IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF TEXAS
FORT WORTH DIVISION

	§	
MIDAS GREEN TECHNOLOGIES, LLC,	§	
PLAINTIFF,	§	CASE NO. ____________________
	§	
V.	§	JURY TRIAL DEMANDED
	§	
IMMERSION SYSTEMS LLC,	§	PATENT CASE
DEFENDANT.	§	
	§	

ORIGINAL COMPLAINT FOR PATENT INFRINGEMENT AGAINST IMMERSION SYSTEMS LLC

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ATTORNEY FOR PLAINTIFF

Plaintiff Midas Green Technologies, LLC ("MGT" or "Plaintiff"), by and through its counsel, hereby brings this action for patent infringement against Immersion Systems, LLC ("Immersion" or "Defendant") alleging infringement of the following validly issued patent ("Patent-in-Suit"): U.S. Patent No. 10,405,457, entitled "Appliance Immersion Cooling System" (" '457 Patent"), a true and correct copy of which is attached hereto as **Exhibit A**.

I. PARTIES

1. MGT is a Texas limited liability company with its principal place of business at 8107 Springdale Road, Austin, Texas 78724.

2. On information and belief, Immersion is a Texas limited liability company with its principal place of business at 7546 Pebble Dr., Fort Worth, Texas 76118, and may be served by and through its registered agent BMS CAT Inc. at 5718 Airport Freeway, Haltom City, Texas 78117.

II. JURISDICTION AND VENUE

3. This lawsuit is a civil action for patent infringement arising under the patent laws of the United States, 35 U.S.C. § 101 et seq.

4. The Court has subject matter jurisdiction of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

5. On information and belief, Immersion is subject to this Court's specific and general personal jurisdiction, pursuant to due process and the Texas Long-Arm Statute, due at least to its business in this forum, including at least a portion of the infringement alleged herein. Furthermore, Immersion is subject to this Court's specific and general personal jurisdiction

because it has a place of business within this District, including at 7546 Pebble Dr., Fort Worth, Texas 76118.

6. Without limitation, on information and belief, within this District and state, Immersion has used the patented inventions thereby committing, and continuing to commit, acts of patent infringement alleged herein. In addition, on information and belief, Immersion has derived revenues from its infringing acts occurring within the Northern District of Texas and Texas.

7. Further, on information and belief, Immersion is subject to the Court's general jurisdiction, including from regularly doing or soliciting business, engaging in other persistent courses of conduct, and deriving substantial revenue from goods and services provided to persons or entities in the Northern District of Texas and Texas. Further, on information and belief, Immersion is subject to the Court's personal jurisdiction at least due to its sale of products and/or services within the Northern District of Texas. Immersion has committed such purposeful acts and/or transactions in the Northern District of Texas and Texas such that it reasonably should know and expect that it could be haled into this Court as a consequence of such activity.

III. VENUE

8. Venue is proper in this district under 28 U.S.C. §§ 1391(b) and 1400(b). On information and belief, Defendant has a place of business at 7546 Pebble Dr., Fort Worth, Texas 76118. On information and belief, from and within this District Defendant has committed at least a portion of the infringements at issue in this case.

IV. FACTUAL BACKGROUND

A. THE ASSERTED PATENT

9. The '457 Patent, entitled "Appliance Immersion Cooling System", was duly and legally issued on September 3, 2019 by the U.S. Patent and Trademark Office, and names Christopher L. Boyd of Austin, TX (US), James P. Koen of Round Rock, TX (US), David Christopher of Laguna, Austin, TX (US), Thomas R. Turner of Georgetown, TX (US), Kenneth D. Swinden of Hutto, TX (US), Mario Conti Garcia of Austin, TX (US), and John Charles Tribou of Austin, TX (US) as the inventors. The application leading to the '457 Patent was filed on April 30, 2014. A true and correct copy of the '457 Patent is attached hereto as **Exhibit A** and incorporated herein by reference.

10. The '457 Patent claims, according to at least one embodiment, among other things, an appliance immersion cooling system that includes a tank adapted to immerse in a dielectric fluid a plurality of electrical appliances, each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank. The tank includes a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot, and a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir. The appliance immersion cooling system also includes a primary circulation facility adapted to circulate the dielectric fluid through the tank. The primary circulation facility includes a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot. The appliance cooling system also includes a secondary fluid circulation facility adapted to extract heat from the dielectric fluid circulating in the primary

circulation facility, and to dissipate to the environment the heat so extracted, and a control facility adapted to coordinate the operation of the primary and secondary fluid circulation facilities as a function of the temperature of the dielectric fluid in the tank.

11. The '457 Patent also claims, according to at least one embodiment, among other things, a tank module adapted for use in an appliance immersion cooling system. The tank module includes a tank adapted to immerse in a dielectric fluid a plurality of electrical appliances, each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank. The tank includes a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot, and a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir. The tank module also includes a primary circulation facility adapted to circulate the dielectric fluid through the tank, including a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot, and a control facility adapted to control the operation of the primary fluid circulation facility as a function of the temperature of the dielectric fluid in the tank.

12. The '457 Patent also claims, according to at least one embodiment, among other things, a tank module adapted for use in an appliance immersion cooling system. The tank module includes a tank adapted to immerse in a dielectric fluid a plurality of electrical appliances, each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank. The tank includes a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, adapted to facilitate substantially uniform recovery of the dielectric

fluid flowing through each appliance slot. The tank module also includes a primary circulation facility adapted to circulate the dielectric fluid through the tank, including a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot, and a control facility adapted to control the operation of the primary fluid circulation facility as a function of the temperature of the dielectric fluid in the tank.

13. MGT is the assignee of all right, title, and interest in the '457 Patent, including all rights to enforce and prosecute actions for infringement and to collect damages for all relevant times against infringers of the '457 Patent. Accordingly, MGT possess the exclusive right and standing to prosecute the present action for infringement of the '457 Patent by Immersion.

B. IMMERSION'S INFRINGING ACTIVITIES AND PRODUCTS

14. On Friday, 07 February 2020, MGT had delivered to Immersion a demand letter and an accompanying claim chart detailing how the "457 Patent reads on the Accused Product ("Feb Demand Letter").

15. On information and belief, Immersion has directly infringed claims of the '457 Patent in the Northern District of Texas, the State of Texas, and elsewhere in the United States, by at least making, using, selling, and offering for sale an apparatus for an appliance immersion cooling system that satisfies each and every limitation of at least claims 1, 6, and 11 of the '457 Patent, including, without limitation, at least Immersion’s Immersion System as represented at https://immersionsystems.io/media/ ("Accused Product").

V. COUNT 1

(PATENT INFRINGEMENT OF U.S. U.S. PATENT NO. 10,405,457)

16. MGT incorporates the allegations of the above paragraphs herein by reference, the same as if set forth herein.

17. The '457 Patent was filed April 30, 2014, and legally issued by the United States Patent and Trademark Office ("USPTO") on September 3, 2019. The '457 Patent is presumed valid and enforceable pursuant to 35 U.S.C. § 282.

18. Without a license or permission from MGT, Immersion has infringed and/or continue to infringe one or more claims of the '457 Patent – directly, contributorily, and/or by inducement – by importing, making, using, offering for sale, or selling products and devices that embody the patented invention, including without limitation, one or more of the patented '457 claims, in violation of 35 U.S.C. § 271.

A. DIRECT INFRINGEMENT

19. On information and belief, Immersion has directly infringed claims of the '457 Patent in the Northern District of Texas, the State of Texas, and elsewhere in the United States, by at least making, using, selling, and offering for sale an apparatus for an appliance immersion cooling system that satisfies each and every limitation of at least claims 1, 6, and 11 of the '457 Patent, including, without limitation, at least the Accused Product, in violation of 35 U.S.C. § 271(a).

20. Attached hereto as **Exhibit B** is an exemplary claim chart detailing representative infringement of claim 1 of the '457 Patent by Immersion.

21. Attached hereto as **Exhibit C** is an exemplary claim chart detailing representative infringement of claim 6 of the '457 Patent by Immersion.

22. Attached hereto as **Exhibit D** is an exemplary claim chart detailing representative infringement of claim 11 of the '457 Patent by Immersion.

B. INDUCED INFRINGEMENT

23. On information and belief, Immersion has been and is inducing infringement of MGT's '457 Patent by actively and knowingly inducing others to make, use, sell, offer for sale, or import at least the Accused Product that embody or use the invention claimed in the '457 Patent in violation of 35 U.S.C. § 271(b).

24. Immersion induced infringement by publication of documents for using at least the Accused Product in an infringing manner, as well as advertising infringing uses to the '457 Patent. Immersion's customers' subsequent usage of the Accused Products to cool electronic appliances via immersion placed every element of at least claim 1, 6, and 11 of the '457 Patent into service, constituting control and therefore infringement.

25. Defendant's infringement has been, and continues to be knowing, intentional, and willful, at least beginning 07 February 2020 with the delivery of MGT's first notice letter and accompanying claim chart.

26. Immersion's acts of infringement of the '457 Patent have caused and will continue to cause MGT damages for which MGT is entitled to compensation pursuant to 35 U.S.C. § 284.

27. Immersion's acts of infringement of the ‘457 Patent have caused and will continue to cause MGT immediate and irreparable harm unless such infringing activities are enjoined by this Court pursuant to 35 U.S.C. § 283. MGT has no adequate remedy at law.

28. This case is exceptional and, therefore, MGT is entitled to an award of attorney fees pursuant to 35 U.S.C. § 285.

VI. JURY DEMAND

29. Pursuant to Rule 38 of the Federal Rules of Civil Procedure, MGT requests a trial by jury of any issues so triable by right.

VII. PRAYER

WHEREFORE, MGT requests judgment against Immersion as follows:

30. Adjudging that Immersion has directly infringed, and actively induced infringement of the '457 Patent, in violation of 35 U.S.C. § 271[(a) and (b);

31. Granting an injunction preliminarily, and permanently enjoining Immersion, its employees, agents, officers, directors, attorneys, successors, affiliates, subsidiaries, and assigns, and all of those in active concert and participation with any of the foregoing persons or entities from infringing, contributing to the infringement of, or inducing infringement of the ‘457 Patent;

32. Ordering Immersion to account and pay damages adequate to compensate MGT for Immersion's infringement of, or inducement to infringe, the '457 Patent, including pre-judgment and post-judgment interest and costs, pursuant to 35 U.S.C. § 284;

33. Ordering an accounting by Immersion for any infringing sales not presented at trial and an award by the court of additional damages for any such infringing sales to MGT;

34. Ordering that the damages award be increased up to three times the actual amount assessed, pursuant to 35 U.S.C. § 284;

35. Declaring this case exceptional and ordering Immersion to pay the costs of this action, including all disbursements, and attorneys' fees as provided by 35 U.S.C. § 285, together with prejudgment interest; and

36. Awarding such other and further relief as this Court deems just and proper.

DATED this 29th day of March, 2018.

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ATTORNEY FOR PLAINTIFF

EXHIBIT A
{'457 Patent}

US010405457B2

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

(10) **Patent No.: US 10,405,457 B2**
(45) **Date of Patent: Sep. 3, 2019**

(54) **APPLIANCE IMMERSION COOLING SYSTEM**

(71) Applicants: **Christopher L. Boyd**, Austin, TX (US); **James P. Koen**, Round Rock, TX (US); **David Christopher Laguna**, Austin, TX (US); **Thomas R. Turner**, Georgetown, TX (US); **Kenneth D. Swinden**, Hutto, TX (US); **Mario Conti Garcia**, Austin, TX (US); **John Charles Tribou**, Austin, TX (US)

(72) Inventors: **Christopher L. Boyd**, Austin, TX (US); **James P. Koen**, Round Rock, TX (US); **David Christopher Laguna**, Austin, TX (US); **Thomas R. Turner**, Georgetown, TX (US); **Kenneth D. Swinden**, Hutto, TX (US); **Mario Conti Garcia**, Austin, TX (US); **John Charles Tribou**, Austin, TX (US)

(73) Assignee: **Midas Green Technologies, LLC**, Austin, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 680 days.

(21) Appl. No.: **14/355,533**

(22) PCT Filed: **Dec. 13, 2013**

(86) PCT No.: **PCT/US2013/075126**

§ 371 (c)(1),
(2) Date: **Apr. 30, 2014**

(87) PCT Pub. No.: **WO2014/109869**

PCT Pub. Date: **Jul. 17, 2014**

(65) **Prior Publication Data**

US 2015/0181762 A1 Jun. 25, 2015

Related U.S. Application Data

(60) Provisional application No. 61/737,200, filed on Dec. 14, 2012, provisional application No. 61/832,211, filed on Jun. 7, 2013.

(51) **Int. Cl.**
H01L 23/44 (2006.01)
H05K 7/20 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 7/20236*** (2013.01); ***H01L 23/44*** (2013.01); ***H05K 7/20272*** (2013.01)

(58) **Field of Classification Search**
CPC H05K 7/20236; H05K 7/20272; H01L 23/42; H01L 23/44
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,590,538 A *	5/1986	Cray, Jr.	....	H05K 7/20236 361/700
5,167,511 A *	12/1992	Krajewski	....	H01R 4/01 361/785

(Continued)

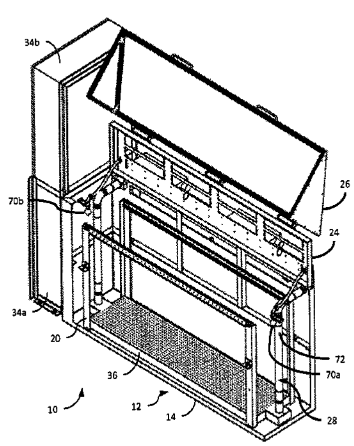
FOREIGN PATENT DOCUMENTS

JP	5956100 B1 *	7/2016	....	G06F 1/20
RU	2042294 C1	8/1995		
SU	1764094 A1	9/1992		

Primary Examiner — Devon Russell
(74) *Attorney, Agent, or Firm* — Jeffrey Van Myers

(57) **ABSTRACT**

A appliance immersion tank system comprising: a generally rectangular tank adapted to immerse in a dielectric fluid a plurality of appliances, each in a respective appliance slot distributed vertically along, and extending transverse to, the long axis of the tank; a primary circulation facility adapted to circulate the dielectric fluid through the tank; a secondary fluid circulation facility adapted to extract heat from the dielectric fluid circulating in the primary circulation facility, and to dissipate to the environment the heat so extracted; and a control facility adapted to coordinate the operation of the primary and secondary fluid circulation facilities as a function of the temperature of the dielectric fluid in the tank. A plenum, positioned adjacent the bottom of the tank, is adapted to dispense the dielectric fluid substantially uni-
(Continued)



formly upwardly through each appliance slot. A weir, integrated horizontally into a long wall of the tank, is adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot. All active and most passive components of both the primary and secondary fluid circulation facilities, and the control facility are fully redundant, and are adapted automatically to operate in a fail-soft mode.

