Summary of the Invention

[0009] In some embodiments, the purpose of the present invention is to provide an apparatus for hot swapping electronic or electrical equipment or devices from an immersion cooling tank containing a boiling heat transfer fluid that reduces the loss of heat transfer fluid vapor into the environment.

[0010] In some applications, some or all of the heat transfer fluid vapor produced inside an immersion cooling tank may be removed by a main condenser running coolant at a temperature proximate or similar to room temperature. In other applications, some or all of the heat transfer fluid vapor produced inside an immersion cooling tank may be transported away actively or passively to a heat exchanger system separated from the immersion cooling tank, such that there is no main condenser inside.

[0011] In a first aspect, the present invention relates to a device for hot swapping ~~one or more~~at least one electronic device~~s~~ from an immersion cooling tank having a first opening. ~~In some embodiments, t~~The device includes a condensing device, removably locatable in the first opening of the immersion cooling tank, the condensing device having a condensing coil forming a second opening through which the at least one electronic device~~(s)~~ is removable; and an apparatus (e.g., a crane) coupled to the condensing device for selectively adjusting at least one of a height and~~/or~~ a location of the condensing device about the first opening of the immersion cooling tank. In some implementations, the condensing device may further include an outer rim portion connected to a topmost portion of the condensing coil. In some applications, an outer peripheral surface of the condensing coil may be adapted to fit within an inner peripheral surface of the immersion cooling tank. Alternatively, in another application, one or more of the outer peripheral dimensions of the outer rim portion of the condensing device may be larger than one or more of the inner peripheral dimensions of the immersion cooling tank.

[0012] In some applications, the crane may include a lifting arm for adjusting the height of the condensing device, a movable platform operatively coupled to the lifting arm for adjusting the location of the condensing device, and a plurality of casters operatively coupled to a bottom portion of the movable platform for positioning the movable platform. In some variations, the crane may be integrated into a movable device such as a self-powered device, an externally powered device, a forklift, and a truck.

[0013] In some embodiments, the device may also include one or more of: a coolant container in fluid communication with the condensing device, a chiller pump for circulating a coolant fluid from the coolant container to the condensing device, an item lock selectively attachable to the electronic device(s), and an apparatus for adjusting a height of the item lock, e.g., a pulley system. In some implementations, the pulley system may include a plurality of sheaves, a winch (e.g., a hand-operated winch or a motor-driven winch), and a hoist wire disposed through sheaves and having a proximal end operatively attached to the winch and a distal end operatively attached to the item lock. Alternatively, the apparatus for adjusting the height of the item lock may include a chain hoist/forklift assembly or a belt-drive/forklift assembly. In some implementations, the chain hoist/forklift assembly may include a number of gear-wheels operatively coupled to a winch and about which a roller chain, to which a mounting bracket may be coupled, may revolve.

[0014] In a second aspect, the present invention relates to a method of hot swapping ~~one or more~~at least one electronic device~~s~~ from an immersion cooling tank having a first opening. ~~In some embodiments, t~~The method ~~may~~ include~~s~~ providing a condensing device having a condensing coil forming a second opening, providing an apparatus coupled to the condensing device, using the apparatus to selectively adjust~~ing~~ a height and a location of the condensing device about the first opening of the immersion cooling tank, inserting an item lock into the immersion cooling tank through the second opening, and removing, with the item lock, the at least one electronic device~~(s)~~ from the immersion cooling tank via the second opening. In some variations, the second opening is smaller than the first opening.

[0015] In some implementations, selectively adjusting the height and the location of the condensing device may include using a crane and inserting the item lock may include using a pulley system to at least one of raise and lower the item lock.

[0016] ~~In a third aspect, the present invention relates to~~ There is also disclosed a condensing device for use in hot swapping one or more electronic devices from an immersion cooling tank having a first opening, In some embodiments, the condensing device includes a condensing coil (e.g., a layered coil, such that at an upper coil is located atop a lower coil) forming a second opening through which the electronic device(s) is removable. In some implementations, the condensing device may include an outer rim portion connected to a topmost portion of the condensing coil. Moreover, in

CLAIMS

1. A device for hot swapping at least one electronic device from an immersion cooling tank having a first opening, the device comprising:

a condensing device, removably locatable in the first opening of the immersion cooling tank, the condensing device comprising a condensing coil forming a second opening through which the at least one electronic device is removable; and

an apparatus coupled to the condensing device for selectively adjusting at least one of a height and a location of the condensing device about the first opening of the immersion cooling tank.

