United States Patent [19]

Grandia

[11] **3,818,983**

[45] **June 25, 1974**

[54] **COOLED ENCLOSURE**

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[22] Filed: **Sept. 18, 1972**

[21] Appl. No.: **290,028**

[52] **U.S. Cl.** ..... **165/105,** 317/100, 317/234 B

[51] **Int. Cl.** **F28d 15/00,** H01l 1/12

[58] **Field of Search** ..... 165/105, 47 T; 317/234 A, 317/234 B, 100; 336/58

[56] **References Cited**

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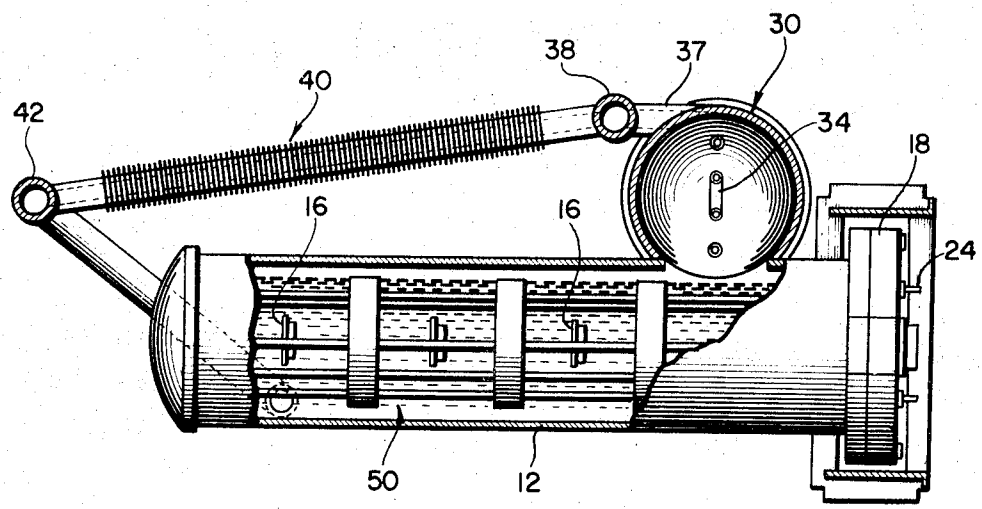
[57] **ABSTRACT**

A cooled enclosure for housing heat generating devices, particularly solid state elements such as SCRs, diodes and other components, including a first chamber in which the heat generating devices are immersed in a refrigerant which will vaporize and abstract heat from the devices. The refrigerant vapor is condensed in a second chamber in which a heat exchanger is disposed, said heat exchanger being supplied with a liquid coolant. The condensed refrigerant then returns to the first chamber and is added to the body of liquid refrigerant in said chamber. An important feature of the invention is an alternate, secondary flow path for the refrigerant vapor through a secondary heat exchanger which is preferably air cooled. Under conditions when the ambient air is effective to condense refrigerant without operation of the primary liquid cooled heat exchanger, the vapor is condensed in such secondary heat exchanger and returned to the refrigerant bath in the first chamber.