16 Claims, 7 Drawing Sheets

(58) **Field of Classification Search**
USPC 361/699
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,297,621	A *	3/1994	Taraci	G01R 31/2891 165/104.13
8,009,419	B2	8/2011	Attlesey et al.	
2005/0259402	A1 *	11/2005	Yasui	H02M 7/003 361/716
2006/0126292	A1 *	6/2006	Pfahnl	H05K 7/20563 361/695
2006/0274501	A1 *	12/2006	Miller	G01R 31/2863 361/690
2011/0075353	A1 *	3/2011	Attlesey	G06F 1/20 361/679.47
2011/0132579	A1 *	6/2011	Best	H05K 7/20763 165/104.31
2011/0240281	A1 *	10/2011	Avery	G05D 23/1917 165/287

* cited by examiner

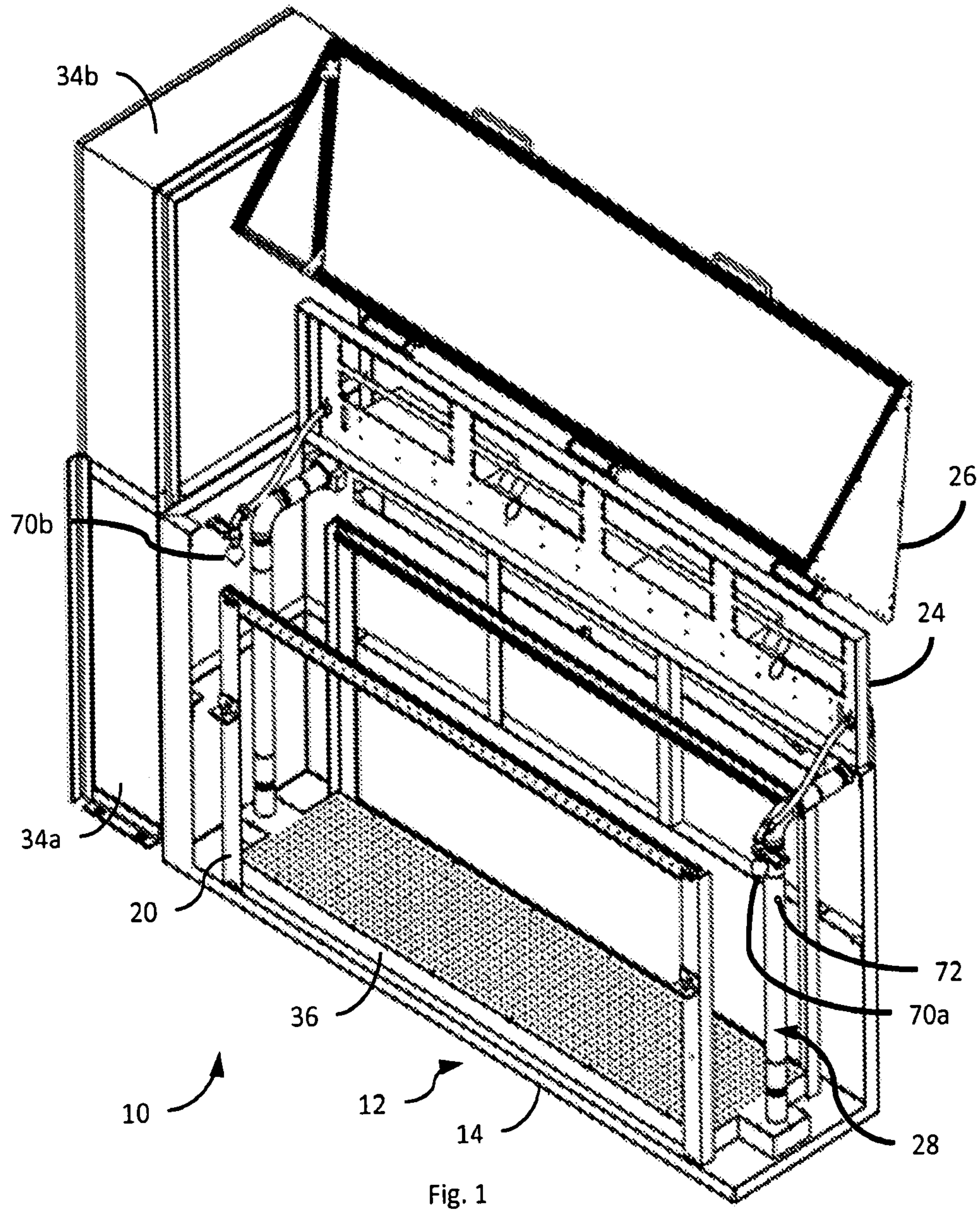


Fig. 1

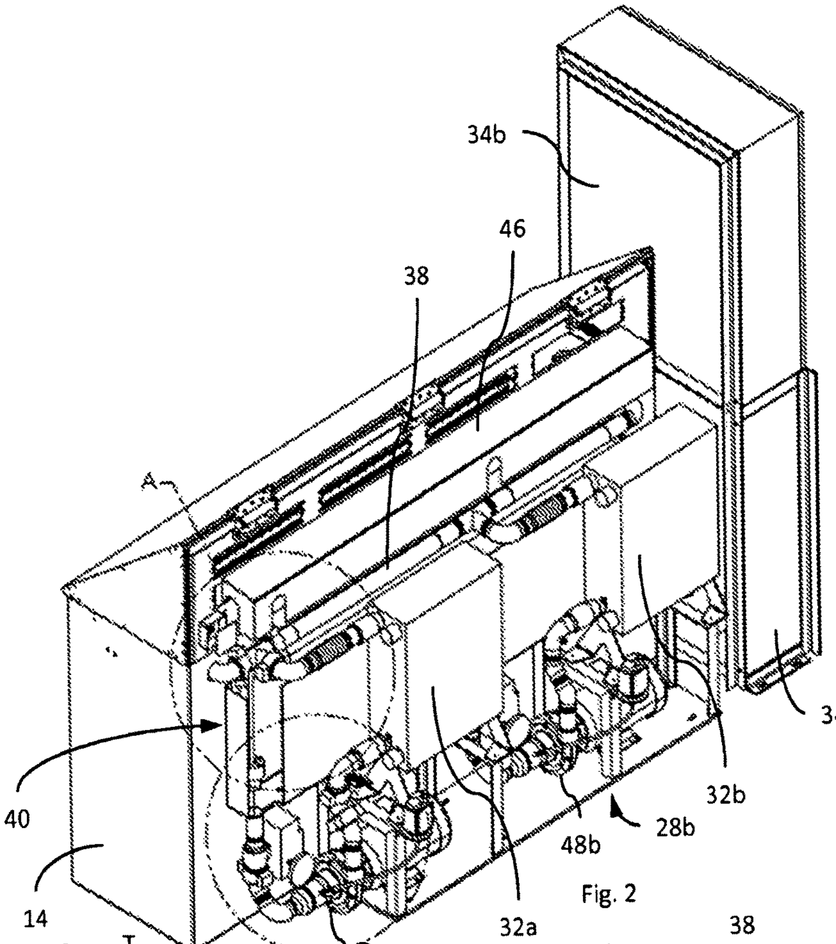

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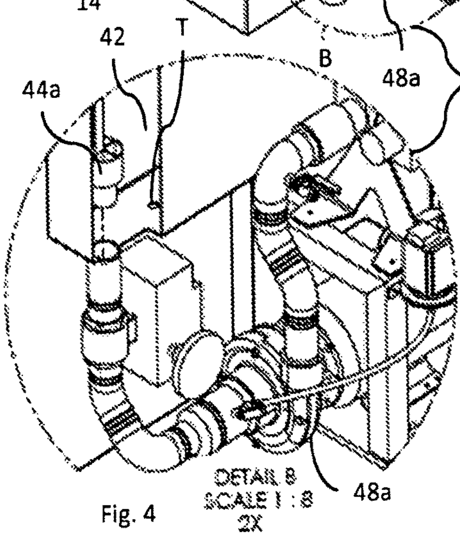
Fig. 2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DETAIL B
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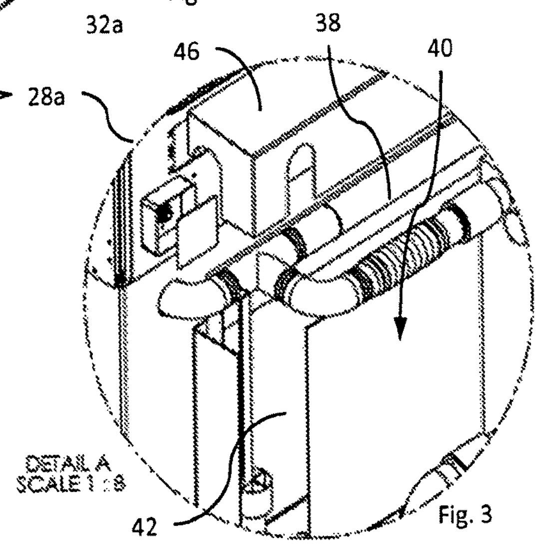
48a

Fig. 4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DETAIL A
SCALE 1 : 8
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Fig. 3

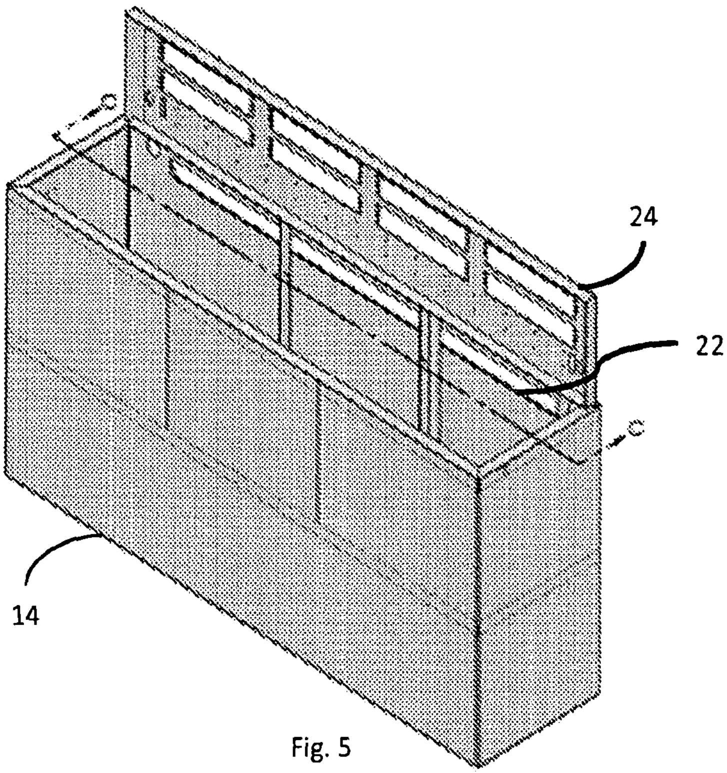
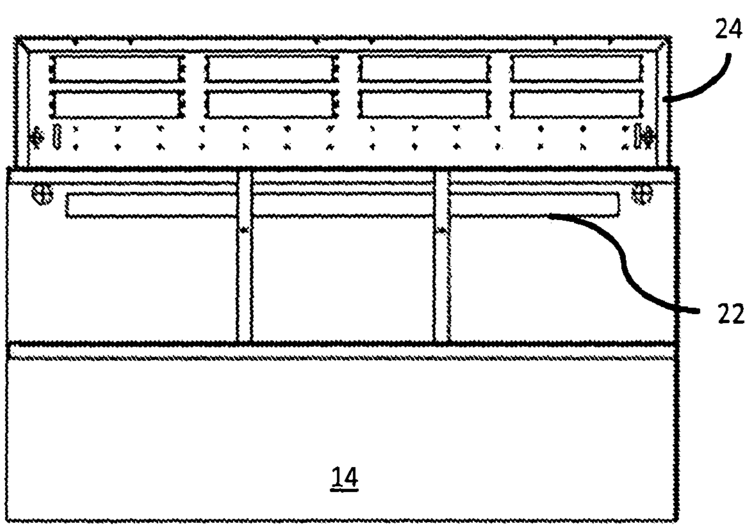


