventional prime movers used with power generators.

535. As per Mr. Kasdorf's declaration, Claims 10-15 and 35-41 recite only common system controls for operating a blockchain mining device and modulating it in response to power availability—a common issue for blockchain mining operations. [CRUSOE-1004]. Further, the limitations of Claims 15 and 40 wherein a backup source of power is integrated into the system recites common equipment that is commonly used for any sort of data processing to ensure regular

production. Claims 14 and 39 recites nothing more than a conventional load bank used in a conventional manner. As per Mr. Kasdorf's declaration, Claim 16 recites the conventional practice using a cooling system to automatically regulate the temperature of computers performing large amounts of data processing. This is almost always a required element of any data center and not an inventive change to a blockchain mining device. [CRUSOE-1004].

536. As per Mr. Kasdorf's declaration, Claim 16 recites the conventional practice using a cooling system to automatically regulate the temperature of computers performing large amounts of data processing. This is almost always a required element of any data center and not an inventive change to a blockchain mining device. [EX1004].

537. As per Mr. Kasdorf's declaration, claims 17, 20-21 recite the common practice of building datacenters or other computers within portable enclosures and do not recite any limitation to any blockchain mining specific requirements. [EX1004].

538. Claim 18 recites the common practice of integrating a standard backup generator within a portable enclosure in conjunction with other equipment.

539. Claims 22-23, and 25-26 describe nothing more than the current industry practice of venting or flaring excess gas at a hydrocarbon facility or using splitting of the gas between a venting or flaring device while supplying the rest to a power generator.

540. As per Mr. Kasdorf's declaration, Claim 34 only recites the additional feature of using a conventional wireless internet connection which is common industry practice for any mobile or remote computing platform. [EX1004].

541. Ultimately, the patent claims of the '372 patent recite conventional equipment that operates in a conventional manner.

XIX. CONCLUSION

542. The findings and opinions set forth in this declaration are based on my work and examinations to date.

543. I may continue my examinations. I may also receive additional documentation and other factual evidence over the course of this PGR that will allow me to supplement and/or refine my opinions. I reserve the right to add to, alter, or delete my opinions and my declaration upon discovery of any additional information. I reserve the right to make such changes as may be deemed necessary.

544. In signing this declaration, I recognize that the declaration will be filed as evidence in an PGR before the PTAB. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross- examination.

545. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: 7/20/2023

Michael Nikolaou, Ph.D.

APPENDIX A

CURRICULUM VITAE

NAME

Michael **Nikolaou**

BIRTHDATE

April 14, 1960

EDUCATION

PhD, Chemical Engineering, University of California, Los Angeles, 1989.
Diploma, Chemical Engineering, National Technical University, Athens, Greece, 1984.

PROFESSIONAL EXPERIENCE

Academic

Professor, Chemical Engineering Dept., University of Houston, (2007-present)
Associate Professor, Chemical Engineering Dept., University of Houston, 9/97-8/07.
Associate Professor, Chemical Engineering Dept., Texas A&M University, 9/95-8/97.
Visiting Scientist, Chemical Engineering Dept., MIT, Fall 1995.
Assistant Professor, Chemical Engineering Dept., Texas A&M University, 9/89-8/95
Teaching/Research Assistant, Chemical Engineering Dept., UCLA, 1/86-8/89.

Industrial

Process Engineer/Computer Specialist, Union Pacific Resources, Bryan, TX, Summer 1991.

PROFESSIONAL RECOGNITION

Chairmanship of National Meetings:

Session chair

AIChE Annual Meeting (several)
AIChE Spring Meeting (several)

Programming Committee member

American Control Conference (several)
ESCAPE 6
DYCOPS 5
ADCHEM 2003, 2009
FOCAPO 2008
IFAC World Congress, 2009
SPE Workshop on Bridging the Gap Between Reservoir Engineering and Facilities Design, 2012 (Organizing Committee)

International Programming Committee Chair

IFAC Conference on Control of Offshore Oil & Gas Drilling Operations, Trondheim, Norway, 2012
FOCAPO/CPC 2023

Awards

Fluor Award, Highest distinction of Cullen College of Engineering, 2019
Dukler Award, Cullen College of Engineering Alumni Award, 2017
Cullen College of Engineering Senior Faculty Research Excellence Award, 2010
"Professor Solution" in "Automation Avengers" educational campaign, ISA, 2008
CAST Directors Poster Paper Award (with M. Darby), AIChE Annual Meeting, 2007
Top 2% Reviewer, Automatica (leading int'l journal on automatic control), 2007
Cullen College of Engineering Teaching Excellence Award, 2007
3rd place, Keck Center 2005 Annual Research Conference Poster Contest
Halliburton Energy Services Award, for paper SPE 71647 (co-authored with M. J. Economides and S. Sankaran)
TEES Fellow, Texas A&M, 1996, 1997
Professor of the Year, Texas A&M AIChE Student Chapter, 1994
Junior TEES Fellow, Texas A&M 1992
Teaching Assistant of the Year, UCLA 1988

TEACHING

Undergraduate

Numerical & Statistical Methods for Chemical Engineers (CHEE 3334, Junior UH)
Process Dynamics & Control (CHEE 3367, Junior UH)
Introduction to Computing for Engineers (CHEE/INDE/CIVE 1331, Freshman/Sophomore UH)
Modeling and Analytical Methods for Chemical Engineers (CHEE 3321, Junior UH)
Plant Economics (Senior, TAMU)
Plant Design (Senior, TAMU)
Chemical Engineering Thermodynamics I (Sophomore, TAMU)
Statistical Methods in Chemical Engineering (Senior elective, TAMU)
Statistical Quality Control Methods (Senior elective, TAMU)
Written and oral communication for chemical engineers (Junior, TAMU)

Graduate

Mathematical Methods in Chemical Engineering (CHEE 6331)
Foundations of Mathematical Methods in Chemical Engineering (CHEE 6397/6330)
Advanced Process Control (CHEE 6367/5367)
Data Analysis and Design of Experiments (Lectures in Experimental Methods – CHEE 6397)
Data Analytics (CHEE 6397)
Gas to Liquids (Lectures in Natural Gas Engineering – PETR 6350)

SUPERVISION OF RESEARCH

PhD Theses Supervision

Texas A&M University

1. Hasmet Genceli (currently with Bryan Research & Engineering)
2. Yong You (currently with Invensys)
3. Vijay Hanagandi (currently Principal of Applied Optimization, Inc.)
4. Harry Sarimveis (currently full Professor, National Technical University, Athens, Greece)
5. Wangyan (Charles) Feng (currently with Hewlett-Packard)
6. Manoj Shouche (currently with Montel Polyolefins)
7. Prem Vuthandam (currently with AspenTech)
8. Alex Schwarm (currently with Applied Materials)
9. Gabe Haarsma (currently with Shell)

