

SERVER COOLING SYSTEM

Field of the Invention

- 5 The invention relates to computer servers and, in particular, the management of heat generated by said servers. In particular, the invention relates to a system for cooling said servers.

Background

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- The requirement for computer servers to remain cool during operation necessitates large extensive cooling systems in the form of temperature controlled rooms having air-conditioning set at the desired temperature which may be on the basis of a 24-hour per day 7 days per week operating time. Apart from the large energy load of maintaining
- 15 said rooms they are, nevertheless, subject to power failure with the problems associated with maintaining residual temperature during said outages. Further, having dedicated server rooms with air-conditioning requires a large footprint and the corresponding capital infrastructure costs for such a system. Further still such cooling systems are not scalable with building design being of paramount concern which potentially limits the
- 20 capacity of the facility or conversely being substantially underutilized and so having an unnecessarily high capital expenditure.

Summary of Invention

In a first aspect the invention provides a server cooling system comprising: an immersion tank for receiving a cooling fluid; a lid in sealing engagement with the
5 immersion tank; brackets fixed to internal surfaces of the immersion tank, said brackets arranged to couple with releasably engageable jigs; wherein each of said jigs is arranged to engage with a computer server so as to immerse said servers in said cooling fluid.

Accordingly, the server cooling system according to the present invention is both
10 scalable and having a small footprint whilst achieving the desired result. The present invention, by providing a self-contained unit, does not impact building design nor require air-conditioning and so avoids the problems inherent with the prior art systems.

The sealing lid, and liquid tightness of the tank may provide a complete air tight
15 enclosure preventing moisture to escape and adding to the efficiency which affects the cooling liquid surrounding the servers.

In one embodiment, sealing may be provided by a single or double o-ring seal with a stainless steel enclosure. This may also be achieved by using plastic, including PVC.
20 HDPE etc. The ability to minimise the loss of moisture may be useful where an expensive cooling liquid is used. The various recycling embodiments, such as recirculating system, overflow tank and condensing unit may all separately or together work towards preserving as much of the cooling liquid as possible.

In a further embodiment, an arrangement of prisms may be placed adjacent to the led lighting on the server, so as to refract the light to a position to be observable from the lid.

- 5 The lid may include a transparent panel to facilitate the observation of these lights without unnecessarily breaking the seal through opening the lid.

- In another embodiment, a separate radiator unit may be placed outside of the server
10 computer room which either centrally services either a single or multiple units at one time.

- This may be achieved by the liquid going through the condenser and then through the chiller which cools the liquid down and then back into the condenser. This looks like
15 long tubes or pipes that run from the unit self to an outside area where it then goes into a small or large stainless steel box that contains the radiator and several fans. This depends on the condenser size and the capacity which has to be cooled down. Number of fan's can vary from 2 to e.g.12 or even 24, which push the air through radiator.

- 20 Alternatively, the replenishment of the cooling liquid to the tank may pass through the condensing unit, either before entering the tank, or on the path to the cooling liquid supply subject to the temperature of the exiting cooling liquid, so as to facilitate condensing the vapour and also avoiding having a separate parallel cooling system.

The server cooling system may further include a control system, in communication with any one or a combination of cooling liquid temperature sensors, liquid level sensors, electricity usage, humidity etc., to control the pump motor(s) and valves.

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The server cooling system may also include a filter unit which is placed inside the overflow tank below the overflow holes so that the liquid is cleaned first before being pumped back into the process cell. This may be achieved by bending a metal tray and adding a carbon filter and filter matt inside the overflow tank.

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Brief Description of Drawings

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other
15 arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figures 1A and 1B are various views of a server cooling system according to one
20 embodiment of the present invention;

Figure 2 is an isometric view of a jig used in a server cooling system according to further embodiment of the present invention;

Figure 3 is an elevation cross-sectional view of a server cooling system according to further embodiment of the present invention;

- 5 Figure 4 is an isometric view of a condensing unit according to further embodiment of the present invention;

Figure 5 is an elevation view of a jig removal unit according to further embodiment of the present invention;

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Figure 6 is an elevation view of a jig removal unit according to a still further embodiment of the present invention;

- Figure 7 is an elevation view of a cable cooling system according to a further
15 embodiment of the present invention, and;

Figures 8A and 8B are various views of a server cooling system according to a still further embodiment.