Fig. 5



Section C-C
Fig. 6

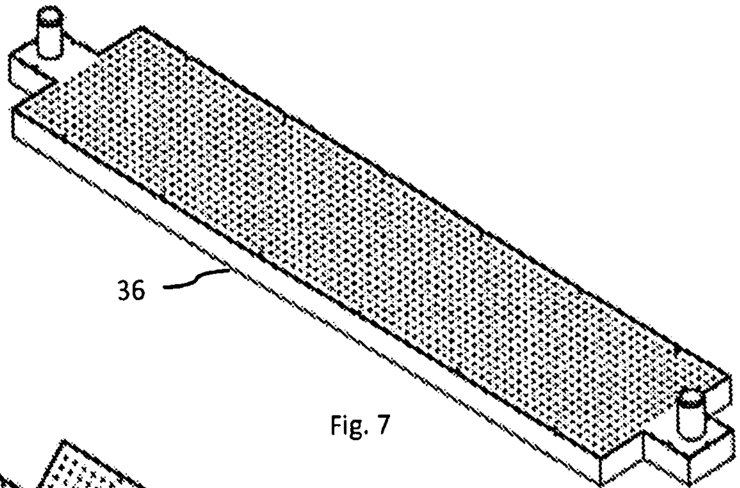


Fig. 7

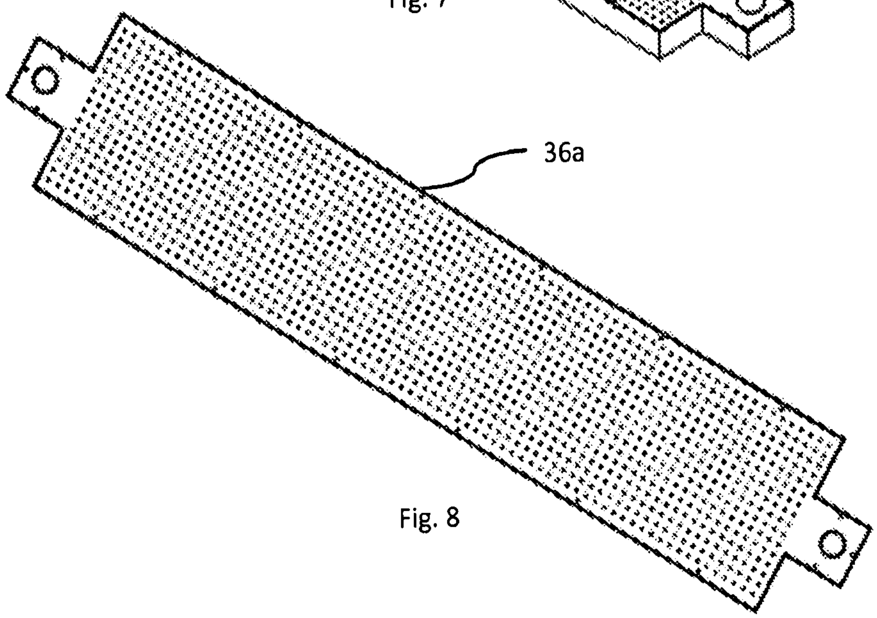


Fig. 8

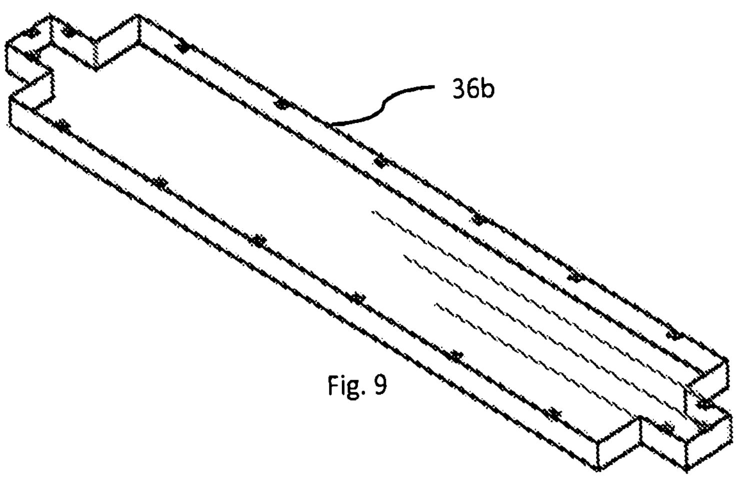


Fig. 9

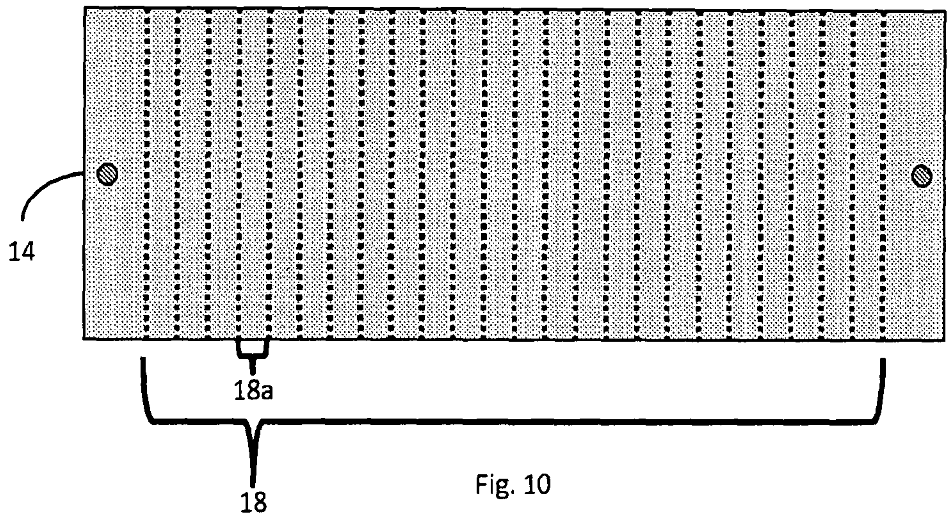


Fig. 10

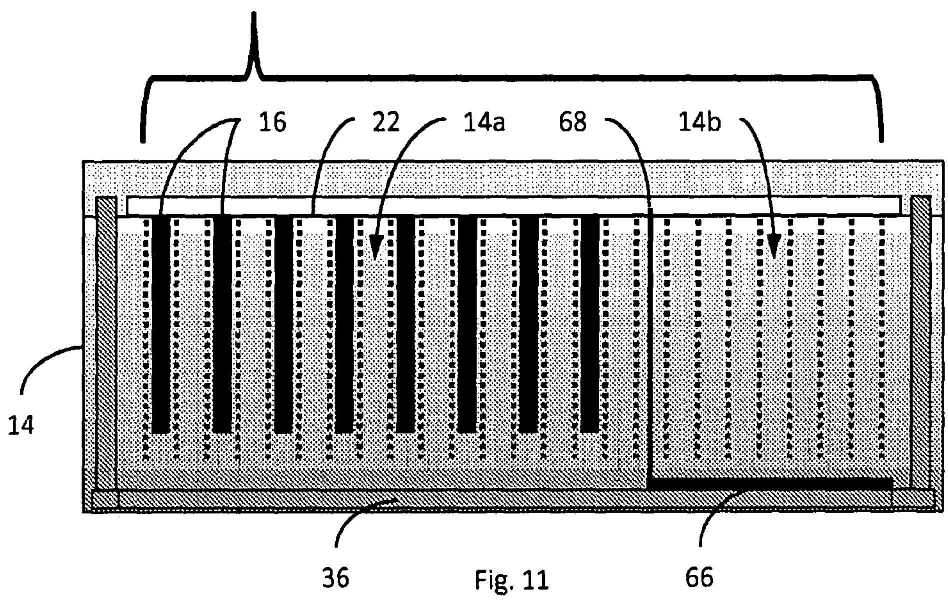
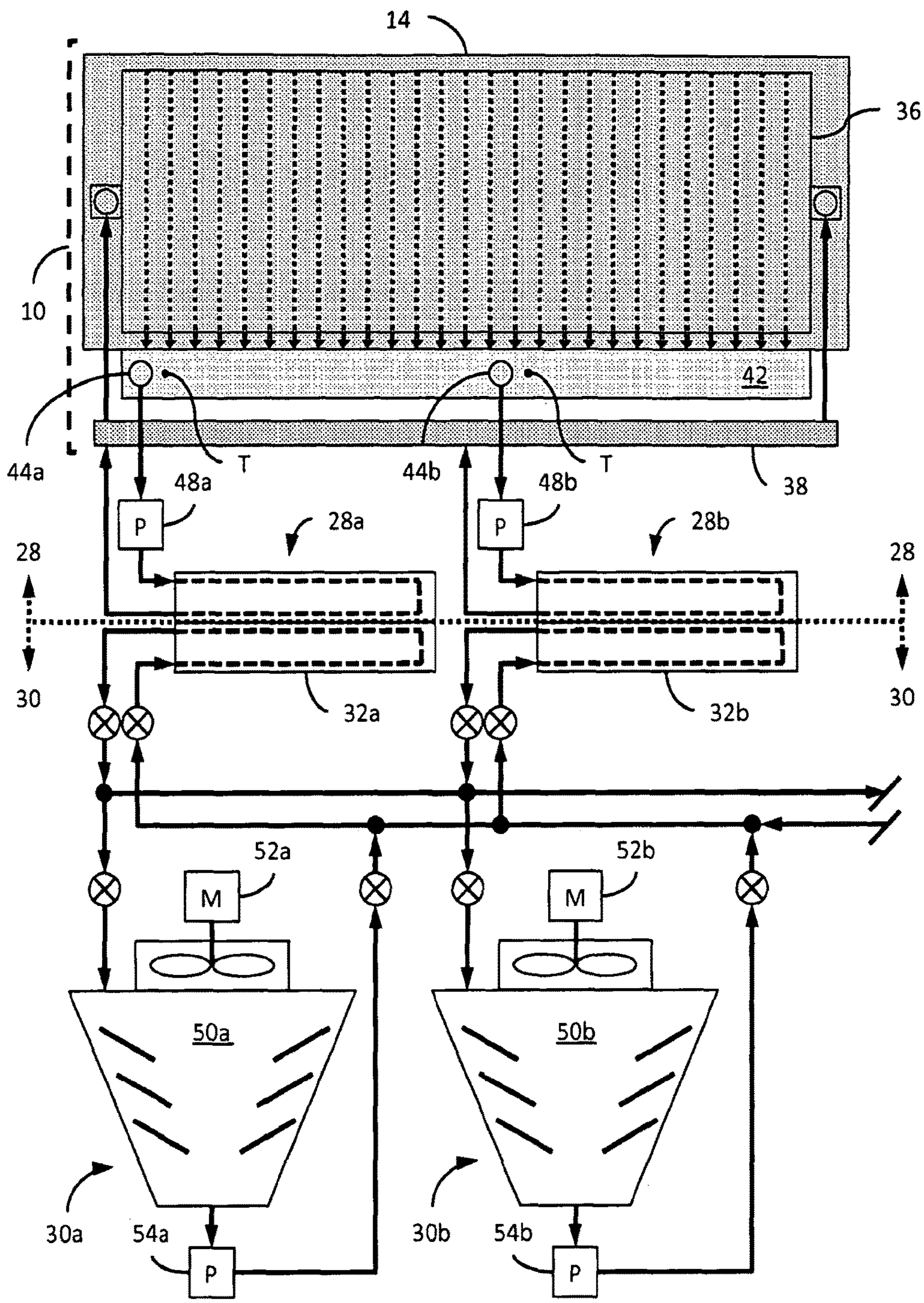


Fig. 11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54a
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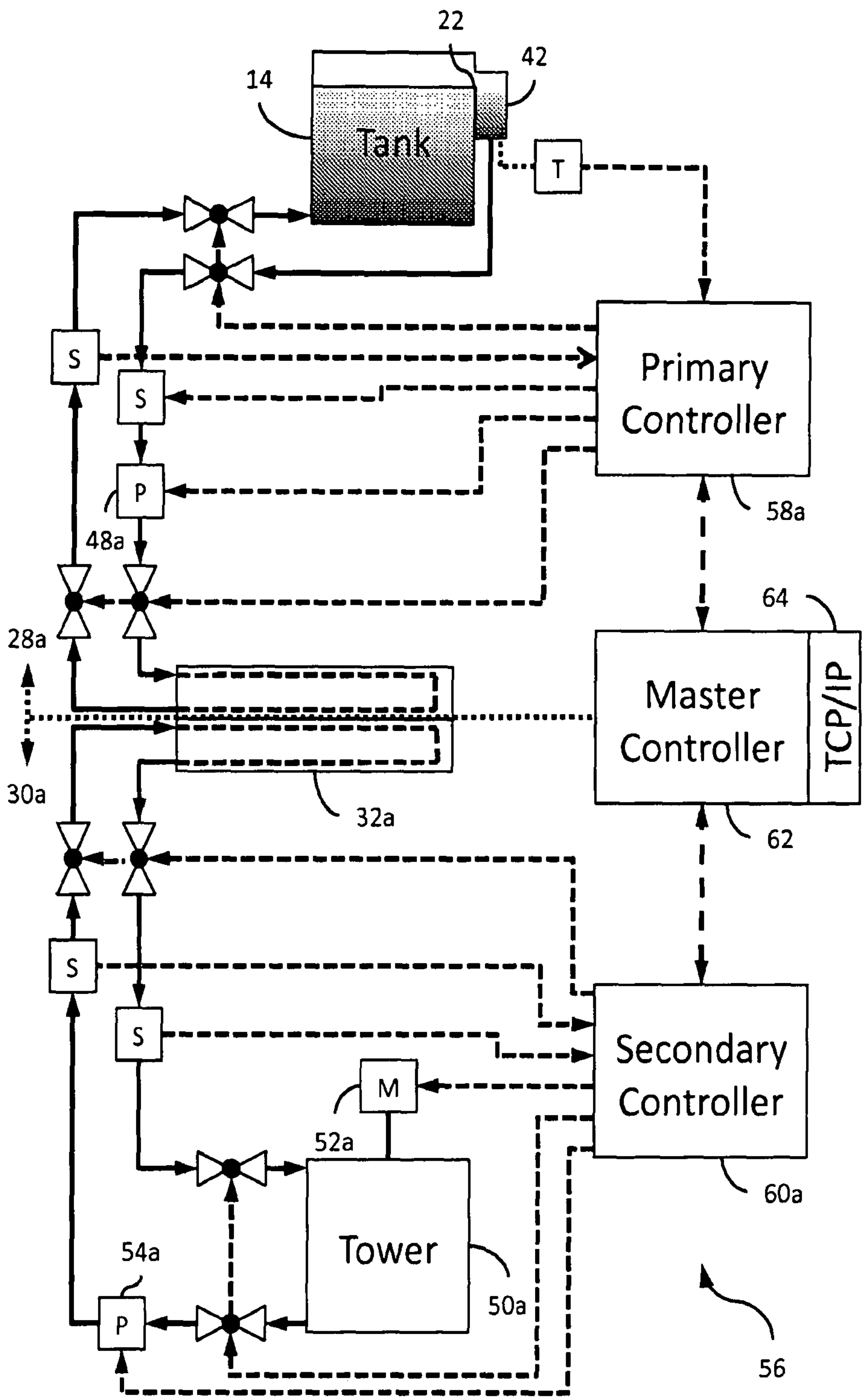
30b
54b
P

Fig. 12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Controller
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S
P
48a
58a
64
28a
Master
Controller
TCP/IP
30a
32a
62
S
S
M
Secondary
Controller
52a
60a
Tower
54a
50a
P
56

Fig. 13

APPLIANCE IMMERSION COOLING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to the following Provisional Applications:

1. Ser. No. 61/737,200, filed 14 Dec. 2012 ("First Parent Provisional"); and
2. Ser. No. 61/832,211, filed 7 Jun. 2013 ("Second Parent Provisional");

and hereby claims benefit of the filing dates thereof pursuant to 37 CFR § 1.78(a)(4). (Collectively, "Parent Provisionals"). The subject matter of the Parent Provisionals, each in its entirety, is expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to electrical appliance cooling systems, and, in particular, to an improved appliance immersion cooling system and method of operation.

2. Description of the Related Art

In general, in the descriptions that follow, we will italicize the first occurrence of each special term of art which should be familiar to those skilled in the art of immersion cooling systems. In addition, when we first introduce a term that we believe to be new or that we will use in a context that we believe to be new, we will bold the term and provide the definition that we intend to apply to that term.

U.S. Pat. No. 4,590,538, "Immersion Cooled High Density Electronic Assembly", Cray (filed 18 Nov. 1981 and issued 20 May 1986) ("Cray"), is an early example of an immersion system for cooling electronic components during normal operation. On information and belief, the machine disclosed therein was the Cray-2 super-computer ("Cray-2") manufactured by Cray Research, Inc. ("Cray Research"), of Chippewa Falls, Wis. Of particular interest to the present application is the description of the significant advantages resulting from using an electrically non-conductive or dielectric fluid to extract heat from electronic circuit assemblies during normal operation (see, e.g., col. 1, line 66-col. 2, line 29).

On information and belief, Cray Research released, in 1985, a marketing brochure entitled "The CRAY-2 Computer System" (a copy of which is submitted herewith) describing the Cray-2. Of particular interest in this brochure is the description therein of the significant advantages resulting from using a dielectric fluid to extract heat from electronic circuit assemblies during normal operation (see, pages 10 and 13).

U.S. Pat. No. 5,167,511, "High Density Interconnect Apparatus", Krajewski, et al. (issued 27 Nov. 1992) ("Krajewski"), discloses another example of an immersion system for cooling electronic components during normal operation (see, e.g., col. 2, lines 43-51). On information and belief, a machine implementing the Krajewski system was also marketed by Cray Research as a follow-on super-computer to the Cray-2.

One particular problem in the vertical-stack-type systems disclosed in the above references is the necessity of draining the cooling fluid whenever physical access to the electronic modules was required. In general, such an operation, besides being time consuming, requires the entire system to be switched off, especially if the component requiring attention

is an essential element in the system architecture, such as the central processing unit ("CPU"). One possible solution to this problem is to immerse circuit assemblies vertically into a tank containing the cooling fluid such that each of the various assemblies can be withdrawn independently from the tank for servicing, replacement, upgrade, etc. One interesting example of such a system is disclosed in a web-presentation entitled "Puget Custom Computer's mineral-oil-cooled PC", by Nilay Patel ("Puget") (posted 12 May 2007 at 11:57 AM; a copy of which is submitted herewith). As noted by the author, the lack of supplemental apparatus in the Puget system to extract waste heat from the oil inherently limited its operating capabilities.