University of Houston

10. S. Alper Eker – Spring 2001 (currently with General Electric Corporate R&D)
11. Haiyang Zhang – Spring 2002 (currently in China)
12. Dimitri Sagias – Fall 2003 (currently with Bayer, Baytown)
13. Pratik Misra – Spring 2003 (currently with Air Products)
14. Luigi Saputelli – Spring 2003 (co-supervised with M. J. Economides) (currently with Halliburton)
15. Sathish Sankaran – Spring 2003 (co-supervised with M. J. Economides) (currently with Anadarko)
16. Nirmal Tatavalli, Ph.D – Summer 2007 (co-supervised with D. J. Economou) (currently with Shell)
17. Ankur Awasthi, PhD – Spring 2008 (currently with BHP)
18. Mark Darby, PhD – Fall 2008 (currently proprietor of CM*i*D Solutions, LLC)
19. Jan Einar Gravdal, PhD – Summer 2011 (co-supervisor; currently with IRIS, Norway)
20. Oeyvind Breyholtz, PhD – Summer 2011 (co-supervisor; currently with Statoil, Norway)
21. Ajay Singh, PhD – Summer 2012 (currently with Halliburton)
22. Pratik Bhagunde, PhD – Summer 2012 (currently with Astra-Zeneca)
23. Srimoyee Bhattacharya, PhD – Fall 2012 (currently with Shell)
24. Liv Carlsen, PhD – Fall 2012 (co-supervisor; currently with IRIS, Norway).
25. Hans-Peter Lohne, PhD – Summer 2013 (co-supervisor; currently at U. of Stavanger, Norway).
26. Shyam Panjwani, PhD 2017
27. Shobhit Misra, PhD 2017
28. Guofan Luo, PhD 2019 (co-supervisor)
29. Iordanis Kesisoglou, PhD 2022 (with Merck, effective May 2022)
30. Garima Singh, PhD 2023

Masters Theses Supervision

Texas A&M University

1. Yong You
2. Harry Sarimveis
3. Tong Zeng
4. Pablo Echeverria

University of Houston

5. Mohan Cherukuri
6. Diwakar Mantha
7. Cédric Oudinot (co-supervised with M. J. Economides)
8. Bilu Cherian (co-supervised with M. J. Economides)
9. Emre Serpen (co-supervised with Christine Ehlig-Economides)
10. Aysu Öztürk
11. Kevin Ziervogel
12. Aditya Kumar (eventually graduated with non-thesis MS)
13. Parag Kulkarni (ECE student) (co-supervisor) – Summer 2012
14. Kyle MacFarlan, 2014
15. Khanal, Aaditya (PETR), 2014
16. Supriya Gupta (PETR), 2015

17. Yue Lin (PETR; eventually graduated with non-thesis MS)
18. Sunit Mathur (PETR), 2017
19. Bharat Thakur (PETR), 2017
20. Nitish Goyal (PETR), 2018
21. Fahad Alwarda (PETR, co-supervisor), 2020
22. Leila Zeinali (PETR, co-supervisor), 2021
23. Murtaza Khan (PETR, co-supervisor), 2023

PUBLICATIONS[1]
Full up to date list is also available at
https://scholar.google.com/citations?hl=en&user=mLs4L3UAAAAJ

1. Refereed Journal Publications (in Chronological Order)

1. **Nikolaou**, M. and V. Manousiouthakis, "A Hybrid Approach to Nonlinear System Stability and Performance", *AIChE Journal,* **35,** 4, 559-572 (1989).
2. Manousiouthakis, V. and M. **Nikolaou**, "Analysis of Decentralized Control Structures for Nonlinear Systems", *AIChE Journal,* **35,** 4, 549-558 (1989).
3. **Nikolaou**, M. and V. Manousiouthakis, "Sensitivity Analysis of Optimal Control Policies for Batch Processes", *Chemical Engineering Communications* **97**, 27-45 (1990).
4. Fan, J. Y., M. **Nikolaou**, and R. E. White, "An Approach to Fault Diagnosis of Chemical Processes via Neural Networks", *AIChE J*. **39**, 1, 82-88 (1993).
5. You, Y., and M. **Nikolaou**, "Dynamic Process Modeling with Recurrent Neural Networks", *AIChE J*., **39**, 10, 1654-1667 (1993).
6. **Nikolaou**, M. and V. Hanagandi, "Input-Output Exact Linearization of Nonlinear Dynamical Systems Modeled by Recurrent Neural Networks", *AIChE J*., **39**, 11, 1890-1894 (1993).
7. Genceli, H., and M. **Nikolaou**, "Robust Stability Analysis of Constrained l_1-Norm Model Predictive Control", *AIChE J*., **39**, 12, 1954-1965 (1993).
8. Holtzapple, M. T., E. P. Ripley, and M. **Nikolaou**, "Saccharification, Fermentation, and Protein Recovery from AFEX-Treated Coastal Bermudagrass", *Biotechnology and Bioengineering*, **44**, 1112–1131 (1994).
9. **Nikolaou**, M., and V. Hanagandi, "Recurrent Neural Networks in Decoupling Control of Multivariable Nonlinear Systems", *Chem. Eng. Communications*, **136**, 201-216 (1995).
10. Vuthandam, P., H. Genceli, and M. **Nikolaou**, "Performance Bounds of Robust Model-Predictive Control", *AIChE J.*, **41**, 9, 2083-2097 (1995).
11. Genceli, H. and M. **Nikolaou**, "Design of Robust Constrained Nonlinear Model Predictive Controllers with Volterra Series", *AIChE J.*, **41**, 9, 2098-2107 (1995).
12. Hanagandi, V., H. Ploehn, and M. **Nikolaou**, "Solution of the Self-Consistent Field Model for Polymer Adsorption by Genetic Algorithms", *Chem. Eng. Sci.* , **51**, 7, 1071-1078 (1996).
13. Sarimveis, H., H. Genceli, and M. **Nikolaou**, "Design of Robust Non-Square Constrained Model Predictive Control", *AIChE J.*, **42**, 9, 2582-2593 (1996).
14. Genceli, H., and M. **Nikolaou**, "New Approach to Constrained Predictive Control with Simultaneous Model Identification", *AIChE J.*, **42**, 10, 2857-2869 (1996).
15. Hanagandi, V., and **Nikolaou**, M. "A Hybrid Approach to Global Optimization Using a Clustering Algorithm in a Genetic Search Framework," *Computers & Chem. Engng.*, **22,** 12, 1913-1925 (1998).
16. **Nikolaou**, M., and V. Hanagandi, "Nonlinearity Quantification and its Application to Nonlinear System Identification", *Chem. Eng. Comm.*, **166**, 1-33 (1998).
17. Shouche M., H. Genceli, P. Vuthandam, and M. **Nikolaou**, "Simultaneous Constrained Model Predictive Control and Identification of DARX Processes", *Automatica*, **34**, 12, 1521-1530 (1998).
18. Moridis, G. J., M. **Nikolaou**, and Y. You, "The Use of Wavelet Transforms in the Solution of Two-Phase Flow Problems", *SPE J.*, **29144**, 169-178 (1996).

[1] Highlights indicate publications with students.