20 **Detailed Description**

Figures 1A and 1B show the server cooling system 5 according to one embodiment of the present invention. The server cooling system 5 comprises an immersion tank 10

- having a sealable lid 15 placed thereon. In this embodiment the lid 15 includes a transparent window 30 to view the inside of the immersion tank 10 without having to break the seal. The server cooling system 5 includes a condenser unit 35 which in this embodiment is located within the lid 15 and acts to condense vapour from the
- 5 immersion tank 10 so as to condense and recycle the cooling liquid. In a further embodiment, the condenser may be placed as close as possible to the liquid cooling level (e.g. max 100mm), with the space between condenser and lid at a minimum distance (e.g. 100mm).
- 10 The server cooling system 5 further includes an overflow immersion tank 25 whereby, on receiving an excess of liquid, said excess liquid flows through the overflow drain 65 into the overflow immersion tank 25. The overflow immersion tank 25 further includes a pumping system 62 which in this case is a primary and secondary pumping system which also includes level sensors to control liquid levels in the overflow tank. The
- 15 pumping system 62 may include one or two pumps placed on a lower storage compartment below the overflow liquid cooling area so as to pump the liquid into the immersion tank 10.

The purpose of the server cooling system 5 is to provide a cooling environment for

20 server 50 placed within the immersion tank. The server 50 is secured within jigs 45 which are selectively removable from the immersion tank through a releasable engagement 40 mounted to a bracket (not shown) within the immersion tank.

A further feature of the present invention includes a cable feed tube 60 within the overflow immersion tank 25 which provides access into the immersion tank through aperture 61 for cabling used for pumps, the computer servers or other ancillary systems. The cable feed tube 60 then channels the cables from the aperture 61 to the outlet 63 placed above the highest liquid level within the overflow immersion tank 25 so as to position the cables away from the immersion tank. The cable feed tube allows for the power cords and cables to be separately replaced, if required, within the system and may be positioned so as to be in the most efficient location for all systems making use of the feed tube.

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Figure 2 shows a jig 45 to be used in the server cooling system. The jig includes lifting brackets 70 used to engage with a lifting device to remove the jig and therefore the server from the immersion tank. The jig further includes engagement lugs 75 for engaging with the brackets within the immersion tank so as to secure the jig, and therefore the server, firmly in place. The jig may include lugs 75 at both the top (as shown) and at the bottom (not shown) of the jig to provide multiple point engagement with the bracket.

The server engages with engagement points such as bolt holes or slots 80 and supported by plates 82 within the jig so as to fix the server securely. The slots 80 may receive quick release pins located on the server. Alternatively, the slots may be used to screw or bolt the server to the jig. The slots may also be used for mounting the motherboards only, instead of mounting the complete server with casing

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The jig includes a void 85 and recess 90 in the base to accommodate cables for powering the server, the cables may feed through the jig so as to conveniently keep the cables from tangling or restricting removal of the jig. In those embodiments whereby
5 the server cooling system includes a cable feed tube, as shown in Figure 1A, the cables may pass through the void 85 and recess 90 so as to feed into the aperture 61 and subsequently through the tube and out the exit 63. In this way the cables are kept from interfering with the operation of the server cooling system.

10 Whilst a fixed frame jig is sufficient to have a server mounted thereto and still fall within the scope of the present invention, Figure 2 shows a further embodiment of the jig being a multi-sized server jig. The jig as shown in Figure 2 may be used for different server types/brands. Each size of server (1U, 2U, 3U, 4U) may have a jig purpose built for that particular server. Alternatively, as shown in Figure 2, by allowing
15 different connections through the slots, one jig may be of sufficient capacity to couple with a range of different servers and thus making the jig more multi-purposed. The multi-purpose jig may include brackets which are detachable and re-attachable so as to accommodate servers having different connection points and thus being of a more flexible design to cover a wider variety of servers.