Another problem with the Cray Research systems in particular is the nature and cost of the chosen cooling fluid: fluorocarbon liquids. As is known, other dielectric fluids, such as mineral oil, have better heat transfer characteristics; of course, being an oil, the use thereof does represent a greater residue problem on modules that may be repairable. Notwithstanding, the Puget system implemented precisely this design choice.

US Patent Application Publication 2011/0132579, "Liquid Submerged, Horizontal Computer Appliance Rack and Systems and Method of Cooling such a Appliance Rack", Best, et al. ("Best"), discloses a appliance immersion tank system, include support apparatus for extracting waste heat from the tank cooling fluid and dissipating to the environment the heat so extracted. Although an improvement in several respects over the prior art discussed above, this system exhibits, inter alia, the following problems: generally non-uniform flow patterns through the several appliance slots within the tank, potentially resulting in uneven cooling across all slots; constricted dielectric fluid supply and return ports resulting in unnecessarily high fluid flow velocities at the respective points of connection to the tank; poor scalability; and inadequate attention to fail-soft operation.

The subject matter of all of the prior art references discussed above, each in its entirety, is expressly incorporated herein by reference.

We submit that what is needed is an improved appliance tank immersion system and method of operation. In particular, we submit that such a system should provide performance generally comparable to the best prior art techniques but more efficiently and effectively than known implementations of such prior art techniques.

BRIEF SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of our invention, . . .

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Our invention may be more fully understood by a description of certain preferred embodiments in conjunction with the attached drawings in which:

FIG. **1** illustrates, in partial cut-away form, a front perspective of a tank module of an appliance immersion cooling system constructed in accordance with our invention;

FIG. **2** illustrates a rear perspective of the tank module shown in FIG. **1**;

FIG. **3** illustrates a close-up perspective of a detail A of FIG. **2**;

FIG. **4** illustrates a close-up perspective of a detail B of FIG. **2**;

FIG. **5** illustrates, in perspective view, several details of the tank shown in FIG. **1**, with special emphasis on the dielectric fluid recovery weir integrated into the long rear wall of the tank;

FIG. **6** illustrates, in cross-section view, the section C-C in FIG. **5**;

FIG. **7** illustrates, in perspective view, the plenum facility shown in FIG. **1**;

FIG. **8** illustrates, in top plan view, the orifice plate portion of the plenum facility shown in FIG. **7**;

FIG. **9** illustrates, in perspective view, the chamber portion of the plenum facility shown in FIG. **7**;

FIG. **10** illustrates, in top plan view, a plurality of appliance slots distributed vertically along, and extending transverse to, a long axis of the tank of FIG. **1**;

FIG. **11** illustrates, in longitudinal cross-sectional view, the plurality of appliance slots distributed vertically along, and extending transverse to, the long axis of the tank of FIG. **1**;

FIG. **12** illustrates, in flow schematic form, one instantiation of a flow arrangement suitable for implementing our invention; and

FIG. **13** illustrates, in control schematic form, one instantiation of a flow control facility suitable for implementing our invention.

In the drawings, similar elements will be similarly numbered whenever possible. However, this practice is simply for convenience of reference and to avoid unnecessary proliferation of numbers, and is not intended to imply or suggest that our invention requires identity in either function or structure in the several embodiments.

DETAILED DESCRIPTION OF THE INVENTION

Shown in FIG. **1** (front view) and FIG. **2** (rear view) is a tank module **10** adapted for use in an appliance immersion cooling system constructed in accordance with a preferred embodiment of our invention. For convenience of reference, we have illustrated in FIG. **1** the tank facility **12** of the immersion module **10** in partial cut-away to emphasize several important internal facilities; we have shown the tank facility **12** in isolation in FIG. **5**. In general, the tank facility **12** comprises: a tank **14** adapted to immerse in a dielectric fluid a plurality of electrical appliances **16**, e.g., contemporary computer servers (see, e.g., FIG. **11**), each in a respective appliance slot **18***a* distributed vertically along, and extending transverse to, a long axis of the tank **14** (see, generally, FIG. **10**); an appliance rack facility **20** of convention design adapted to suspend the appliances **16** (see, e.g., FIG. **11**) in respective appliance slots **18** (see, FIG. **10**); a weir **22** (best seen in isolation in FIG. **5** and FIG. **6**), integrated horizontally into one long wall of the tank **14** adjacent all appliance slots **18**, and adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each of the appliance slots **18**; an interconnect panel facility **24** attached to the upper rear edge of the tank **14** and adapted to mount various appliance power distribution equipment, cable interconnection panels and the like (none shown); and a cover **26** adapted to be opened and closed from the front of the tank **14** (and which may include a translucent portion to allow viewing of the interior of the tank **14** when in the closed position). In addition to the tank facility **12**, the immersion module **10** comprises: a primary circulation facility **28** (portions of which are shown in both FIG. **1** and FIG. **2**); a secondary fluid circulation facility **30** (of which only redundant heat exchangers **32***a* and **32***b* are shown in FIG. **2**); and control equipment cabinets **34***a* and **34***b*, each adapted to accommodate the module status and control equipment associated with a respective one of the primary circulation facilities **28***a* and **28***b* (see, FIG. **13**).

As can be best seen in FIG. **2**, the primary circulation facility **28** (comprising redundant sub-facilities **28***a* and **28***b*) comprises both passive (conduits, couplers, etc.) and active (valves, pumps, sensors, etc.) components; a subset of the passive components are shared, whereas, in general, the active components are duplicated and adapted to cooperate in operation as separate, redundant sub-facilities. Excluding the tank **14**, the primary shared component is the plenum facility **36** (see, FIG. **1** and FIG. **7**) comprising an orifice plate **36***a* (see, FIG. **8**) and a plenum chamber **36***b* (see, FIG. **9**). As can be seen in FIG. **1**, cooled dielectric fluid is pumped into both ends of the plenum facility **36** via a shared distribution header **38** (see, FIG. **2** and FIG. **3**). In general, the plenum plate **36***a* comprises at least one row of orifices vertically aligned with each appliance slot **18***a*, with the dimensions and flow rates of each set being adapted to provide substantially equal flow of the dielectric fluid upwardly into each appliance slot **18***a*. Preferably, each appliance slot **18***a* is supplied via several rows of orifices, thus generally tending to reduce the volume of the dielectric fluid exiting each orifice and to make the flow of dielectric fluid more uniform upwardly through the appliance slots **18**. One further shared component is the dielectric fluid recovery facility **40** (FIG. **2**) comprising a dielectric fluid recovery reservoir **42** (see, FIG. **3**, FIG. **4** and FIG. **13**) positioned vertically beneath the overflow lip of the weir **22** and adapted smoothly to receive the dielectric fluid as it flows over the weir **22**; the dielectric fluid recovery reservoir **42** is further adapted to allow the recovered fluid to be removed from the reservoir **42** via redundant recovery ports **44***a* and **44***b* (only port **44***a* can be seen in FIG. **2** as the port **44***b* is obscured by the heat exchanger **32***a*; but see FIG. **12**). As can be seen in both FIG. **3** and FIG. **4**, we consider it desirable to provide a vortex breaker at the input of each of the recovery ports **44**. Also, we provide a removable recovery reservoir cover **46** adapted to also cover a major portion of the distribution header **38**; note that, in both FIG. **2** and FIG. **3**, we have illustrated the reservoir cover **46** in a partially raised orientation so as to better depict details that would otherwise be obscured. Note that we have constructed the reservoir **42** such that the average height of dielectric fluid above the recovery ports **44** develops sufficient hydrostatic head to meet the requirements of the pumps **48**, while also tending to minimize the likelihood of breaking suction during normal operation.

At this point in the primary circulation facility **28**, we provide fully redundant sub-facilities **28***a* and **28***b*, each comprising a primary circulation pump (**48***a* and **48***b*) and associated passive and active components which, collectively, provide the motive power for circulating the dielectric fluid through the shared components and tank **14**. As can be generally seen, each of these sub-facilities **28***a* and **28***b* is adapted to recover the dielectric fluid exiting the tank **14** via the weir **22**, re-pressurize the recovered fluid, pass the re-pressurized fluid through a respective one of the heat exchangers **32***a* and **32***b*, and then back to the plenum facility **36** via the header **38**.

Shown in FIG. **12** is one flow arrangement suitable for integrating our tank module **10** into a fully redundant, appliance immersion cooling system, comprising the primary circulation facility **28** and the secondary fluid circulation facility **30**. In general, the secondary fluid circulation facility **30** comprises redundant secondary circulation sub-facilities **30**_a_ and **30**_b_, each of which is adapted to circulate a cooling fluid, e.g., treated water, through the respective heat exchanger **32**_a_ and **32**_b_ to extract heat from dielectric fluid counter-circulating therethrough and to dissipate to the environment the heat so extracted. In the illustrated embodiment, each of the secondary fluid sub-facilities **30**_a_ and **30**_b_ comprise conventional cooling towers **50**_a_ (including fan facility **52**_a_) and **50**_b_ (including fan facility **52**_b_), and secondary circulation pumps **54**_a_ and **54**_b_. To facilitate flexible operation in installations including multiple immersion modules **10** in combination with a plurality of secondary circulation sub-facilities **30**, a common header arrangement can be implemented as illustrated in the secondary fluid circulation loop, with flow control valves located at key flow control points as is known.

Shown in FIG. **13** is a control facility **56** adapted to monitor and control the operation of both the immersion module **10** (including all active components of the primary circulation facility **28**), and the secondary fluid circulation facility **30**. As will be evident to those skilled in this art, efficient operation of our immersion module **10** requires continuous monitoring and control of several essential operating parameters, including fluidic temperatures, pressures, conductivity and pH at several points in the primary and secondary circulation loops. Although the several sensory and control functions can be implemented using traditional dedicated hardware components, we prefer to employ at least one programmable logic controller ("PLC"), commercially available from any of a number of respected vendors, e.g., the Allen-Bradley brand of PLCs from Rockwell Automation, Inc. In the instantiation illustrated in FIG. **13**, we have depicted: a primary controller **58**_a_ adapted to monitor and control the operation of the primary circulation sub-facility **28**_a_ as a function of the temperature of the dielectric fluid in the tank **14**; a secondary controller **60**_a_ adapted to monitor and control the operation of the secondary fluid circulation sub-facility **30**_a_ as a function of the temperature of the dielectric fluid flowing through the heat exchanger **32**_a_; and a master controller **62** adapted to coordinate the activities of the primary controller **58**_a_ and secondary controller **60**_a_. As can be seen, we have incorporated into the primary circulation sub-facility **28**_a_: supply and return sensors, including a temperature probe, T, inserted into a thermowell (not shown) installed in the bottom of the reservoir **42** adjacent a respective return port **44**_a_ (note that, in FIG. **4**, only one of the holes that receive the thermowells is illustrated, but both holes are illustrated in FIG. **12**); a pair of sensor facilities, S, which may sense temperature, pressure and conductivity, as deemed desirable); and return (and, if desired, supply) flow control valves and controls for the primary circulation pump **48**_a_; of course, a redundant set of these components exists for the primary circulation sub-facility **28**_b_. In general, the goal is to maintain the temperature of the dielectric fluid in the tank **14** between a predetermined minimum temperature and a predetermined maximum temperature.

As noted above, we have provided separate control equipment cabinets **34**_a_ and **34**_b_, each adapted to accommodate the several components comprising a respective one of the primary controllers **58**_a_ and **58**_b_. For convenience of access, we prefer to co-locate with each of the cooling towers **50** a protective housing (not shown) for the respective secondary controller **60**. Of course, the control facility **56** can be instantiated as a single, multi-module PLC facility, with similar or other combinations of monitoring devices as deemed most appropriate for a particular installation. Alternatively, one or more, and perhaps all, of the functions performed by the controllers **58**, **60** and **62** may be implemented in the form of dedicated application-specific software executing on a conventional computer platform having the appropriate resources; indeed, it would be entirely feasible to implement the entire control facility **56** on a server **16** installed in a tank **14**.

One desirable enhancement that we recommend is a remote control facility, implemented, e.g., via the master controller **62** (or by way of a direct, per-controller interface), adapted to facilitate remote monitoring of system status (e.g., temperatures, pressures, etc.) and control over system control parameters (e.g., temperature and pressure limits, etc.) to the primary controllers **58** and secondary controllers **60**. For example, using a conventional data communication hardware module **64**, e.g., an ethernet card implementing the TCP/IP protocol, a modern web browser can be adapted to provide a graphical user interface ("GUI") with sufficient functionality to facilitate monitoring and control of an entire installation from a remote location. Such a GUI may be implemented using any of a number of programming paradigms, e.g., PHP, .NET and the like.

Operational control of redundant, continuous process flow systems is generally well known. Preferable, each of the several redundant sub-facilities are routinely activated to assure current functionality, and to allow the inactive sub-facility to be serviced according to an established schedule. We believe this continuous rotation of system resources to be so important that we recommend switching the sub-facilities at least once, and preferably, several times, per day; although this is possible to implement manually, we prefer to enable the master controller **62** to control the sequencing of the several switch-over operations. One further aspect of this sophistication in control is the ability to perform stress testing of the several sub-systems under controlled conditions so as to assure appropriate response to real-time emergencies.

In our First Parent Provisional, we have disclosed an alternate embodiment comprising an appliance immersion tank facility wherein the function of the plenum facility **36** is performed by a manifold facility comprising a ladder-arrangement of tubular spray bars, each bar of which supplies dielectric fluid to a respective appliance slot. As we noted, one particular advantage of this arrangement is that individual spray bars may be shut off if the respective appliance slot is not occupied and, thus, save energy. To further increase energy efficiency, we have provided optional vertical flow barriers adapted to partition the tank into an active portion, having active appliances, and a stagnant portion, having no active appliances. One further enhancement we disclosed is the provision of temperature sensors per appliance slot, such that the flow rate through each spray bar can be dynamically varied as a function of the temperature of the dielectric fluid exiting the respective slot. Other operative configurations will be readily perceived by those skilled in this art.

In a manner analogous to the embodiment described in our First Parent Provisional, it would be advantageous, from an energy point of view, to provide a plurality of flow barrier plates **66** (shown by way of example only in FIG. **11**), each adapted to be attached to the top of the plenum facility **36** so as substantially to block the flow of the dielectric fluid through the row(s) of orifices in the plenum plate **36**_a_ corresponding to at least a respective one of the appliance slots **18**_a_; an elastomeric layer (not shown) could be provided on the interface surface of the plate(s) **66** to enhance the sealing effect. Such an arrangement would allow the total flow through the plenum facility **36** to be adjusted, in the field, as a function of the actual number of active appliances **16** in the tank **14**. Further, this arrangement can incorporate a relocatable vertical baffle plate **68** (see FIG. **11**) adapted substantially to partition the tank **14** into an active portion **14***a* containing the active appliances **16** and an inactive portion **14***b* containing no appliances (or at least no active appliances **16**); preferably, the baffle plate **68** is adapted to be mounted in the appliance rack facility **28** in a manner similar to an actual appliance **16** (the baffle plate **68** need not fully block the flow of dielectric fluid between the active portion **14***a* and inactive portion **14***b*, but only significantly impede the flow between these portions). Note that, in the example scenario illustrated in FIG. **11**, we have shown one possible arrangement of a total of 8 active appliances **16** distributed across 16 appliance slots **18***a* so as to spread the total heat load across adjacent empty slots **18***a*. Such an optimal arrangement is possible only if less than a majority of the available appliance slots **18***a* are occupied by an active appliance **16**. Clearly, such optional adjunct facilities enhance flexibility in operation, accommodating dynamic adjustment of the flow rates in the primary circulation sub-facilities **28***a* and **28***b* under variable heat loads, while providing opportunities to conserve energy that might otherwise be expended moving the dielectric fluid through the inactive portion **14***b* of the tank **14**. Other operative configurations will be readily perceived by those skilled in this art.