19. Shouche, M., H. Genceli, and M. **Nikolaou**, "Dependence of Model Predictive Control and Identification Performance on On-Line Optimization Techniques", *Computers Chem. Engng.,* **26**, 9, 1241-1252 (2002).
20. Vuthandam, P., and M. **Nikolaou**, "Constrained Model Predictive Control and Identification: A Weak Persistent Excitation Approach", *AIChE J.*, **43**, 9, 2279-2288 (1997).
21. **Nikolaou**, M., and P. Vuthandam, "FIR Model Identification: Achieving Parsimony through Kernel Compression with Wavelets", *AIChE J.*, **44**, No. 1, 141-150 (1998).
22. Schwarm, A., and M. **Nikolaou**, "Chance Constrained Model Predictive Control", *AIChE Journal*, **45**, 8, 1743-1752 (1999).
23. Eker, S. A., and M. **Nikolaou**, "Adaptive Control through On-line Optimization: The MPCI Paradigm and Variants", *Appl. Math. And Comp. Sci.*, **9**, 1, 101-128 (1999).
24. **Nikolaou**, M., "Identification and Adaptive Control", *Comp. Chem. Eng., special issue on NSF/NIST Vision 2020 Workshop*, 23/2, pp. 217 - 227, (1998).
25. Zhang, H., Y. Peng, M. **Nikolaou**, "Development of a Data Driven Dynamic Model for a Plasma Etching Reactor", *J. Vac. Sci. Tech.* B 20 (3): 891-901 MAY-JUN 2002.
26. Eker, S. A., and M. **Nikolaou**, "Linear Control of Nonlinear Systems - The Interplay between Nonlinearity and Feedback", *AIChE J.*, 48 (9): 1957-1980 SEP 2002.
27. Misra P, **Nikolaou** M, "Input design for model order determination in subspace identification", *AICHE J* 49 (8): 2124-2132 AUG 2003.
28. **Nikolaou** M, Misra P, "Linear control of nonlinear processes: recent developments and future directions", *COMPUT CHEM ENG* 27 (8-9): 1043-1059 SEP 15 2003.
29. V. H. Tam, A. N. Schilling, and M. **Nikolaou**, "Modelling time-kill studies to discern the pharmacodynamics of meropenem," *Journal Of Antimicrobial Chemotherapy*, vol. 55, pp. 699-706, 2005.
30. V. H. Tam and M. **Nikolaou**, "Mathematical modelling of resistance emergence," *Journal Of Antimicrobial Chemotherapy*, vol. 56, pp. 983-983, 2005.
31. M. **Nikolaou**, P. Misra, V. H. Tam, and A. D. Bailey, "Complexity in semiconductor manufacturing, activity of antimicrobial agents, and drilling of hydrocarbon wells: Common themes and case studies," *Computers & Chemical Engineering*, vol. 29, pp. 2266-2289, 2005.
32. L. Saputelli, M. **Nikolaou**, and M. J. Economides, "Self-learning reservoir management," *SPE Reservoir Evaluation & Engineering*, vol. 8, pp. 534-547, 2005.
33. M. **Nikolaou** and V. H. Tam, "A new modeling approach to the effect of antimicrobial agents on heterogeneous microbial populations," *Journal of Mathematical Biology*, vol. 52, pp. 154-182, 2006.
34. **Nikolaou**, M., "Control of Snack Food Manufacturing Systems: Potato chips and micro-chips are more similar than commonly believed", *IEEE Control Systems Magazine*, **featured on cover of** special issue on process control, 26 (4) : 40-54, 2006.
35. L. Saputelli, M. **Nikolaou** b, and M.J. Economides, "Real-Time Reservoir Management: A Multi-Scale Adaptive Optimization and Control Approach", *J. Computational Geosciences*, invited publication for Special Issue on Closed-Loop Reservoir Management, 10, 61-96, 2006.
36. Darby, M. L., and M. **Nikolaou**, "A Parametric Programming Approach to Moving Horizon State Estimation", *Automatica*, 43 (5): 885-891, 2007.
37. **Nikolaou** M, Schilling AN, Vo G, et al., "Modeling of microbial population responses to time-periodic concentrations of antimicrobial agents" ANNALS OF BIOMEDICAL ENGINEERING 35 (8): 1458-1470 AUG 2007.
38. Tam, V. H.; Schilling, A. N.; Poole, K.; **Nikolaou**, M., Mathematical modelling response of Pseudomonas aeruginosa to meropenem. *Journal Of Antimicrobial Chemotherapy* **2007,** 60, (6), 1302-1309.

39. Tam, V. H.; Vo, G.; Kabbara, S.; **Nikolaou**, M., Pharmacodynamics of gentamicin against Pseudomonas aeruginosa: modelling bacterial response to drug-selective pressures. *International Journal Of Antimicrobial Agents* **2007,** 29, S87-S88.
40. Tam, V. H.; Ledesma, K. R.; Vo, G.; Kabbara, S.; Lim, T. P.; **Nikolaou**, M., Pharmacodynamic Modeling of Aminoglycosides against Pseudomonas aeruginosa and Acinetobacter baumannii: Identifying Dosing Regimens To Suppress Resistance Development. *Antimicrobial Agents And Chemotherapy* **2008,** 52, (11), 3987-3993.
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43. W. J. Foster, N. Dowla, S. Y. Joshi, M. **Nikolaou**, "The fluid mechanics of scleral buckling surgery for the repair of retinal detachment", *Graefes Arch Clin Exp Ophthalmol*, DOI 10.1007/s00417-009-1198-z, SEP 2009. (ONLINE).
44. M. **Nikolaou**, "Optimizing the Logistics of Compressed Natural Gas Transportation by Marine Vessels", *Journal of Natural Gas Science and Engineering*, 2(1), 1-20, **2010**.
45. Bhagunde P, Chang KT, Singh R, Singh V, Garey KW, **Nikolaou** M, Tam VH, "Mathematical Modeling To Characterize the Inoculum Effect", *Antimicrobial Agents And Chemotherapy*, Volume: 54 Issue: 11 Pages: 4739-4743 Published: NOV 2010.
46. Gravdal, J.E., **Nikolaou**, M., Breyholtz, Ø., and Carlsen, L.A. 2010. Improved Kick Management During MPD by Real-Time Pore-Pressure Estimation. *SPE Drilling & Completion,* 25 (4): 577-584. SPE-124054-PA. doi: 10.2118/124054-PA.
47. Bhagunde, P., R. Singh, K. R. Ledesma, K. T. Chang, M. **Nikolaou** and V. H. Tam (2011). "Modelling biphasic killing of fluoroquinolones: guiding optimal dosing regimen design." *Journal of Antimicrobial Chemotherapy* 66(5): 1079-1086.
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50. Diomede, P., M. **Nikolaou** and D. J. Economou (2011). "Voltage waveform to achieve a desired ion energy distribution on a substrate in contact with plasma." *Plasma Sources Science & Technology* 20(4).
51. Economides, M. J. and M. **Nikolaou** (2011). "Technologies for Oil and Gas Production: Present and Future." *AIChE Journal* 57(8): 1974-1982. (Exceprted in *Chemical Engineering Progress*, 8:12, 2011).
52. Tam, V. H. and M. **Nikolaou** (2011). "A Novel Approach to Pharmacodynamic Assessment of Antimicrobial Agents: New Insights to Dosing Regimen Design." **featured on cover of** *PLoS Computational Biology* 7(1). (**Reviewed at Priority Paper Evaluation** by J. Mouton, *Future Microbiol*. (2011) 6(6), 613–616).
53. Guo, B. N., K. Abdelraouf, K. R. Ledesma, K. T. Chang, M. **Nikolaou** and V. H. Tam (2011). "Quantitative Impact of Neutrophils on Bacterial Clearance in a Murine Pneumonia Model." *Antimicrobial Agents and Chemotherapy* 55(10): 4601-4605.
54. Guo, B., Abdelraouf, K., Ledesma, K., **Nikolaou**, M., Tam, V. (2012). "Predicting bacterial fitness cost associated with drug resistance", *Journal of Antimicrobial Chemotherapy* 67(4): 928-932.