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Figure 3 is an elevation cross-sectional view of the immersion tank according to a further embodiment of the present invention.

Here a server 50 is engaged with a jig 45 which in turn is mounted to the bracket 95 through lugs 75. Where the embodiment of Figure 3 varies is through the use of an extendable cable guide 100 whereby cables from the server 50 are fed into the cable guide aperture 105 and through the guide 100 to exit from the aperture 110. The
5 aperture 110 may align with or be proximate to the aperture 61 of the cable feed tube 60. The extendable cable guide 100 is arranged in a loop arrangement such that on removal of the jig 45 the cable guide 100 is of sufficient length to unfurl and extend out of the immersion tank without placing stress on the cable. Accordingly the cable tube 100 is arranged to follow the jig on removal such that the cable can be easily disengaged once
10 the jig is removed from the immersion tank.

Figure 4 shows a condensing unit 35 used to condense vapour from the cooling liquid. The condensing unit 35 is arranged to receive a cooling medium through an entry tapping 120, with the medium circulated about the loops within the condensing unit 35
15 and subsequently removed through exit tapping 115. Thus the condensing unit provides convective heat transfer to condense the cooling liquid vapor so as to allow it to be recycled to the sealed immersion tank preventing loss of the valuable liquid.

As mentioned, a feature of the jigs within the server cooling system is the ability for the
20 jigs to be removed so as to remove the servers from the cooling liquid. A jig removal system 125 is shown in Figure 5 whereby an arm 130 has attachments 135 extending downwards to engage with the jig. The attachments may be cables operated by a crank 145 so as to lower into the immersion tank, engage the relevant jig and lift the jig from

the immersion tank. The jig removal system includes a base 150 on rollers 155 so that it can be rolled into place, engage the jig and subsequently remove it. In order to balance the load applied to the removal systems counter weights 140 may also be provided to accommodate the weight of the jig and server.

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Figure 6 shows as alternative jig removal system 160. This includes a support frame 165 which allows for an arm 170 having grips 180 projecting therefrom. The grips 180 are movable relative to each other along the arm 170 so as to be sufficiently adjustable to engage a variety of jig. The movable feature may also assist in the engagement process as the grips 180 may also engage the engagement brackets in a pincer type movement 70. The engagement brackets 70 are engaged by the grips 180 whereby projections connect with the brackets 70 to securely fix the jig to the jig removal system. The arm 170 is then movable vertically along the frame 165 by a movable connection 175 and thus the jig can be lifted and lowered via the arm 170 moving vertically along the frame 165. The frame 165 and connection 175 may also provide for horizontal movement such that the jig on being lifted out of the immersion tank may then move horizontally to a position away from the immersion tank so as to remove or otherwise service the server.

20 The frame 165 may further have a jig engagement assembly 195 mounted 200 to the frame. This may allow the arm and grips to move the jig from the immersion tank and then place it in engagement with the assembly 195 whereby the server may be serviced

or removed. This allows for the arm 170 to then engage or otherwise be used on a different jig 45.

Figure 7 shows a cable cooling system 210 according to the present invention. The
5 cable cooling system includes a cooling coil 215 wrapped around cables 205 whereby a cooling medium is flowed into the coil 220 and recycled 225 so as to provide convective heat transfer to the cables.

The cables on exiting the immersion tank may be at approximately 50°C which on
10 entering the atmosphere may produce water vapor which is subsequently condensed on cooling, creating a flow of condensation through the cable, damaging equipment. Accordingly, the cable cooling system seeks to cool the cables on removal from the immersion tank by passing these through the coil 215 which may be metal and in particular metal having good heat transfer properties. The cooling medium passing
15 through the coils 215 may be water or other such cooling medium and further may be cool water, such as at 10°C. The intention is to sufficiently cool the cables to prevent condensation forming and so a target temperature of the cables leaving the coils 215 may be approximately 20°C or no more than room temperature.