In our Second Parent Provisional, we have disclosed another embodiment comprising a more conventional, less-modularized instantiation with appropriate flow and control facilities. In this embodiment, we chose to implement tank clusters, comprising, e.g., **4** appliance immersion tank facilities, with substantially all of the other equipment being constructed from stand-alone, commercially available components. Such an arrangement offers greater opportunities to select and install improved components, or to add enhancements to the installation, as deemed desirable after initial installation. Other operative configurations will be readily perceived by those skilled in this art.

As we noted above with reference to the embodiment illustrated in FIG. **12**, the secondary flow header facility is well adapted to allow any secondary circulation sub-facility **30** to be connected to any active heat exchanger **32**. Such a facility provides great flexibility in dealing with unusual system conditions, especially in installations wherein the secondary circulation sub-facilities **30***a* and **30***b* are each sized to support a cluster of tank modules **10**. Imagine, for example, that, while one of the secondary circulation facilities **30**, say sub-facility **30***a*, is being serviced, the activities of the set of appliances **16** in one tank **14** in the cluster are higher than normal, resulting in a rise in temperature in that tank **14** above the desired maximum. In response, the master controller **62** can direct Primary Controllers **58***a* and **58***b* assigned to tank **14** to operate both of the primary circulation sub-facilities **28***a* and **28***b* simultaneously, i.e., in parallel. Using the secondary flow header facility, the heat being extracted by both of the heat exchangers **32***a* and **32***b* may be dissipated using the resources of the single on-line secondary circulation sub-facility **30***b*. Thus, one clear advantage of this alternate embodiment is the ability dynamically to perform load balancing across all system resources. Other operative configurations to support subsystem load balancing will be readily perceived by those skilled in this art.

Preferably, one or more filters (not shown) are included in the flow path through each of the primary circulation sub-facilities **28***a* and **28***b* to remove any particulates or other undesirable foreign matter that may have been picked up by the dielectric fluid on its passage though the entire primary circulation facility **28**; chemical sensors may also be provided to detect the presence of unexpected chemicals that may indicate failure of sub-components within one of the appliances **16**. Similar components, such as pH sensors, may also included in the secondary fluid circulation facility **30**.

As can be seen generally in FIG. **1**, we provide a pair of low dielectric fluid level sensors **70***a* and **70***b* adapted to trigger an alarm signal in the event that, for whatever reason, the level of the dielectric fluid in the tank **14** drops below a predetermined minimum level. Additionally, the responsive primary controller **58** can initiate other actions to address the detected problem, including activating audio alarms, transmitting electronic alert signals and the like.

To solve a reciprocal problem, namely leakage from an external portion of the primary circulation loop **28** resulting in the dielectric fluid in the tank **14** being back-siphoned through the plenum facility **36**, we recommend incorporating a siphon breaker **72** (see, FIG. **1**) in the supply pipe at a predetermined location well above the plenum facility **36** but somewhat below the level of the weir **24**. Such a siphon breaker can be as simple as a relatively small diameter hole **72** drilled through the supply pipe at the selected location; due to the relatively high viscosity of the dielectric fluid, even when heated, any resulting leakage during normal operation will be relatively insignificant. Other operative responses to address these and other unusual fluidic conditions will be readily perceived by those skilled in this art.

As is known (see, e.g., Best), many conventional, commercially available electrical/electronic appliances include components that will not function correctly if immersed in a dielectric fluid, especially one as viscous as mineral oil: cooling fans and rotating media disk drives. In general, all cooling fans are unnecessary in an immersion cooling system and can be simply removed. The media drives, however, are usually necessary for normal appliance operation. One option is to remove each drive, totally seal the drive against fluid entry, and reinstall the now-sealed drive (pre-sealed drives are also available). Another option is to remove the drive and mount it on the interconnect panel facility **24**; typically special cabling will be required to re-attach the drive to the internal appliance socket. Yet another option is to replace the rotating media drive with a solid-state drive having no moving components. Other operative configurations will be readily perceived by those skilled in this art.

It will be recognized that, in all of the embodiments described herein, emphasis was placed on minimizing the total volume of the dielectric fluid circulating throughout each immersion module **10**. We submit that the key concept here is to move the secondary fluid to the point of heat exchange with the primary fluid, rather than to move the primary fluid to the point of heat exchange with the secondary fluid. Thus, in our preferred embodiment, all of the essential components of the primary circulation facility **28** are tightly co-located with the tank **14** so as to form a highly-integrated module. Further, our placement of the reservoir **42** outside of (but immediately adjacent to) the tank **14** tends to reduce the total volume of the dielectric fluid (as opposed to the alternative arrangement we proposed in our First Provisional, wherein a recovery trough was disposed within the tank **14**); then, we positioned the components comprising the primary circulation sub-facilities **28** so as to be vertically beneath the footprint of the reservoir **42**. In addition to conserving valuable floor space in a typical data center installation, the resulting modular configuration facilitates both easy initial installation and subsequent upgrade to efficiently satisfy increasing data center workloads. Indeed, our invention greatly enhances system scalability, a key concern to data center operators. Finally, our system-wide redundancy substantially assures fail-soft operation during periods of unusual environmental conditions, infrastructure instability or political unrest.

Although we have described our invention in the context of particular embodiments, one of ordinary skill in this art will readily realize that many modifications may be made in such embodiments to adapt either to specific implementations. By way of example, it will take but little effort to adapt our invention for use with electronic appliances other than contemporary servers; and to adjust the dimensions of the appliance accommodation slots accordingly. Similarly, practitioners in the art will readily recognize that other, known secondary circulation facilities may be employed effectively, including forced air, vapor compression systems, earth-water sink loops, waste heat recovery and recycling systems, and the like (see, e.g., the several alternatives discussed in Best). Further, the several elements described above may be implemented using any of the various known manufacturing methodologies, and, in general, be adapted so as to be operable under either hardware or software control or some combination thereof, as is known in this art.

Thus it is apparent that we have provided an improved system and method of operation for immersion cooling of appliances and the like. In particular, we submit that such a method and apparatus provides performance generally comparable to the best prior art techniques but more efficiently and effectively than known implementations of such prior art techniques.

What we claim is:

1. An appliance immersion cooling system comprising:

a tank adapted to immerse in a dielectric fluid a plurality of electrical appliances, each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank, the tank comprising:

a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot; and;

a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir;

a primary circulation facility adapted to circulate the dielectric fluid through the tank, comprising:

a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot;

a secondary fluid circulation facility adapted to extract heat from the dielectric fluid circulating in the primary circulation facility, and to dissipate to the environment the heat so extracted; and

a control facility adapted to coordinate the operation of the primary and secondary fluid circulation facilities as a function of the temperature of the dielectric fluid in the tank.

2. The system of claim **1** wherein the tank and primary circulation facility comprise a highly-integrated module.

3. The system of claim **1** wherein the tank further comprises:

an interconnect panel facility adapted to mount appliance support equipment.

4. The system of claim **1** wherein the primary circulation facility further comprises:

at least first and second primary circulation sub-facilities, each adapted to operate independently to circulate the dielectric fluid through the tank;

wherein the control facility is further adapted to coordinate the operation of the first and second primary circulation sub-facilities and the secondary fluid circulation facilities so to maintain the temperature of the dielectric fluid in the tank substantially between a predetermined minimum temperature and a predetermined maximum temperature.

5. The system of claim **1** wherein the control facility further comprises a communication facility adapted to facilitate monitoring and control of the control facility from a remote location.

6. A tank module adapted for use in an appliance immersion cooling system, the tank module comprising:

a tank adapted to immerse in a dielectric fluid a plurality of electrical appliances, each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank, the tank comprising:

a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot; and;

a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir;

a primary circulation facility adapted to circulate the dielectric fluid through the tank, comprising:

a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot; and

a control facility adapted to control the operation of the primary fluid circulation facility as a function of the temperature of the dielectric fluid in the tank.

7. The module of claim **6** wherein the tank and primary circulation facility comprise a highly-integrated module.

8. The module of claim **6** wherein the tank further comprises:

an interconnect panel facility adapted to mount appliance support equipment.

9. The module of claim **6** wherein the primary circulation facility further comprises:

at least first and second primary circulation sub-facilities, each adapted to operate independently to circulate the dielectric fluid through the tank;

wherein the control facility is further adapted to coordinate the operation of the first and second primary circulation sub-facilities so to maintain the temperature of the dielectric fluid in the tank substantially between a predetermined minimum temperature and a predetermined maximum temperature.

10. The module of claim **6** wherein the control facility further comprises a communication facility adapted to facilitate monitoring and control of the control facility from a remote location.

11. A tank module (**10**) adapted for use in an appliance immersion cooling system, the tank module comprising:

a tank (**12**) adapted to immerse in a dielectric fluid a plurality of electrical appliances (**16**), each in a respective appliance slot (**18**) distributed vertically along, and extending transverse to, a long wall of the tank (**10**), the tank (**10**) comprising:

a weir **22**, integrated horizontally into the long wall of the tank (**10**) adjacent all appliance slots (**18**), adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot (**18**);

a primary circulation facility (**28**) adapted to circulate the dielectric fluid through the tank (**10**), comprising:

a plenum (**36**), positioned adjacent the bottom of the tank (**10**), adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot (**18**); and

a control facility (**58**) adapted to control the operation of the primary fluid circulation facility (**28**) as a function of the temperature of the dielectric fluid in the tank (**10**).

12. The tank module of claim **11** wherein the tank further comprises:

an interconnect panel facility (**24**) adapted to mount appliance support equipment.

13. The module of claim **11** wherein the primary circulation facility further comprises:

at least first and second primary circulation sub-facilities (**28***a*, **28***b*), each adapted to operate independently to circulate the dielectric fluid through the tank;

wherein the control facility is further adapted to coordinate the operation of the first and second primary circulation sub-facilities so to maintain the temperature of the dielectric fluid in the tank substantially between a predetermined minimum temperature and a predetermined maximum temperature.

14. The module of claim **11** wherein the control facility further comprises a communication facility (**62**, **64**) adapted to facilitate monitoring and control of the control facility from a remote location.

15. An appliance immersion cooling system comprising a tank module according to any one of the preceding claims **11** through **14**.

16. An appliance immersion cooling system according to claim **15**, further comprising:

a secondary fluid circulation facility adapted to extract heat from the dielectric fluid circulating in the primary circulation facility, and to dissipate to the environment the heat so extracted.

* * * * *

EXHIBIT B

UNITED STATES PATENT NO. 10,405,457 ("BOYD")

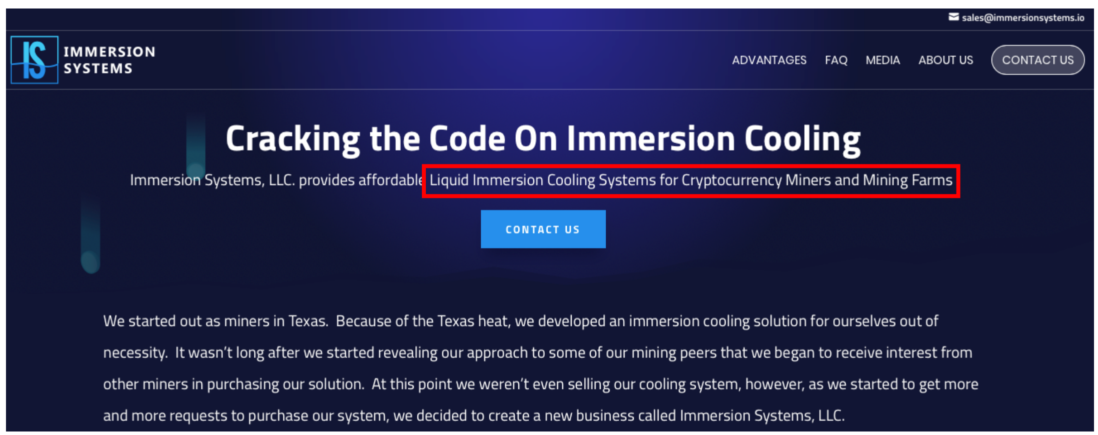
PRELIMINARY CLAIM CHART FOR INFRINGEMENT OF REPRESENTATIVE INDEPENDENT CLAIM 1

Note: This representative claim chart is provided solely for pleading purposes in this action and is based upon information known at this time. This chart does not represent Plaintiff's infringement contentions, the asserted claims, or all of Plaintiff's allegations regarding infringement. Plaintiff further reserves the right to assert additional or different theories of infringement, including infringement under the doctrine of equivalents.

Infringement analysis provided for any preamble should not be construed as an admission that such preamble is limiting.