55. Breyholtz, Ø. and M. **Nikolaou** (2012). "Drilling Automation: Presenting a Framework for Automated Operations." *SPE Drilling & Completion,* 27(1): 118-126.
56. Darby, M.L. and **Nikolaou**, M. (2012). "MPC: Current practice and challenges". *Control Engineering Practice,* 20(4): 328-342.
57. Bhattacharya, S., and M. **Nikolaou**, (2012). "Unified Fracture Design for Unconventional Reservoirs", *Journal of Natural Gas Science and Engineering*, 9, 184-195.
58. **Nikolaou**, M. (2013). "Computer-Aided Process Engineering in Oil and Gas production", *Computers and Chemical Engineering,* special issue on CPC VIII, 51(0), 96-101. (**Most-downloaded list**)
59. Singh, A., and M. **Nikolaou**, (2013). "Control of a process with unmeasured disturbances that change its steady-state gain sign", *Journal of Process Control*, 23(3): 294-305.
60. Carlsen, L.A., G. Nygaard, and M. **Nikolaou**, (2013). "Evaluation of Control Methods for Drilling Operations with Unexpected Gas Influx", *Journal of Process Control*, 23(3): 306-316.
61. Bhattacharya, S., and M. **Nikolaou**, (2013). "Analysis of Production History for Unconventional Gas Reservoirs with Statistical Methods", *SPE Journal*, 18(5): 878-896.
62. Singh, A. and M. **Nikolaou**, (2014) "Optimal rules for central bank interest rate subject to zero lower bound", *Economics*, 8 (2014-37): 1—67. http://dx.doi.org/10.5018/economics-ejournal.ja.2014-37 .
63. Singh, A., and M. **Nikolaou**, (2014) "Debottlenecking level control for tanks in series", *Journal of Process Control* 24(3): 158-171.
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69. Misra, S and M. **Nikolaou** (2015), "Adaptive Design of Experiments for Identification of Dynamic Models subject to Integral Controllability", *Computers and Chemical Engineering*.
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89. Kesisoglou, I., B. M. Eales, P. R. Merlau, V. H. Tam and M. **Nikolaou** (2022). "Deciphering longitudinal optical-density measurements to guide clinical dosing regimen design: A model-based approach." Computer Methods and Programs in Biomedicine 227: 107212.
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2. Book Chapters (in Chronological Order)

1. **Nikolaou**, M., and Y. You, "Use of Wavelets for Numerical Solution of Differential Equations", *Wavelet Applications in Chemical Engineering*, B. Joseph and R. Motard (Editors), 209-274, Kluwer (1994).
2. Hanagandi, V., and M. **Nikolaou**, "Applications of Genetic Algorithms in Chemical Engineering", *Practical Handbook of Genetic Algorithms*, Lance Chambers Ed., Volume 2, 221-252, CRC Press (1995).
3. **Nikolaou**, M., "Model Predictive Controllers: A Critical Synthesis of Theory and Industrial Needs", *Advances in Chemical Engineering Series*, Academic Press (2001).
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5. M. **Nikolaou**, "Compressed Natural Gas" in *Advanced Natural Gas Engineering*, X. Wang and M. J. Economides, Gulf Publishing, 2009.

3. Major Reports

Nikolaou, M., Jesse L. Buffington, Angel Herrera, Jr., and Hwang Inkeuk, *Traffic Air Pollution Effects of Elevated, Depressed, and at-Grade Level Freeways in Texas*, FHWA/TX-97/1327-4, Texas Transportation Institute, The Texas A&M University System, College Station, Texas 77843-3135 (1997).

4. Refereed Conference Proceedings Publications (in Chronological Order)

1. Manousiouthakis, V. and M. **Nikolaou**, "On the Nonlinear Block Relative Gain", *Proceedings of the American Control Conference*, Seattle, WA, 2120-2125 (1987).
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4. **Nikolaou**, M. and V. Manousiouthakis, "On the Characterization and Evaluation of Stability of Nonlinear Systems", *Proceedings of the American Control Conference*, Atlanta, GA, 1559-1564 (1988).
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7. **Nikolaou**, M., and H. Sarimveis, "Process Modeling with Recurrent Neural Networks", *ANNIE 91 Proceedings* (1991).
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10. **Nikolaou**, M., "Neural Network Modeling of Nonlinear Dynamical Systems", *ACC Proceedings*, 1460-1464, San Francisco, CA (1993).
11. Moridis, G. J., and M. **Nikolaou**, "The Laplace Transform Wavelet (LTW) Method for the Solution of the Equations of Flow and Transport Through Porous Media", *EOS Trans. AGU*, **74**, 43, 307 (1993).
12. Vuthandam, P., H. Genceli, and M. **Nikolaou**, "Analysis and Synthesis Methods for Robust Model Predictive Control", *ADCHEM'94 Proceedings*, Kyoto, JAPAN (1994).
13. **Nikolaou**, M., "The 2-norm for Nonlinear Processes: Application to Modeling and Control Problems", *PSE'94 Proceedings*, Kyongju, KOREA (1994).
14. **Nikolaou**, M., "Teaching Numerical Methods Using Interactive Computer Spreadsheets in Class", *Proceedings of ASEE Annual Conference*, Session 3162, 2731-2736, Edmonton, Canada (1994).
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18. **Nikolaou**, M., Computer-Aided Process Engineering in the Snack Food Industry, in *Fifth International Conference on Chemical Process Control – CPC V*, AIChE, Kantor et al. (Eds.) (1996).
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20. Sarimveis, H., H. Genceli, and M. **Nikolaou**, "Design of Robust Non-Square Constrained Model Predictive Control", to be included in *European Symposium on Computer-Aided Process Engineering Proceedings*, Rhodes, Greece (May, 1996).
21. Genceli, H., and M. **Nikolaou**, "A New Approach to Constrained Predictive Control with Simultaneous Model Identification", to be included in *European Symposium on Computer-Aided Process Engineering Proceedings*, Rhodes, Greece (May, 1996).
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26. Zhang, H., and M. **Nikolaou**, "Control of Spatial Uniformity in Microelectronics Manufacturing: An Integrated Approach", APC/AEC XII Sematech Workshop, Lake Tahoe (2000).