2. The device of claim 1, wherein the condensing device further comprises an outer rim portion connected to the condensing coil.

3. The device of claim 1, wherein the apparatus comprises a crane.

4. The device of claim 3, wherein the crane comprises:

a lifting arm for adjusting the height of the condensing device;

a movable platform operatively coupled to the lifting arm for adjusting the location of the condensing device; and

a plurality of casters operatively coupled to a bottom portion of the movable platform for positioning the movable platform.

5. The device of claim 3, wherein the crane is integrated into a movable device selected from the group consisting of a self-powered device, an externally powered device, a forklift, and a truck.

6. The device of claim 1 further comprising:

a coolant container in fluid communication with the condensing device; and

a chiller pump for circulating a coolant fluid from the coolant container to the condensing device.

7. The device of claim 1 further comprising an item lock selectively attachable to the electronic device.

8. The device of claim 7 further comprising an apparatus for adjusting a height of the item lock.

9. The device of claim 8, wherein the apparatus for adjusting the height of the item lock comprises a pulley system.

10. The device of claim 9, wherein the pulley system comprises:

a plurality of sheaves;

a winch; and

a hoist wire disposed through the plurality of sheaves and having a proximal end operatively attached to the winch and a distal end operatively attached to the item lock.

11. The device of claim 10, wherein the winch is at least one of a hand-operated winch and a motor-driven winch.

12. The device of claim 8, wherein the apparatus for adjusting the height of the item lock comprises at least one of a chain hoist/forklift assembly or a belt-drive/forklift assembly.

13. The device of claim 12, wherein the chain hoist/forklift assembly comprises:

a plurality of gear-wheels;

a winch operatively coupled to at least one of the gear-wheels;

a roller chain disposed about the gear-wheels; and

a mounting bracket operatively coupled to the roller chain.

14. The device of claim ~~1~~7, wherein the item lock ~~further~~ comprises a vibration motor.

15. The device of claim ~~1~~8, wherein the ~~device~~ apparatus for adjusting the height of the item lock is selected from the group consisting of ~~comprises at least one of~~ a gantry-type overhead crane, a monorail-type overhead crane, and a bridge-type overhead crane.

16. The device of claim ~~1~~8, wherein the ~~device~~ apparatus for adjusting the height of the item lock comprises an angled extension rod.

17. The device of claim 16, wherein the angled extension rod is operatively coupled to a lifting tower.

18. The device of claim 17, wherein the lifting tower is at least one of secured to the immersion cooling tank and selectively movable along the immersion cooling tank.

19. The device of claim 1, wherein an outer peripheral surface of the condensing coil is adapted to fit within an inner peripheral surface of the immersion cooling tank.

20. The device of claim 2, wherein at least one outer peripheral dimension of the outer rim portion is larger than at least one inner peripheral dimension of the immersion cooling tank.

21. The device of claim 1, wherein the condensing device comprises an adjustable condensing device having a selectively variable second opening.

22. The device of claim 1 further comprising a cover for the first opening of the immersion cooling tank.

23. The device of claim 22, wherein the cover comprises a sheet with at least one of fixed or variable opening dimensions.

24. A method of hot swapping at least one electronic device from an immersion cooling tank having a first opening, the method comprising:

providing a condensing device comprising a condensing coil forming a second opening;

providing an apparatus coupled to the condensing device;

using the apparatus to selectively adjust~~ing~~ a height and a location of the condensing device about the first opening of the immersion cooling tank;

inserting an item lock into the immersion cooling tank through the second opening; and

removing, with the item lock, the at least one electronic device from the immersion cooling tank via the second opening.

25. The method of claim ~~25~~24, wherein ~~selectively adjusting the height and the location of the condensing device comprises using~~the apparatus comprises a crane.

26. The method of claim ~~25~~24, wherein inserting the item lock comprises using a pulley system to at least one of raise and lower the item lock.

27. The method of claim ~~25~~24, wherein the second opening is smaller than the first opening.

~~28. A condensing device for use in hot swapping at least one electronic device from an immersion cooling tank having a first opening, the condensing device comprising a~~

~~condensing coil forming a second opening through which the at least one electronic device is removable.~~

~~29. The condensing device of claim 28 further comprising an outer rim portion connected to the condensing coil.~~

~~30. The condensing device of claim 29, wherein at least one outer peripheral dimension of the outer rim portion is larger than at least one inner peripheral dimension of the immersion cooling tank.~~