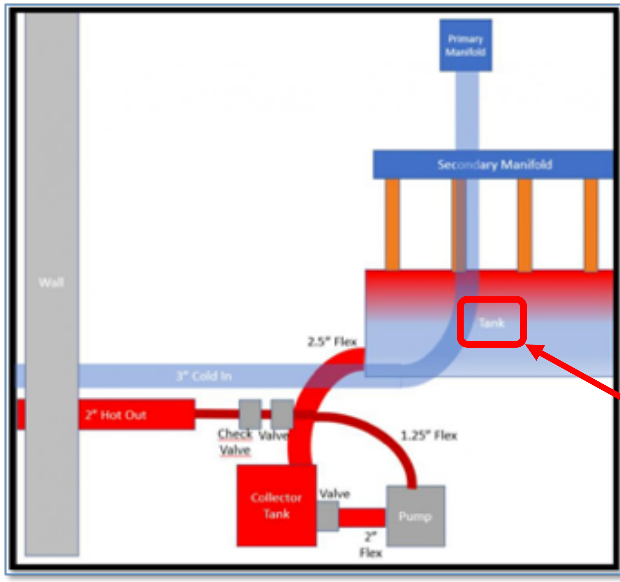
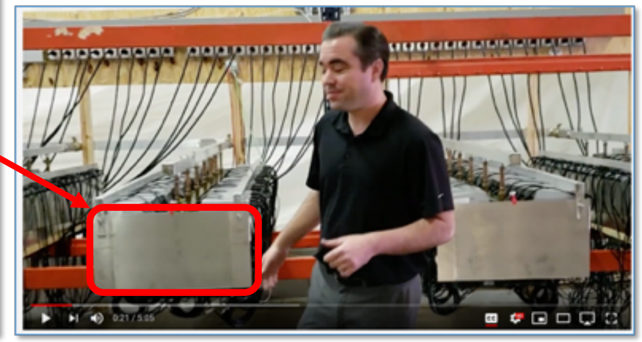
<table>
<tr><th>Claim</th><th>Immersion's Immersion System as represented at https://immersionsystems.io/media/
(the accused product/instrumentality)</th></tr>
<tr><td>1. An appliance immersion cooling system comprising:</td><td>

The accused product forms an appliance immersion cooling system, *e.g.*, "Liquid Immersion Cooling Systems for Cryptocurrency Miners and Mining Farms". "Appliance" includes "contemporary computer servers", *Boyd,* col. 3, lines 45-46, *e.g.* Cryptocurrency Miners

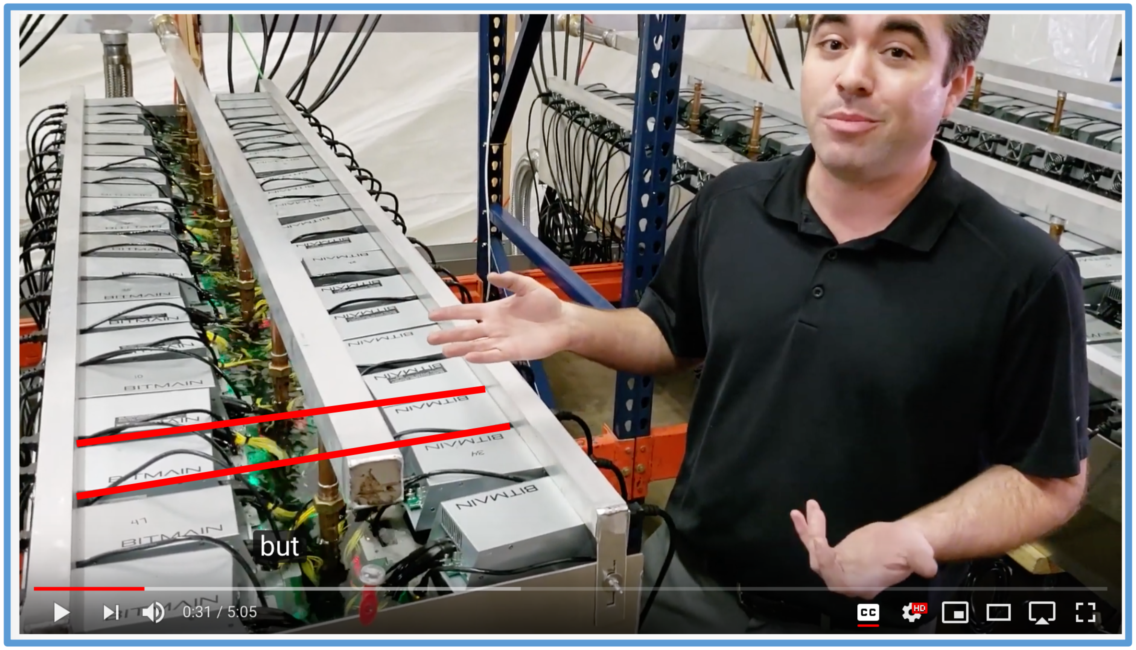


Source: Immersion Systems, LLC's Website, About Us : https://immersionsystems.io/about/

</td></tr>
</table>

a tank	The accused product includes a tank, *e.g.*, illustrated here in Immersions FAQ documentation and in Immersion's video demonstrating the Immersion cooling system.   *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:21;Immersion Systems Frequently Asked Questions* [*https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf*](https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf)*, p. 8*

adapted to immerse in a dielectric fluid a plurality of electrical appliances,	 **General Information** **What all is included in your immersion system?** • **Our standard setup includes:** ○ Immersion Tanks ○ Dry coolers ○ BitCool BC-888 dielectric fluid ○ Pumps ○ Filter system ○ Associated plumbing ○ BitCool BC-888 dielectric fluid ○ Filter system ○ Associated plumbing ○ Automated controller for monitoring & controlling pumps, dry coolers, temperature, pressure, etc. ○ Standard pallet rack system for housing the tanks The accused product is adpated to immerse in a dielectric fluid, *e.g.*, "BitCool BC-888 dielectric fluid", a plurality of electrical appliances, *e.g.*, the speaker's description of the immersion cooling system as "our flagship model" and a "42 miner tank" at 0:44 of video. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:31; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 3*

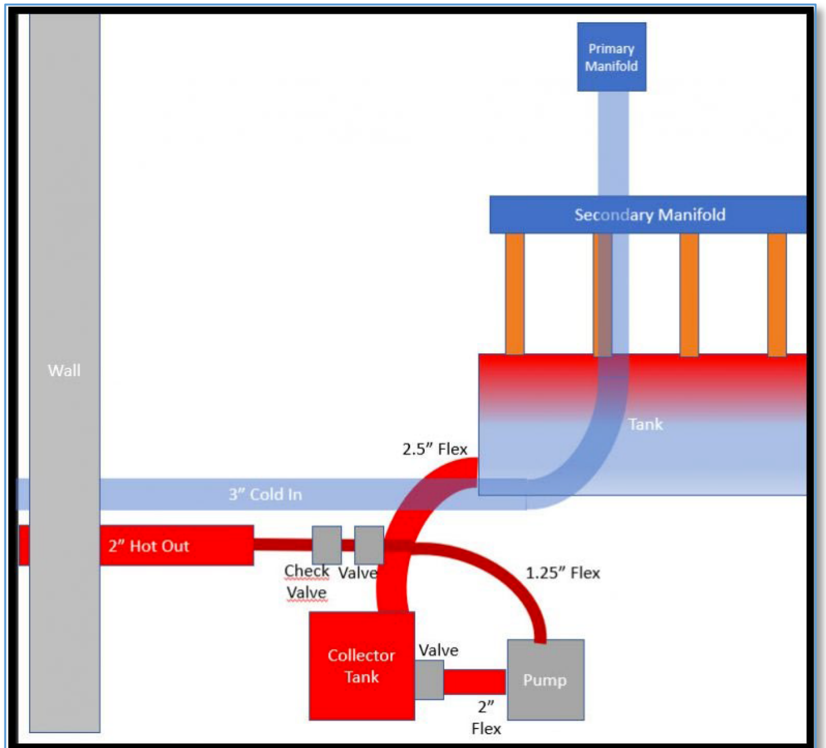
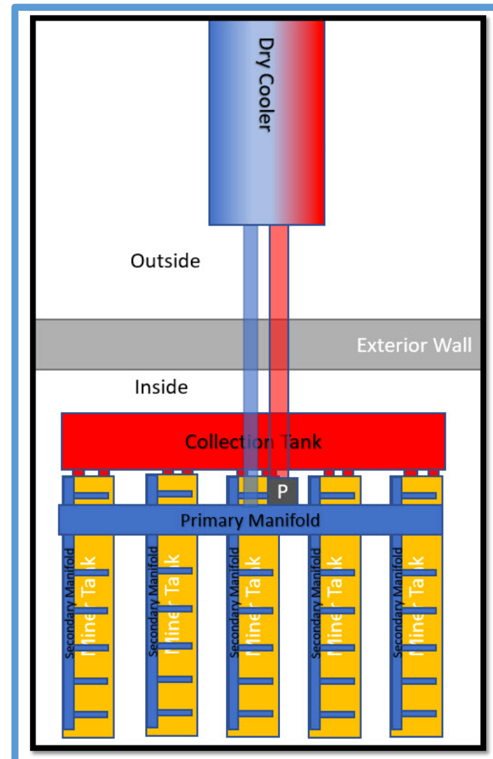
each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank,	 The accused product includes appliance slots, *e.g.*, each bit miner is shown in a resepective slot, each of those slots being distributed vertically along, *e.g.*, the bit miner appliance slot is distributed vertically down into the tank, and extending traverse to the long wall of the tank. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:31;*

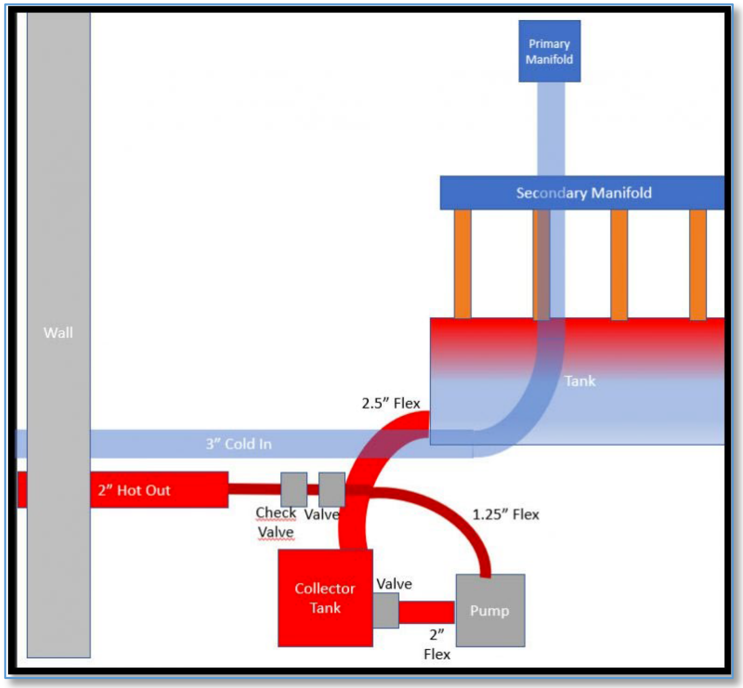
<table>
<tr>
<td>the tank comprising:
a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot; and</td>
<td>

The accused product includes a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, e.g., the horizontal line of holes just below the top long edge of the tank, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing throug each appliance slot, e.g., the level of the fluid in the tank of the accused product is level with the holes, facilitating a laminar flow of the dielectric fluid over the lip created by the weir holes, the weir holes being distributed equidistantly along the length of the long wall of the tank of the accused product, thus facitliating substantially uniform recovery of the fluid in the tank. The dielectric fluid is then shown descending vertically into the recovery tank of the accused product.

Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:40</td>
</tr>
</table>

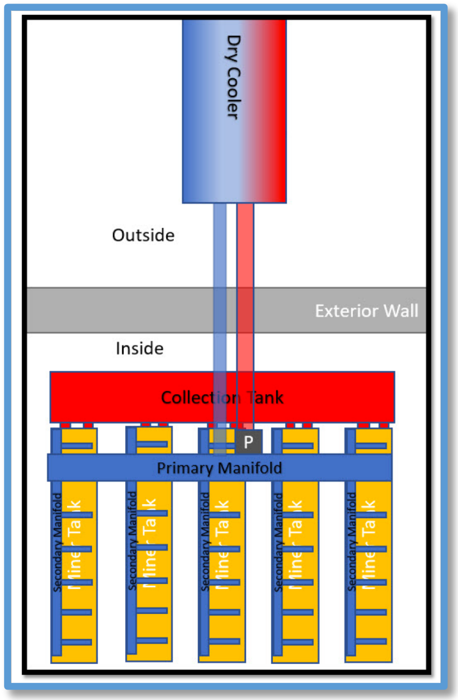
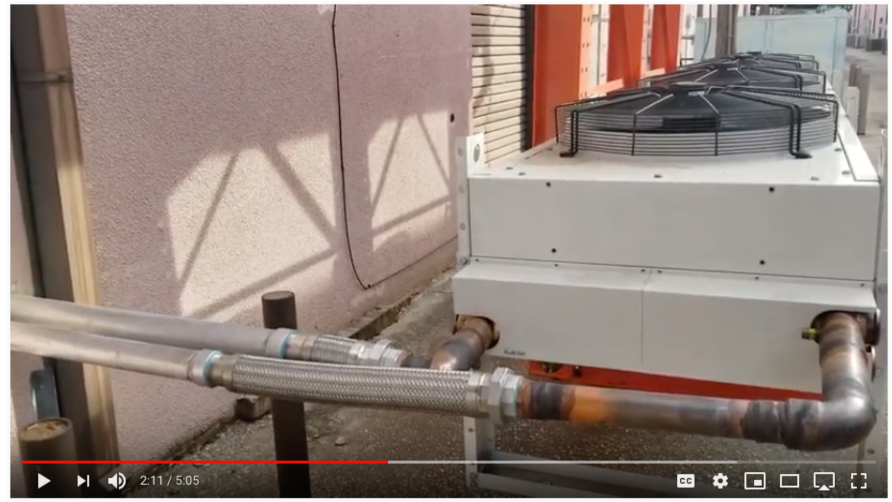
a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir	 The accused product includes a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir, *e.g.*, the person in the video talks about " looking down into the fluid recovery chamber where the fluid overflows the side of the tank down into the fluid recovery chamber …". Transcription of the video, beginning at 1:40 - "Now I am looking down into the fluid recovery chamber where the fluid overflows the side of the tank down into the fluid recovery chamber …" *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:40-1:48*

a primary circulation facility adapted to circulate the dielectric fluid through the tank	  The accused product includes a primary circulation facility adapted to circulate the dielectric fluid through the tank, *e.g.*, the pump sends the hot dielectric fluid out to the exterior dry cooler (here illustrated as 2" Hot Out), cooled dielectric fluid returns to the tank, enters the Primary Manifold, then the Secondary Manifold, the enters the bottom of the tank, and moving up through the tank to the previously illustrated weir, into the recovery reservoir, out to the collection tank, and back to the pump. *Source: https: Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8-9*

<table>
<tr>
<td>comprising:
a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot;</td>
<td>

The accused product includes a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot, e.g., a plenum is illustrated by the "blue" area of the tank, where cold returns from the dry cooler to the "bottom channel" via the primary and secondary manifolds, and is further identified by the speaker in the video at 1:00 to 1:11 - "… a plate that separates the bottom channel from the top channel, and then forces the fluid back up through the miners …"

Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:00 – 1:11; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8</td>
</tr>
</table>

a secondary fluid circulation facility adapted to extract heat from the dielectric fluid circulating in the primary circulation facility, and to dissipate to the environment the heat so extracted; and	  The accused product includes a secondary fluid circulation facility adapted to extract heat from the dielectric fluid circulating in the primary circulation facility, and to dissipate to the environment the heat so extracted, *e.g.*, the secondary fluid (air) circulation facility is the dry cooler, adapted to extract heat from the dielectric fluid. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 2:11; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 9*

a control facility adapted to coordinate the operation of the primary and secondary fluid circulation facilities as a function of the temperature of the dielectric fluid in the tank.

How much does a full immersion system cost?

- A full immersion system designed for Antminer S9 machines is going to run roughly $200 - $300 per miner. That said, the cost may vary significantly depending on your specific configuration, as plumbing and other component or material needs will likely differ on a case by case basis. While our systems are modular and usually consist of the same general layout, each miner's facility is different, and those variances are taken into consideration during our preparation of the estimate.
- For example, if your mine consisted of all Whatsminer M10 machines (55 TH @ 3600 watts), the price per miner would increase, as they produce 3x the BTU's when compared to an S9. As such, that setup would have greater cooling requirements and may require additional cooling capacity. This would result in the need for the system to be designed with a lower miner-to-dry cooler ratio so that the heat dissipation requirements can be met.

General Information

What all is included in your immersion system?