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30. Saputelli L., Malki H., Canelon J. and M. **Nikolaou**, "A critical overview of artificial neural network applications in the context of continuous oil field optimization" SPE 77703, SPE Annual Meeting (2002).
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32. Misra, P., M. **Nikolaou**, and A. D. Bailey, III, "Application of reduced-rank multivariate methods to the analysis of spatial uniformity of Silicon wafer etching", ADCHEM 2003, Hong Kong, 2003 (held in January 2004 because of SARS.)
33. L. Saputelli, M. **Nikolaou**, M. Economides, V. Kelessidis, "Real-Time Decision Making for Value Creation while Drilling", SPE/IADC Middle East Drilling Technology Conference & Exhibition Abu Dhabi, UAE, 20-22 October (2003).
34. Saputelli, L., M. Economides, M. **Nikolaou**, A. Demarchos, "Real-Time Decision Making for Value Creation while Drilling and Well Intervention", paper AADE-03-NTCE-12, 2003 National Technology Conference "Practical Solutions for Drilling Challenges", Radisson Astrodome Houston, Texas, April 1 – 3, (2003).
35. **Nikolaou**, M., and V. H. Tam, "Modeling the effect of antibiotics on bacterial populations of distributed resistance: A system approach" FOSBE 2005, Santa Barbara, CA (2005).
36. **Nikolaou**, M., A. S. Cullick, and L. Saputelli, "Production Optimization: A Moving Horizon Approach", SPE 99358, Intelligent Energy 2006, Amsterdam, NL (2006).
37. **Nikolaou**, M., L. Saputelli, G. Mijares, S. Sankaran , and L. Reis "A Consistent Approach toward Reservoir Simulation at Different Time Scales", SPE 99451, Intelligent Energy 2006, Amsterdam, NL (2006).
38. Darby, M. and M. **Nikolaou**, "RTO: An Overview and Assessment of Current Practice", SICOP/ADCHEM 2006, Gramado, Brazil (2006).
39. A. Awasthi, S. Sankaran, M. **Nikolaou**, L. Saputelli, G. Mijares, "Closing the Gap Between Reservoir Modeling and Production Optimization", SPE 107463-MS (2007).
40. L. A. Carlsen, G. Nygaard, J. E. Gravdal, M. **Nikolaou**, J. Schubert, Performing the Dynamic Shut-In Procedure Because of a Kick Incident When Using Automatic Coordinated Control of Pump Rates and Choke-Valve Opening, SPE 113693-MS (2008).
41. A. Awasthi, S. Sankaran, M. **Nikolaou**, L. Saputelli, G. Mijares, "Short-Term Production Optimization by Automated Adaptive Modeling and Control", SPE 112239-MS (2008).
42. A. Awasthi, S. Sankaran, M. **Nikolaou**, L. Saputelli, G. Mijares, "Meeting the Challenges of Real-Time Production Optimization—A Parametric Model-Based Approach", SPE 111853-MS (2008).
43. Darby, M. and M. **Nikolaou**, "Multivariable System Identification for Integral Controllability – Computational Issues", ADCHEM 2009, Instanbul, Turkey (2009).
44. Darby, M., M. Harmse, B. Froisy, and M. **Nikolaou**, "Model Predictive Control: Current Practice and Challenges", PLENARY talk, ADCHEM 2009, Instanbul, Turkey (2009).
45. M. **Nikolaou**, M. J. Economides, X. Wang, and M. Marongiu-Porcu, "Distributed Compressed Natural Gas Sea Transport" paper OTC-19738-MS, Offshore Technology Conference, Houston, TX 2009.

46. Ø. Breyholtz, G. Nygaard, and M. **Nikolaou**, "Advanced Automatic Control for Dual-Gradient Drilling", paper SPE 124631, SPE Annual Technical Conference and Exhibition, New Orleans, 2009.
47. J. E. Gravdal, M. **Nikolaou**, Ø. Breyholtz, and L. A. Carlsen, "Improved Kick Management During MPD by Real-Time Pore-Pressure Estimation", paper SPE 124054-MS, SPE Annual Technical Conference and Exhibition, New Orleans, 2009.
48. Ø. Breyholtz, G. Nygaard, and M. **Nikolaou**, "Automatic Control of Managed Pressure Drilling", invited talk, American Control Conference, June 2010.
49. Ø. Breyholtz, G. Nygaard, H. Siahaan, M. **Nikolaou**, " Managed Pressure Drilling: A Multi-Level Control Approach", paper SPE 128151, Intelligent Energy, Amsterdam, March 2010.
50. Bhattacharya, S. and M. **Nikolaou** (2011a). "Optimal Fracture Spacing And Stimulation Design For Horizontal Wells In Unconventional Gas Reservoirs". SPE-147622-MS, SPE Annual Technical Conference and Exhibition. Denver, Colorado.
51. Bhattacharya, S. and M. **Nikolaou** (2011b). "Using Data From Existing Wells To Plan New Wells in Unconventional Gas Field Development". SPE-147658-MS, Canadian Unconventional Resources Conference. Calgary, Alberta.
52. Moridis, G. J., H. Kuzma-Anderson, M. T. Reagan, T. A. Blasingame, R. Santos, K. Boyle, C. M. Freeman, D. Ilk, Y. W. Wang, S. C. Pullman, S. Bhattacharya and M. **Nikolaou** (2011). "SeTES: A Self-Teaching Expert System for the Analysis, Design, and Prediction of Gas Production From Unconventional Gas Resources". SPE-149485-MS, Canadian Unconventional Resources Conference. Calgary, Alberta, Canada, 2011, SPE.
53. **Nikolaou**, M. "Computer-Aided Process Engineering in Oil and Gas production", Invited presentation at CPC VIII, Savannah, GA, Jan 2012.
54. Bravo, C. E., L. A. Saputelli, F. I. Rivas, A. G. Perez, M. **Nikolaou**, G. Zangl, N. d. Guzman, S. D. Mohaghegh and G. Nunez (2012). "State-of-the-Art Application of Artificial Intelligence and Trends in the E&P Industry: A Technology Survey". SPE-150314-MS, SPE Intelligent Energy International. Utrecht, The Netherlands, Society of Petroleum Engineers.
55. Saputelli L., Bravo C., **Nikolaou** M., Lopez C., Cramer R., Mochizuki T., Moricca G. (2013). "Best practices and lessons learned after 10 years of digital oilfield (DOF) implementations", SPE 167269.
56. **Nikolaou**, M, X Wang, and MJ Economides (2013) Optimization of Compressed Natural Gas Marine Transportation with Composite-Material Containers, SPE 165898-MS.
57. C. Wreden, J.T. Watters, R. Giroux, M. **Nikolaou**, K. Macfarlan, D.A. Richardson (2014) Deepwater Reverse-Circulation Primary Cementing: Applicability and Technical Path Forward for Implementation, OTC 25194-MS.
58. HB. Siahaan, EH Vefring, M **Nikolaou**, JE. Gravdal (2105). Evaluation of Coordinated Control During Back Pressure MPD Operations, Evaluation of Coordinated Control During Back Pressure MPD Operations, SPE 169205.
59. Y Lin, HY Wang, S He, M **Nikolaou**, (2015). Increasing Shale Gas Recovery through Thermal Stimulation: Analysis and an Experimental Study, SPE-175070-MS.
60. Supriya Gupta, Michael **Nikolaou**, Luigi Saputelli, Cesar Bravo (SEP 2016). ESP Health Monitoring KPI: A Real-Time Predictive Analytics Application. SPE 181009-MS, SPE Intelligent Energy International Conference and Exhibition.
61. Supriya Gupta, Luigi Saputelli, Michael **Nikolaou**, (SEP 2016). Applying Big Data Analytics to Detect, Diagnose, and Prevent Impending Failures in Electric Submersible Pumps, SPE 181510-MS, SPE Annual Technical Conference and Exhibition.