20 Figures 8A and 8B show a server cooling system 235 according to a further embodiment of the present invention. Here, a plurality of jigs 240 are immersed within the cooling liquid 260 having extendable spring wire connections 245 to allow for power cords to be controlled and organized whilst the server is pulled in and out of the

tank. The extendable spring wire system resembles a spring like lever system or leaf spring on which the cables are placed that allow the cables to uniformly fall into the same position as the server is lifted and lowered. This is an alternative arrangement to the cable guide as described in Figure 3.

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In this embodiment the condenser unit 280 is located below the lid as compared to the lid mounted condenser unit shown in Figures 1A and 1B. Further, the tank includes an overflow aperture 275 to prevent overfilling of the cooling liquid 260.

10 Within the overflow tank is included the cable feed tube 265 having a cable cooling system similar to that described in Figure 7. The overflow tank further includes a primary 250 and a secondary 255 pump system to ensure recirculation of the cooling liquid to maintain the convective heat transfer to cool the servers 240.

15 A further feature of this embodiment is the drawer 285 which contains the cooling liquid 260 and jigs 240 to permit relative lateral movement 290 of the jigs and cooling liquid, providing for direct maintenance of the setup. Thus, whilst access is provided through the lid for the removal and placement of a jig, should maintenance be required for the entire unit, the drawer 285 allows for this to be removed and replaced without
20 disrupting the overall server cooling system.

CLAIMS

1. A server cooling system comprising:
 - an immersion tank for receiving a cooling fluid;
 - 5 a lid in sealing engagement with the immersion tank;
 - brackets fixed to internal surfaces of the immersion tank, said brackets arranged to couple with releasably engageable jigs;
 - wherein each of said jigs is arranged to engage with a computer server so as to immerse said servers in said cooling fluid; and
 - 10 an overflow immersion tank mounted to the immersion tank for receiving the cooling fluid exceeding a predetermined threshold within the immersion tank, said predetermined threshold determined by placement of an aperture connecting said immersion tank to said overflow immersion tank.
- 15 2. The server cooling system according to claim 1, wherein said predetermined threshold determined by placement of an aperture connecting said tank to said overflow tank.
- 20 3. The server cooling system according to claim 1 or 2, further including a cooling liquid recirculation system comprising at least one pump in fluid communication with a supply of said cooling fluid and the immersion tank said liquid recirculation system arranged to pump the cooling liquid into the immersion tank and remove liquid therefrom.

4. The server cooling system according to claim 3, wherein the cooling fluid supply includes the overflow tank.
5. The server cooling system according to any one of claims 1 to 4, further
5 including cable feed tube mounted to an external wall of the immersion tank, said cable feed tube having an aperture to receive cables from servers within the immersion tank and an outlet arranged to position said cables away from the immersion tank.
- 10 6. The server cooling system according to claim 5, wherein the cable feed tube is mounted to a wall separating the immersion tank and the overflow tank, said outlet positioned above a maximum liquid level in the overflow tank.
- 15 7. The server cooling system according to any one of claims 1 to 6, further including an extendable cable guide positioned within the immersion tank and arranged to receive cables from said servers, said extendable cable guide arranged to unfurl as a server is lifted from the immersion tank.
- 20 8. The server cooling system according to any one of claims 1 to 7, wherein the jig includes a plurality engagement points arranged to engage with a plurality of different server types.
9. The server cooling system according to any one of claims 1 to 8, further including a condensing unit located within the immersion tank and adjacent to a

top of said immersion tank, said condensing unit arranged to condense cooling liquid vapour within the immersion tank.

10. The server cooling system according to claim 9, wherein the condensing unit is
5 mounted to the lid of the immersion tank.

11. The server cooling system according to any one of claims 1 to 10, further including a jig removal unit for engaging and lifting said jig from the immersion tank.