- **Our standard setup includes:**
  - Immersion Tanks
  - Dry coolers
  - BitCool BC-888 dielectric fluid
  - Pumps
  - Filter system
  - Associated plumbing
  - BitCool BC-888 dielectric fluid
  - Filter system
  - Associated plumbing
  - Automated controller for monitoring & controlling pumps, dry coolers, temperature, pressure, etc.
  - Standard pallet rack system for housing the tanks

The accused product includes a control facility adapted to coordinate the operation of the primary and secondary fluid circulation facilities as a function of the temperature of the dielectric fluid in the tank, *e.g.*, the "standard setup includes … **[a]utomated controller** for monitoring and **controlling** pumps, dry coolers, **temperature**, pressure, etc."

Source: https: Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 2-3

EXHIBIT C

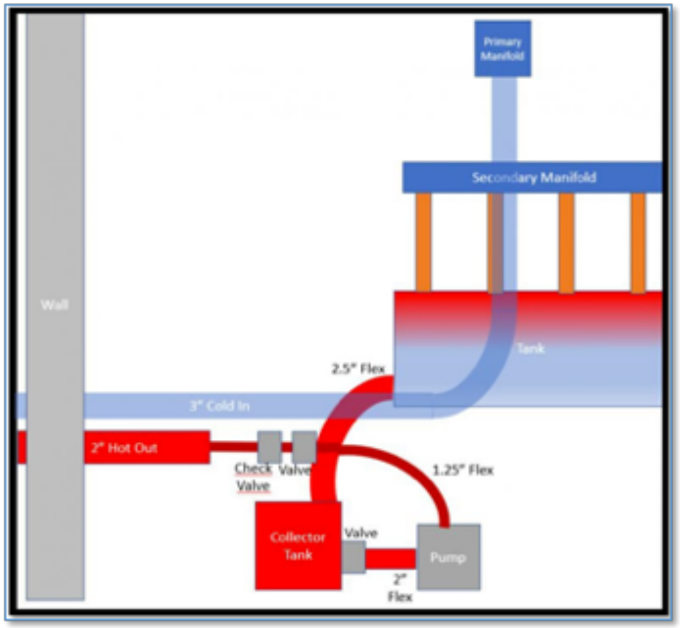
UNITED STATES PATENT NO. 10,405,457

PRELMINARY CLAIM CHART FOR INFRINGEMENT OF REPRESENTATIVE INDEPENDENT CLAIM 6

Note: This representative claim chart is provided solely for pleading purposes in this action and is based upon information known at this time. This chart does not represent Plaintiff's infringement contentions, the asserted claims, or all of Plaintiff's allegations regarding infringement. Plaintiff further reserves the right to assert additional or different theories of infringement, including infringement under the doctrine of equivalents.

Infringement analysis provided for any preamble should not be construed as an admission that such preamble is limiting.

Claim	Immersion's Immersion System as represented at https://immersionsystems.io/media/
6. A tank module adapted for use in an appliance immersion cooling system, the tank module comprising:	The accused product includes a tank module adapted for use in an appliance immersion cooling system, *e.g.*, illustrated here in Immersions FAQ documentation and in Immersion's video demonstrating the Immersion cooling system. 

	 *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:21;Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8*

a tank adapted to immerse in a dielectric fluid a plurality of electrical appliances,

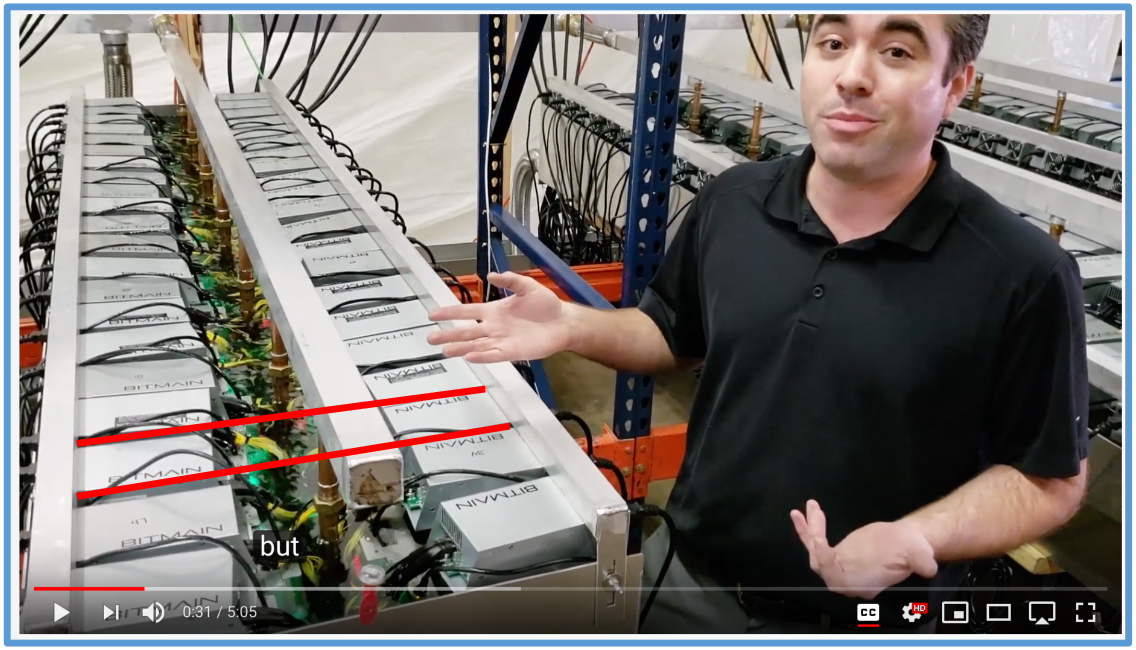
General Information

What all is included in your immersion system?

- **Our standard setup includes:**
  - Immersion Tanks
  - Dry coolers
  - BitCool BC-888 dielectric fluid
  - Pumps
  - Filter system
  - Associated plumbing
  - BitCool BC-888 dielectric fluid
  - Filter system
  - Associated plumbing
  - Automated controller for monitoring & controlling pumps, dry coolers, temperature, pressure, etc.
  - Standard pallet rack system for housing the tanks

The accused product includes a tank that is adpated to immerse in a dielectric fluid, *e.g.*, "BitCool BC-888 dielectric fluid", a plurality of electrical appliances, *e.g.*, the speaker's description of the immersion cooling system as "our flagship model" and a "42 miner tank" at 0:44 of video.

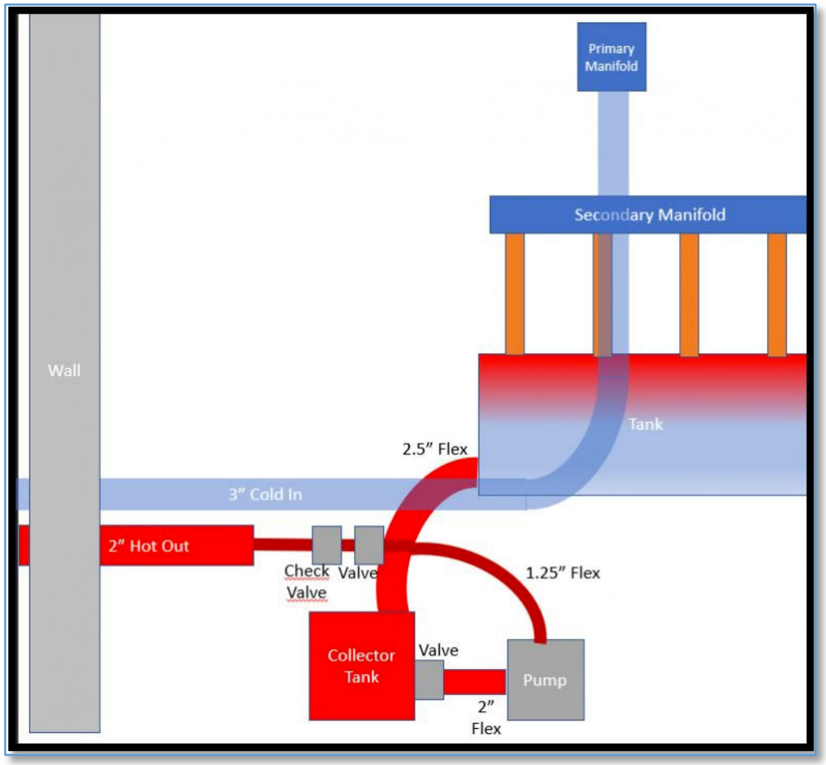
Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:31; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 3

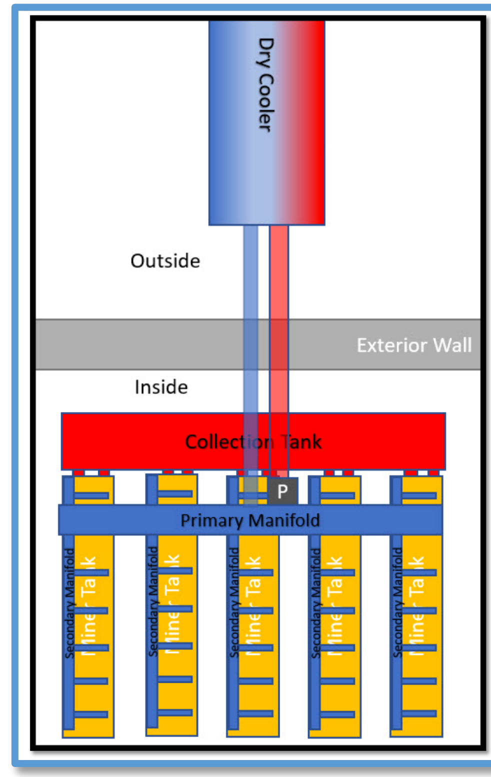
each in a respective appliance slot distributed vertically along, and extending transverse to, a long wall of the tank,	 The accused product includes appliance slots, *e.g.*, each bit miner is shown in a resepective slot, each of those slots being distributed vertically along, *e.g.*, the bit miner appliance slot is distributed vertically down into the tank, and extending traverse to the long wall of the tank. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:31;*

the tank comprising: a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot; and	 The accused product includes a weir, integrated horizontally into the long wall of the tank adjacent all appliance slots, *e.g.*, the horizontal line of holes just below the top long edge of the tank, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing throug each appliance slot, *e.g.*, the level of the fluid in the tank of the accused product is level with the holes, facilitating a laminar flow of the dielectric fluid over the lip created by the weir holes, the weir holes being distributed equidistantly along the length of the long wall of the tank of the accused product, thus facitliating substantially uniform recovery of the fluid in the tank. The dielectric fluid is then shown descending vertically into the recovery tank of the accused product. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:40*

a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir	 The accused product includes a dielectric fluid recovery reservoir positioned vertically beneath the overflow lip of the weir and adapted to receive the dielectric fluid as it flows over the weir, *e.g.*, the person in the video talks about " looking down into the fluid recovery chamber where the fluid overflows the side of the tank down into the fluid recovery chamber …". Transcription of the video, beginning at 1:40 - "Now I am looking down into the fluid recovery chamber where the fluid overflows the side of the tank down into the fluid recovery chamber …" *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:40-1:48*

a primary circulation facility adapted to circulate the dielectric fluid through the tank

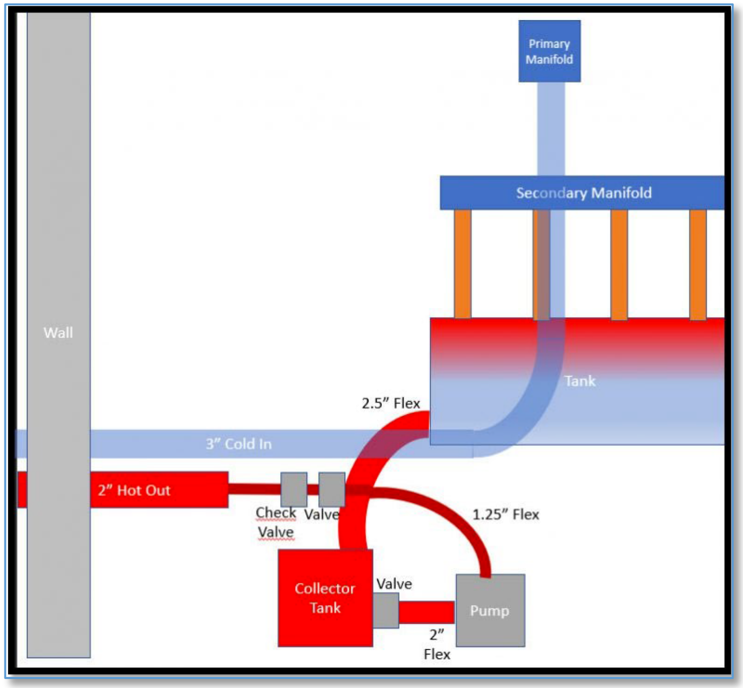




The accused product includes a primary circulation facility adapted to circulate the dielectric fluid through the tank, *e.g.*, the pump sends the hot dielectric fluid out to the exterior dry cooler (here illustrated as 2" Hot Out), cooled dielectric fluid returns to the tank, enters the Primary Manifold, then the Secondary Manifold, the enters the bottom of the tank, and moving up through the tank to the previously illustrated weir, into the recovery reservoir, out to the collection tank, and back to the pump.

Source: https: Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8-9

comprising:
a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot;



The accused product includes a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot, *e.g.*, a plenum is illustrated by the "blue" area of the tank, where cold returns from the dry cooler to the "bottom channel" via the primary and secondary manifolds, and is further identified by the speaker in the video at 1:00 to 1:11 - "… a plate that separates the bottom channel from the top channel, and then forces the fluid back up through the miners …"

Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:00 – 1:11; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8

<table>
<tr>
<td>a control facility adapted to coordinate the operation of the primary fluid circulation facility as a function of the temperature of the dielectric fluid in the tank.</td>
<td>

How much does a full immersion system cost?

- A full immersion system designed for Antminer S9 machines is going to run roughly $200 - $300 per miner. That said, the cost may vary significantly depending on your specific configuration, as plumbing and other component or material needs will likely differ on a case by case basis. While our systems are modular and usually consist of the same general layout, each miner's facility is different, and those variances are taken into consideration during our preparation of the estimate.
- For example, if your mine consisted of all Whatsminer M10 machines (55 TH @ 3600 watts), the price per miner would increase, as they produce 3x the BTU's when compared to an S9. As such, that setup would have greater cooling requirements and may require additional cooling capacity. This would result in the need for the system to be designed with a lower miner-to-dry cooler ratio so that the heat dissipation requirements can be met.

General Information

What all is included in your immersion system?

- **Our standard setup includes:**
  - Immersion Tanks
  - Dry coolers
  - BitCool BC-888 dielectric fluid
  - Pumps
  - Filter system
  - Associated plumbing
  - BitCool BC-888 dielectric fluid
  - Filter system
  - Associated plumbing
  - Automated controller for monitoring & controlling pumps, dry coolers, temperature, pressure, etc.
  - Standard pallet rack system for housing the tanks

The accused product includes a control facility adapted to coordinate the operation of the primary fluid circulation facility as a function of the temperature of the dielectric fluid in the tank, *e.g.*, the "standard setup includes … **[a]utomated controller** for monitoring and **controlling** pumps, dry coolers, **temperature**, pressure, etc."