62. Supriya Gupta, Luigi Saputelli, Michael **Nikolaou**, (OCT 2016). Big Data Analytics Workflow to Safeguard ESP Operations in Real-Time, SPE 181224-MS, SPE North America Artificial Lift Conference and Exhibition.
63. Alwarda, F., G. Liu, M. **Nikolaou** and C. Ehlig-Economides (2020). Automated Procedure for Quantifying ISIP And Friction Losses from Stage By Stage Hydraulic Fracture Treatment Falloff Data. SPE Annual Technical Conference and Exhibition, OnePetro.
64. Zeinali, L., C. Ehlig-Economides and M. **Nikolaou** (2021). Enhanced Geothermal System Model for Flow through a Stimulated Rock Volume. SPE Annual Technical Conference and Exhibition, OnePetro.

Papers at Technical Meetings without Conference Proceedings

Regular presenter annually at AIChE National Meetings (only abstracts required)

Other Publications (in Chronological Order)

1. M. J. Economides, and M. **Nikolaou**, "Energy: Facts and Myths", *Kathimerini*, (major Greek daily; in Greek), June 2009.
2. M. J. Economides, and M. **Nikolaou**, "Greece's great opportunity", *Kathimerini*, (major Greek daily; in Greek), April 2009.
3. Economides, M., N. Mitsos, and M. **Nikolaou**, “Natural Gas and Geopolitical Implications” (in Greek) *Phileleftheros*, Cyprus daily, January 2011.
4. Economides, M., and M. **Nikolaou**, “The Future of Natural Gas in Cyprus” (in Greek), *O Politis (Citizen)*, Cyprus daily, October 2011.

Refereed Publications in Citation Order (Partial List of 12 most cited)

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RTO: An overview and assessment of current practice ML Darby, M Nikolaou, J Jones, D Nicholson Journal of Process control 21 (6), 874-884	355	2011
MPC: Current practice and challenges ML Darby, M Nikolaou Control Engineering Practice 20 (4), 328-342	338	2012
Chance-constrained model predictive control AT Schwarm, M Nikolaou AIChE Journal 45 (8), 1743-1752	336	1999
Model predictive controllers: A critical synthesis of theory and industrial needs M Nikolaou Academic Press 26, 131-204	203	2001
Robust stability analysis of constrained l_1-norm model predictive control H Genceli, M Nikolaou AIChE Journal 39 (12), 1954-1965	202	1993
Modelling time–kill studies to discern the pharmacodynamics of meropenem VH Tam, AN Schilling, M Nikolaou Journal of antimicrobial chemotherapy 55 (5), 699-706	152	2005
An approach to fault diagnosis of chemical processes via neural networks JY Fan, M Nikolaou, RE White AIChE Journal 39 (1), 82-88	146	1993
Self-learning reservoir management L Saputelli, M Nikolaou, MJ Economides SPE Reservoir Evaluation & Engineering 8 (06), 534-547	136	2005
Real-time reservoir management: A multiscale adaptive optimization and control approach L Saputelli, M Nikolaou, MJ Economides Computational Geosciences 10, 61-96	104	2006
State of the art of artificial intelligence and predictive analytics in the E&P industry: a technology survey C Bravo, L Saputelli, F Rivas, AG Pérez, M Nikolaou, G Zangl, ... Spe Journal 19 (04), 547-563	95	2014
Simultaneous constrained model predictive control and identification of DARX processes M Shouche, H Genceli, V Premkiran, M Nikolaou Automatica 34 (12), 1521-1530	89	1998
Design of robust constrained model-predictive controllers with volterra series H Genecili, M Nikolaou AIChE Journal 41 (9), 2098-2107	89	1995

Invited Seminars

Lawrence Berkeley National Laboratory, 1994.
U. of Texas, Austin, 1995.
U. of Massachusetts, Amherst, 1995.
Chemical Process Control Conference, Invited Talk, Tahoe City, 1996 (leading quinquennial international event on Chemical Process Control)
Northwestern University, 1995.
Rice University, 1996.
U. of Houston, 1995, 1997.
NSF/NIST Workshop, New Orleans, 1998.
NSF Workshop on Nonlinear Model Predictive Control, Ascona, Switzerland, 1998.
Texas Tech, Lubbock, TX, 2000.
Texas-Wisconsin Modeling & Control Consortium, Invited Talk, U. of Texas, Austin, 2001.
AspenWorld, Invited Talk, 2002.
"Advanced Computer Control of Chemical Processes: A Critical Overview of Historical and Technical Developments", AIChE South TX Section, January 2004.
"The Role of Academia" GEMI Workshop, April 3, 2003.
"Industry/University Collaborative Technology Development and Dissemination", Invited talk, AspenTech, 3/9/2004.
"Advanced Computer Control of Chemical Processes: A Critical Overview of Historical and Technical Developments", invited talk, AIChE South TX Section, 1/12/2004.
"Production Optimization: A Case for Intelligent Oilfield Operations", invited talk, ConocoPhillips, Houston, TX, 3/14/2005.
"Production Optimization: A Case for Intelligent Oilfield Operations", invited talk, Landmark Graphics, Houston, TX, 2/21/2005.
"Intelligent Oilfield Operations", invited talk, Pontifícia Universidade Católica do Rio de Janeiro, Brazil, 10/8/2004.
"A New Mathematical Modeling Approach to the Effect of Antimicrobial Agents to Heterogeneous Microbial Populations", Methodist Hospital Workshop, November 9, 2005.
"Modeling for making micro-chips, killing pathogens, and drilling hydrocarbon wells: Common themes & case studies", University of Oklahoma, October 20, 2005.
Distinguished Speaker, SPE FIRST ANNUAL EMERGING ENGINEERS CONFERENCE, Houston, TX, May 5, 2005.
"Systems, Control and Optimization" Workshop: Intelligent Wells – A Primer, University of Houston, August 30, 2006.
"Systems, Control and Optimization" Workshop: Instituto Colombiano del Petroleo, October 18, 2006.
" Control-Relevant Identification of Ill-Conditioned Multivariable Systems", ExxonMobil, Baytown, TX, March 8, 2007.
" A New Mathematical Modeling Approach to the Effect of Antimicrobial Agents on Microbial Populations of Distributed Resistance: Theory and Experiments", Mechanical Engineering Dept., UH, April 2007.
"Making the Business Case for Collaborative Technology Investment", Future Fields Summit, London, UK, May 9, 2007.
"Experience from Automation Technologies in Other Industries and Their Transfer to the Petroleum Industry", Real-Time Optimization Advanced Technical Workshop by SPE, Houston, TX, January 22, 2007.

"Experience from Automation Technologies in Other Industries and Their Transfer to the Petroleum Industry", Drilling Workshop organized by the International Research Institute of Stavanger, Rice U., Houston, TX, May 7, 2008.

"Experience from Automation Technologies in Other Industries and Their Transfer to the Petroleum Industry", International Research Institute of Stavanger, Norway, June 1, 2008.

(KEYNOTE) "A Holistic View to Natural Gas Production", Risavika Natural Gas Center opening, Stavanger, Norway, August 25, 2008.

"Modeling: Art, Science and Engineering", University of British Columbia, Vancouver, Canada, March 19, 2009.

"Compressed Natural Gas: Present Status and Future Challenges", First Trondheim Gas Technology Conference", October 2009.

"Energy Geopolitics", ELIAMEP, Athens, Greece, May 2009.

"Control hierarchy for drilling automation", International Research Institute of Stavanger, Bergen, Norway, June 2009.

"Modeling: Art, Science, and Engineering", National Technical University, Athens, Greece, May 2009.

"Automation Avengers", ISA Annual Conference (education presentation to 600 HISD students), Houston, October 2009.

“Control system integration for offshore drilling operations”, invited presentation at International Research Institute of Stavanger, Bergen, Norway, June 2010.

“Corn Ethanol”, invited presentation, Celanese, Houston, TX, Dec. 2010**.**

“Modeling: Art, Science, and Engineering”, Imperial College, London, UK (June, 2011). (Invited lecture on the occasion of being External PhD Examiner).

“Improving Safety through Process Automation”, International Research Institute of Stavanger (IRIS) Bergen, Norway (2012).

“Liquefied Natural Gas”, Mare Forum, Pafos, Cyprus (2012).

"Monetizing Natural Gas: GTW, GTL, LNG, and CNG", Mare Forum, Pafos, Cyrpus (2013)

"Monetizing Natural Gas: GTW, GTL, LNG, and CNG", Mare Forum, Athens, Greece (2014)

"Intelligent Energy: The Synergy between Computers and Oil and Gas", Invited Talk, SINOPEC, Beijing, PRC, June 2016.

"Intelligent Energy: The Synergy between Computers and Oil and Gas", Invited Talk, Petroleum Engineering, UH, 2016.

"Intelligent Energy: Computer-Aided Solutions for Oil and Gas", Invited Talk, Petroleum Engineering, Texas A&M U., November 2016.

"Building Good Models for Model-Based Multivariable Controllers: Theory, Algorithms, and Case Studies", Invited Talk, Shell Technology Center, Houston, TX, June 2016.

"Intelligent Energy: Computer-Aided Solutions for Oil & Gas", **Keynote** talk, IPPTC, Beijing, PRC, 2017.

“Intelligent Energy: The Synergy between Computers and Oil & Gas”, Upstream Production Measurement Forum, Houston, TX – Invited Talk, 2018.

“Data-Driven Modeling for Production Optimization, SPE workshop: Smart integration in production system modeling”, Galveston, TX – Invited Talk, 2018.

“Data Analytics in Oil & Gas”, UH Energy webinar, 2020, https://www.youtube.com/watch?v=YsueMZ80gdc

(with M. Darby) “Data Analytics for the Process Industries”, UH Energy webinar, 2021, https://www.youtube.com/watch?v=nsfTvdMKoRc

“Data Analytics in Oil and Gas”, UH Energy presentation to HPE Pointnext Services, 2021.

Patents (in Chronological Order)

- Based on Sathish Sankaran's PhD Thesis, supervised by M. **Nikolaou**:
    - Economides, MJ; Deeg, WFJ; Valko, P; **Nikolaou**, M; and Sankaran, S, *System and Method for Stress and Stability Related Measurements In Boreholes*, US Patent No. 6,834,233 (2004).
    - Economides, MJ; Deeg, WFJ; Valko, P; **Nikolaou**, M; and Sankaran, S, *Method for Stress and Stability Related Measurements in Boreholes*, US Patent No. 7,006,918 (2006).
- Based on multiple grants for collaborative work between the two inventors:
    - Tam, V. H., and M. **Nikolaou**, *High-Throughput Screening For Antimicrobial Dosing Regimens*, US Patent No. 8,452,543 (2013).
- Based on Ankur Awasthi's PhD Thesis, supervised by M. **Nikolaou**:
    - Mijares, G; Garcia, A; Sankaran, S; Rodriguez, S; Saputelli, S; Awasthi, A; and **Nikolaou**, M, *Systems and Methods for Optimization of Real Time Production Operations*, US Patent No. 8,396,826 (2013).
    - Mijares, G., A. Garcia, S. Sankaran, J. Rodriguez, L. Saputelli, A. Awasthi and M. **Nikolaou** (2019). Systems and methods for optimization of real time production operations, US Patent 10,354,207.
- Based on Ajay Singh's PhD Thesis, supervised by M. **Nikolaou**:
    - Singh, AP; **Nikolaou**, M; Saputelli, L; Maucec, M, *Methods and Systems for Reservoir History Matching for Improved Estimation Of Reservoir Performance*, PCT/US2013/042711.
- Based on Supriya Gupta's MS Thesis, supervised by M. **Nikolaou**:
    - Gupta, S; M **Nikolaou**; C Bravo; L. Saputelli, *System And Method For Detecting, Diagnosing, And Correcting Trips or Failures of Electrical Submersible Pumps*, US Patent 11,078,774 (2021).
- Based on G. Luo's PhD Thesis, co-supervised by M **Nikolaou**
    - Provisional Patent Application (3/12/2019): UHID 2019-012 - UNIH-0162PRO (109293.162) - "Method And System For Enhanced Oil Recovery In Hydraulically Fractured Horizontal Wells" (with C. Economides and G. Luo)
- Based on J. Kesisoglou's PhD Thesis, supervised by M **Nikolaou**
    - **Nikolaou**, M., V. H. Tam and I. Kesisoglou (2023). OPTICAL BASED METHODS FOR DETERMINING ANTIMICROBIAL DOSING REGIMENS, US Patent App. 17/636,079.

FUNDED RESEARCH

Grants (in Chronological Order)