Source: https: Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 2-3

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</table>

EXHIBIT D

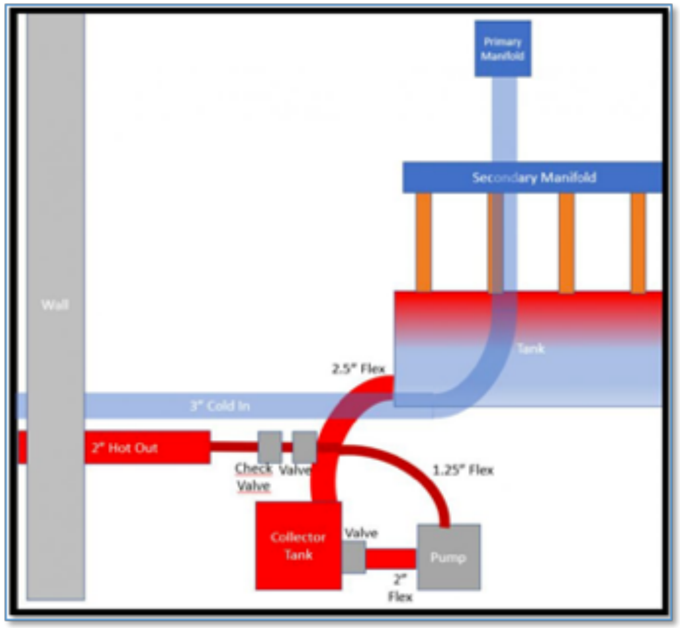
UNITED STATES PATENT NO. 10,405,457

PRELIMINARY CLAIM CHART FOR INFRINGEMENT OF REPRESENTATIVE INDEPENDENT CLAIM 11

Note: This representative claim chart is provided solely for pleading purposes in this action and is based upon information known at this time. This chart does not represent Plaintiff's infringement contentions, the asserted claims, or all of Plaintiff's allegations regarding infringement. Plaintiff further reserves the right to assert additional or different theories of infringement, including infringement under the doctrine of equivalents.

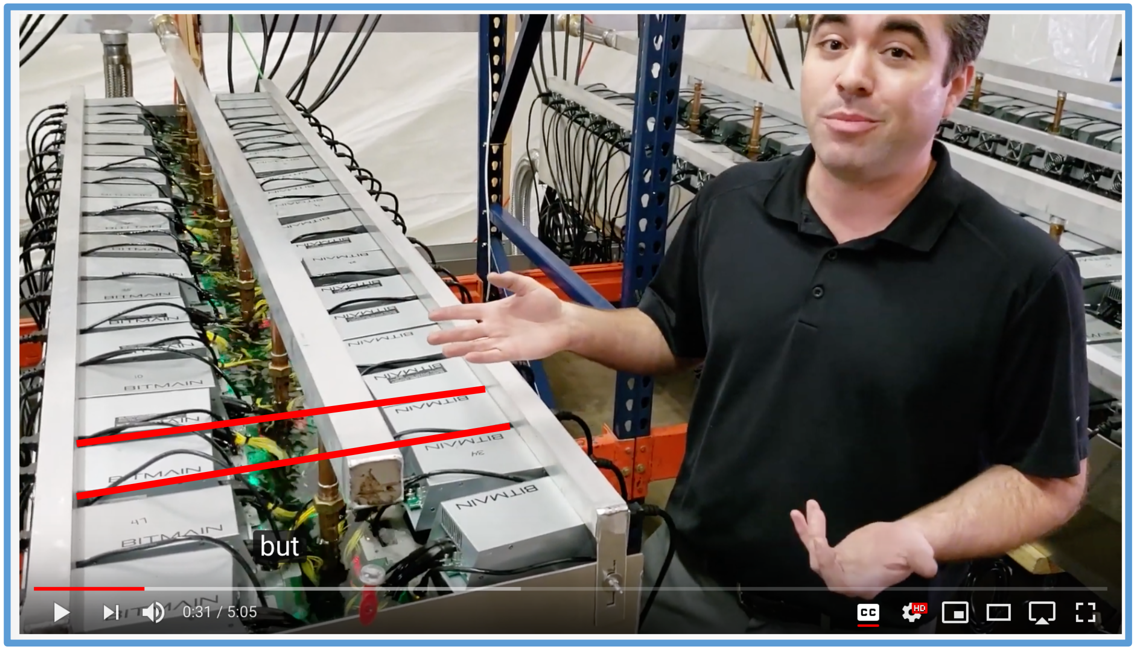
Infringement analysis provided for any preamble should not be construed as an admission that such preamble is limiting.

Claim	Immersion's Immersion System as represented at https://immersionsystems.io/media/
11. A tank module (10) adapted for use in an appliance immersion cooling system, the tank module comprising:	The accused product includes a tank module adapted for use in an appliance immersion cooling system, *e.g.*, illustrated here in Immersions FAQ documentation and in Immersion's video demonstrating the Immersion cooling system. 



Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:21;Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8

a tank (12) adapted to immerse in a dielectric fluid a plurality of electrical appliances (16),	 **General Information** **What all is included in your immersion system?** • **Our standard setup includes:** ○ Immersion Tanks ○ Dry coolers ○ BitCool BC-888 dielectric fluid ○ Pumps ○ Filter system ○ Associated plumbing ○ BitCool BC-888 dielectric fluid ○ Filter system ○ Associated plumbing ○ Automated controller for monitoring & controlling pumps, dry coolers, temperature, pressure, etc. ○ Standard pallet rack system for housing the tanks The accused product includes a tank that is adpated to immerse in a dielectric fluid, *e.g.*, "BitCool BC-888 dielectric fluid", a plurality of electrical appliances, *e.g.*, the speaker's description of the immersion cooling system as "our flagship model" and a "42 miner tank" at 0:44 of video. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:31; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 3*

each in a respective appliance slot (18) distributed vertically along, and extending transverse to, a long wall of the tank (10)	 The accused product includes appliance slots, *e.g.*, each bit miner is shown in a resepective slot, each of those slots being distributed vertically along, *e.g.*, the bit miner appliance slot is distributed vertically down into the tank, and extending traverse to the long wall of the tank. *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 0:31;*

<table>
<tr>
<td>the tank (10) comprising:
a weir 22, integrated horizontally into the long wall of the tank (10) adjacent all appliance slots (18), adapted to facilitate substantially uniform recovery of the dielectric fluid flowing through each appliance slot (18);</td>
<td>

The accused product includes a weir, integrated into the long wall of the tank adjacent all appliance slots, e.g., the horizontal line of holes just below the top long edge of the tank, having an overflow lip adapted to facilitate substantially uniform recovery of the dielectric fluid flowing throug each appliance slot, e.g., the level of the fluid in the tank of the accused product is level with the holes, facilitating a laminar flow of the dielectric fluid over the lip created by the weir holes, the weir holes being distributed equidistantly along the length of the long wall of the tank of the accused product, thus facitliating substantially uniform recovery of the fluid in the tank. The dielectric fluid is then shown descending vertically into the recovery tank of the accused product.

Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:40</td>
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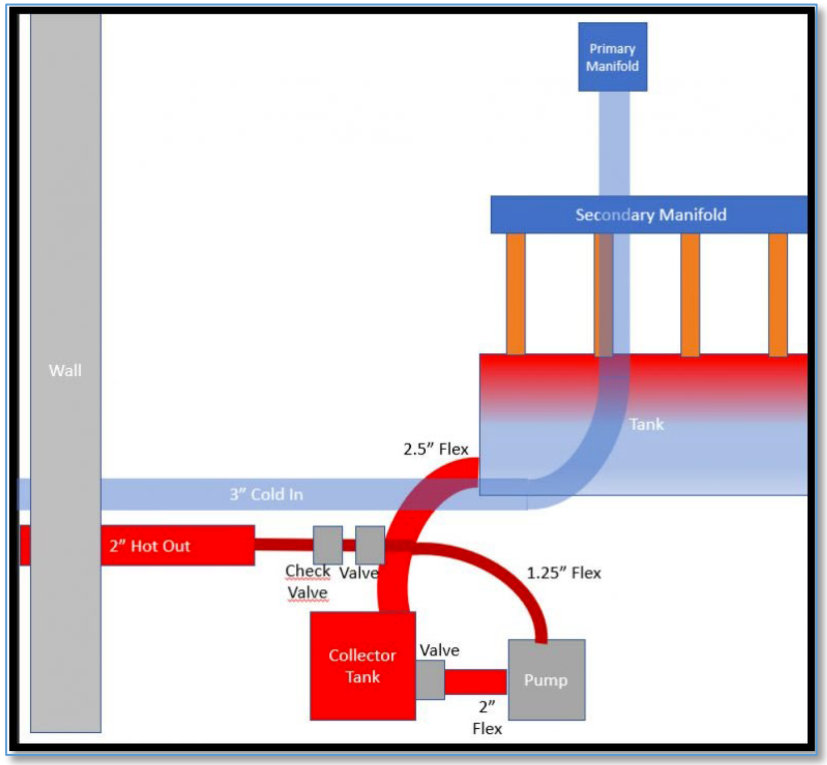
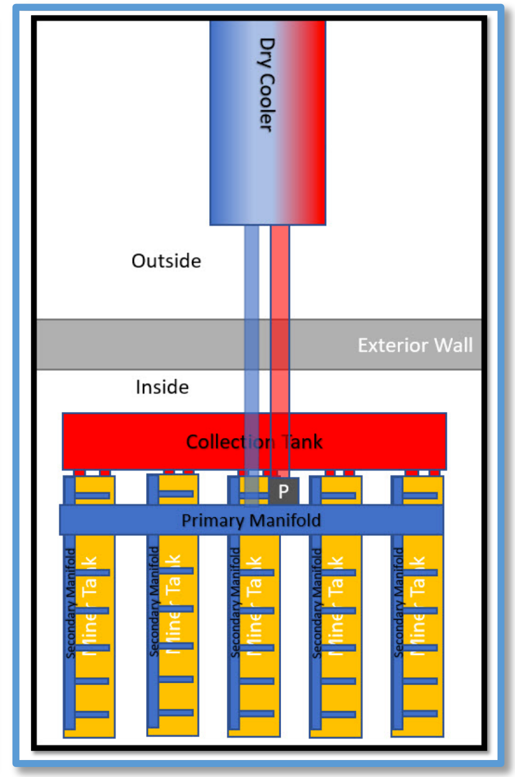
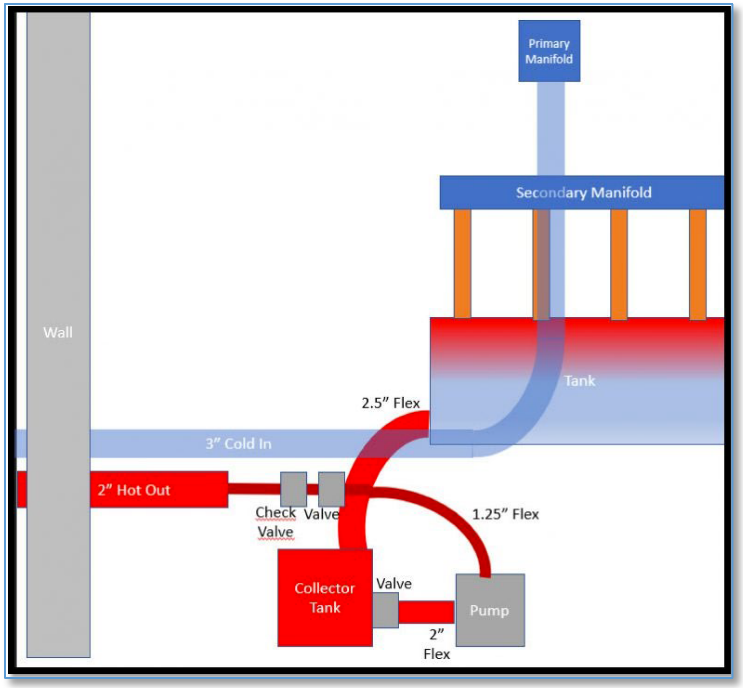
<table>
<tr>
<td>a primary circulation facility (28) adapted to circulate the dielectric fluid through the tank (10),</td>
<td>




The accused product includes a primary circulation facility adapted to circulate the dielectric fluid through the tank, *e.g.*, the pump sends the hot dielectric fluid out to the exterior dry cooler (here illustrated as 2" Hot Out), cooled dielectric fluid returns to the tank, enters the Primary Manifold, then the Secondary Manifold, the enters the bottom of the tank, and moving up through the tank to the previously illustrated weir, into the recovery reservoir, out to the collection tank, and back to the pump.

Source: https: Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8-9
</td>
</tr>
</table>

comprising: a plenum (36), positioned adjacent the bottom of the tank (10), adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot (18); and	 The accused product includes a plenum, positioned adjacent the bottom of the tank, adapted to dispense the dielectric fluid substantially uniformly upwardly through each appliance slot, *e.g.*, a plenum is illustrated by the "blue" area of the tank, where cold returns from the dry cooler to the "bottom channel" via the primary and secondary manifolds, and is further identified by the speaker in the video at 1:00 to 1:11 - "… a plate that separates the bottom channel from the top channel, and then forces the fluid back up through the miners …" *Source: https: Immersion Systems Video //www.youtube.com/watch?v=kQ6cycss5ds, at 1:00 – 1:11; Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 8*

a control facility (58) adapted to control the operation of the primary fluid circulation facility (28) as a function of the temperature of the dielectric fluid in the tank (10).

How much does a full immersion system cost?

- A full immersion system designed for Antminer S9 machines is going to run roughly $200 - $300 per miner. That said, the cost may vary significantly depending on your specific configuration, as plumbing and other component or material needs will likely differ on a case by case basis. While our systems are modular and usually consist of the same general layout, each miner's facility is different, and those variances are taken into consideration during our preparation of the estimate.
- For example, if your mine consisted of all Whatsminer M10 machines (55 TH @ 3600 watts), the price per miner would increase, as they produce 3x the BTU's when compared to an S9. As such, that setup would have greater cooling requirements and may require additional cooling capacity. This would result in the need for the system to be designed with a lower miner-to-dry cooler ratio so that the heat dissipation requirements can be met.

General Information

What all is included in your immersion system?

- **Our standard setup includes:**
  - Immersion Tanks
  - Dry coolers
  - BitCool BC-888 dielectric fluid
  - Pumps
  - Filter system
  - Associated plumbing
  - BitCool BC-888 dielectric fluid
  - Filter system
  - Associated plumbing
  - Automated controller for monitoring & controlling pumps, dry coolers, temperature, pressure, etc.
  - Standard pallet rack system for housing the tanks

The accused product includes a control facility adapted to coordinate the operation of the primary fluid circulation facility as a function of the temperature of the dielectric fluid in the tank, *e.g.*, the "standard setup includes … **[a]utomated controller** for monitoring and **controlling** pumps, dry coolers, **temperature**, pressure, etc."

Source: https: Immersion Systems Frequently Asked Questions https://immersionsystems.io/wp-content/uploads/2019/11/Immersion-FAQ-1.pdf, p. 2-3