NSF, “Comprehensive Design Methodology for Nonlinear Controllers”, $55K (Initiation), 1990-1993.
Frito-Lay, “Control of Snack Food Processes”, $105,000, 1992-1994.
ARP, “Numerical Methods for Differential Equations with Wavelets”, $39,000, 1991-1993.
ATP-D, “Novel Control Methodology for Snack Food Extrusion Cooking”, $150,000, 1993-1996.
Frito-Lay, “Novel Control Methodology for Snack Food Extrusion Cooking”, $136,000, 1993-1996.
Shell Development, unrestricted, $20K/year + student summer support, 1992-1994 and 1997-2003.
DoE (through Lawrence Berkeley Lab), “Wavelets for Solution of Differential Equations Describing Underground Reservoir Two-Phase Flow”, $30,000, 1993-1994.
TXDoT (through TTI), “Traffic Air Pollution Effects of Elevated, Depressed, and at-Grade Level Freeways in Texas”, $100,000, 1993-1996.
Frito-Lay, unrestricted, $150,000, 1996-2000.
NSF, “Design of Model Predictive Control Systems with Enhanced Autonomy”, $180,000, 1997-2001.
Internal grants at Texas A&M University and UH.
Halliburton, “Development of a Novel Methodology for Stress and Stability Related Measurements in Boreholes”, $325,000, 1998-2000 (with M. Economides and P. Valko).
NSF/Lam Research Corporation, “A Study on Plasma Etching Yield Improvements through a Faculty-in-Industry Internship”, $58,000, 6-10/2001.
Lam Research Corporation, Unrestricted, $25,000/year, 2001-2003.
Kellogg Brown and Root, Unrestricted, $30,000+/year, 2001-2004; $40,000/year, 2006.
NSF, “Adaptive design of experiments for optimal uniformity in semiconductor manufacturing”, $340,000, 1/1/2003 – 12/31/2006 (CTS – 0227232) (with D. J. Economou).
American Chemical Society, Petroleum Research Fund, “A New Approach to High-Performance Drilling of Hydrocarbon Wells”, $80,000, 1/1/2004-8/31/2007.
Johns Hopkins, CAAT, “Development of a mathematical model to predict bacterial response to antimicrobial agents”, $18,000, 1/1/2005-12/31/2005.
eSimulation, Unrestricted, $20,000, 2006.
Landmark/Halliburton, "Real-time production optimization", $25,000, 1/1-31/12/2007.
Astra Zeneca, "Pharmacodynamics of antibiotics on resistant bacterial populations", $219,393 7/16/07 to 7/15/09 (with V. H. Tam),
National Science Foundation, “Development and experimental testing of a new approach to modeling the effect of antimicrobial agents on heterogeneous microbial populations”, $400,000, 1/1/2008-12/31/2010. (with V. H. Tam)
Research Partnership to Secure Energy for America (RPSEA), A Self-Teaching Expert System For The Analysis, Design And Prediction Of Gas Production From Shales, $753,060 for M. **Nikolaou** (~$3,000,000 project total).
Shell Global Solutions, “Analysis of Real-time optimization”, $124180, 9/1/2007-8/31/2009.
MaxWells, "Intelligent Drilling of Hydrocarbon Wells" Support for two visiting PhD students from International Research Institute of Stavanger (IRIS) Norway.
Unrestricted grant, Optima PowerWare, $44,000, 2009, 2011.
Unrestricted grant to Chemical & Biomolecular Engineering Dept. for one PhD student scholarship, Bayer Baytown, $90,000, 2008-2010.
RPSEA, “A Self-Teaching Expert System for the Analysis, Design, and Prediction of Gas Production From Unconventional Gas Resources”, $490,000, 2009-2011.
Halliburton, “Shale Oil and Gas Development”, $30,000, 2012.

RPSEA, “Lowering Drilling Cost, Improving Operational Safety, and Reducing Environmental Impact Through Zonal Isolation Improvements for Horizontal Wells Drilled in the Marcellus and Haynesville Shales”, $255,000, 2012-2014.

RPSEA, “Deepwater Reverse-Circulation Primary Cementing”, $220,000, 2012-2015.

RPSEA, “Positive Annular Seal to Isolate Fresh Water Aquifers and Wellhead from Shale Hydrocarbon Contamination: Prevention of Fluid Migration and Remediation of Sustained Casing Pressure”, $227,000, 2013-2016.

National Institutes of Health (NIH), "Optimized Antimicrobial Combinations to Suppress Resistance" (1R56AI111793-01) $519,000, 2014-16 (with V. H. Tam).

GEAR, “A novel idea for treatment of persistent bacterial infections”, $30,000, 2017-2019 (with J. C. Conrad).

National Institutes of Health (NIH), “Personalized Antimicrobial Combinations to Combat Resistance”, $3,646,690, 2018-2022 (with V. H. Tam).

DOE, DE-FOA-0002525-GTO-Wells of Opportunity (WOO), $45,000/y for MN (multiple investigators)

SERVICE ACTIVITIES

University Service (in Chronological Order)

YEARS	DEPT./COLLEGE/UNIV.	COMMITTEE TITLE/PURPOSE
1993-1996	CoE, Texas A&M U.	EFAC (Engineering Faculty Advisory Committee)
1995-1997	Texas A&M U.	Council of Principal Investigators
1994-1997	Ch.E. Dept., Texas A&M	Undergraduate Curriculum Committee
1996-1997	Ch.E. Dept., Texas A&M	Graduate Curriculum Committee
1996-1997	Ch.E. Dept., Texas A&M	Web site team leader
1998-	CoE, UH	ABET Steering Committee
1999-2001	Ch.E. Dept., UH	Director of Graduate Studies
2001-2006	Ch.E. Dept., UH	AIChE Student Chapter Advisor
2002-2012	CoE, UH	Graduate Standards Committee
2002-2007	Ch.E. Dept., UH	MChE Program Director
2003-2007	CCoE, UH	Communications Committee
2003-2007	CCoE, UH	Computing Facilities Committee
2005-	Ch.E. Dept., UH,	ABET Outcomes Assessment Committee Chair,
2007-2008	Ch.E. Dept., UH	International ChE graduate student admissions
2007-2010	UH	Graduate and Professional Studies Council
2007-2010	UH	UH Teaching Excellence Awards Committee
2007-2012	UH	SACS Instructional Effectiveness Committee
2007-2010	Texas A&M	Advisory Board, ChE Curriculum Reform Project (NSF)
2005-2009	Process Technology Dept., Houston Community College, Advisory Board	
2011-2012	THECB Tuning Oversight Council for Engineering and Science (www.thecb.state.tx.us)	
2015-present	UH	GPSC in Faculty Senate
2017-2019	UH	ADVANCE Project Liaison, CcoE
2017-present	UH	MChE Program Director

Consulting (in Chronological Order)

Shell Development and Shell Oil, TX, 1990, 1993, 2001.
Frito-Lay Corporation, Dallas, TX, 1991-1997.
Bryan Research & Engineering, Bryan, TX, 1996.
General Electric, Houston, TX, 1998-present.
Simulation Sciences, Houston, TX, 1998.
Noble Drilling, Houston, TX, 2001-03.
Coral Energy, Houston, TX, 2002-03.
Lam Research, Fremont, CA, 2002.
Landmark Graphics, Houston, TX, 2005-06.
Intelligent Agent Corporation, Houston, TX 2006-09.
XGas, Houston, TX, 2008-present.
SABIC, Houston, TX, 2010.
Synergy Fluids, Houston, TX, 2012-2013.
Halliburton, Houston, TX, 2012.
Beirne, Maynard & Parsons, Houston, TX, 2012-2015.
EPT International, 2014-present.
Slider/Schlumberger, 2014.
M Whittaker, Houston, TX, 2015.
OJ Usoro, Houston, TX, 2016-2017.
Fish & Richardson, 2017-2021.
RotoSlide, 2014-present.

OTHER

Professional Affiliations

Society of Petroleum Engineers
American Institute of Chemical Engineers
Omega Chi Epsilon
Technical Chamber of Greece (Registered Engineer)

Foreign Languages

German (excellent)
Spanish & French (engineering material reading ability)
Greek (mother tongue)

Personal

US Citizen, married, two children