1 Claim, 3 Drawing Figures



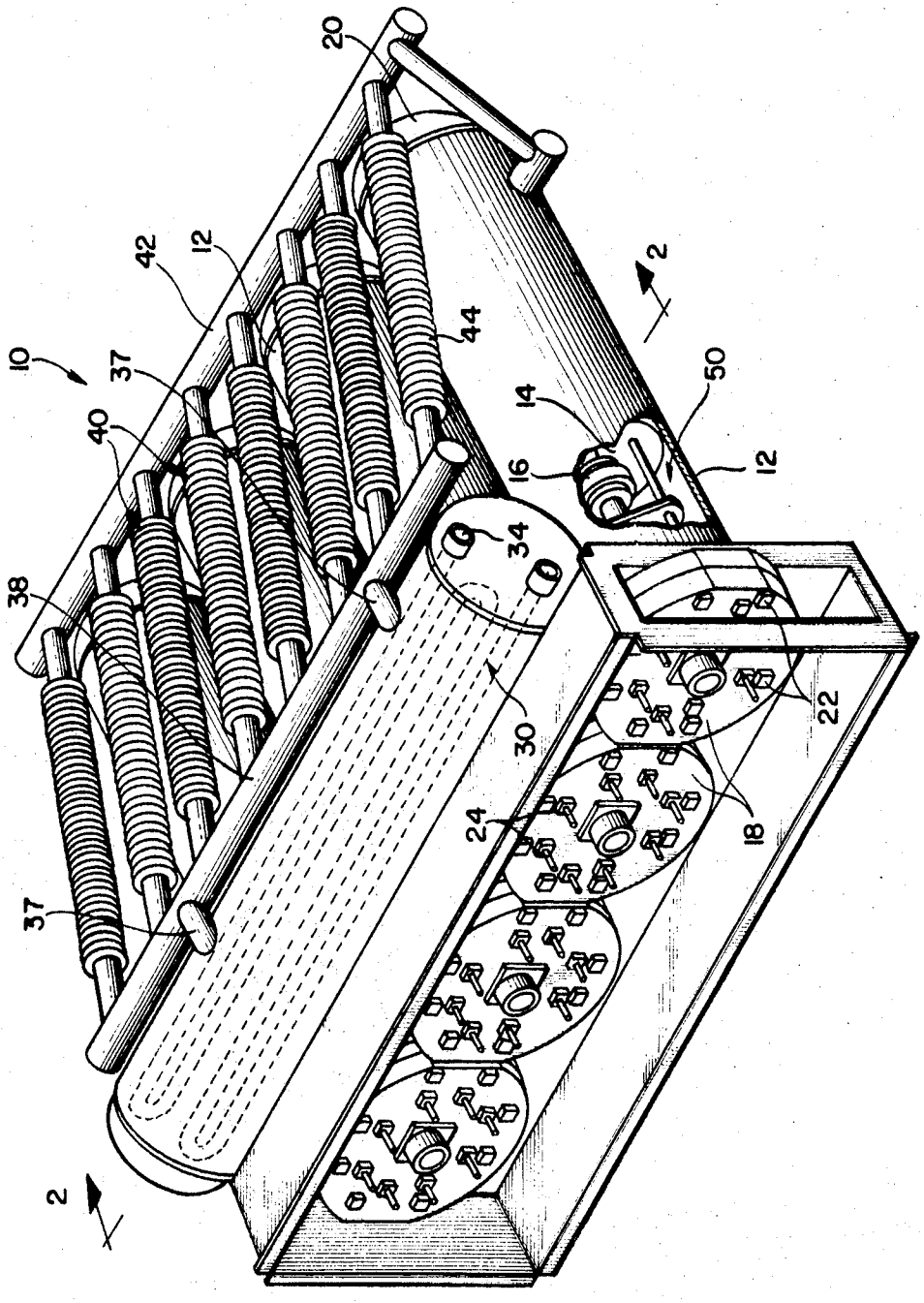


FIG. 1

FIG.2

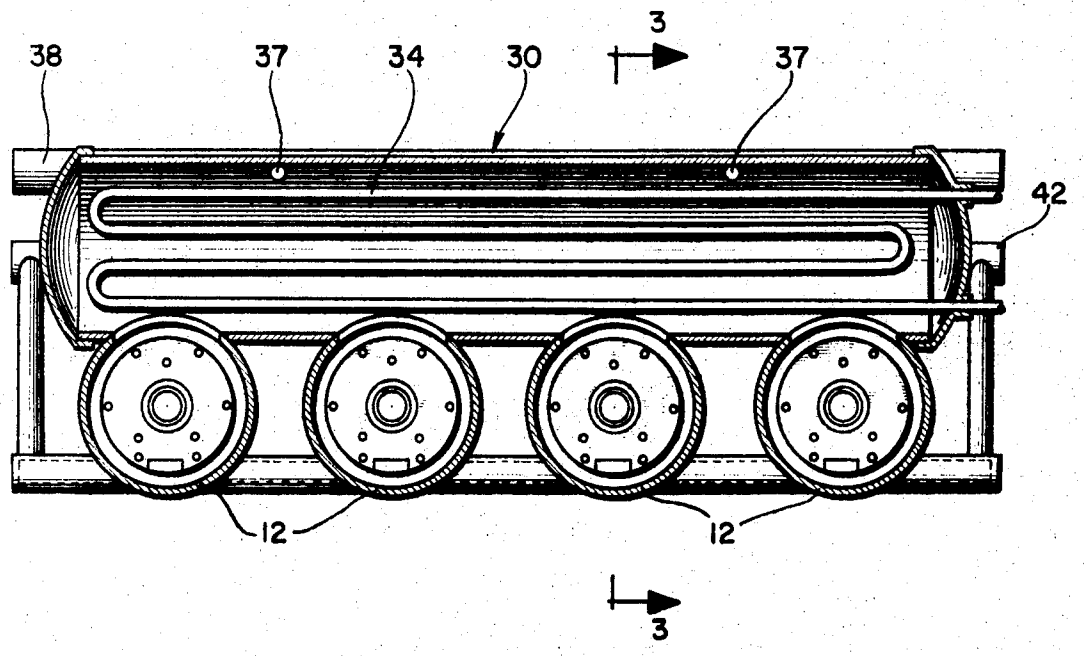
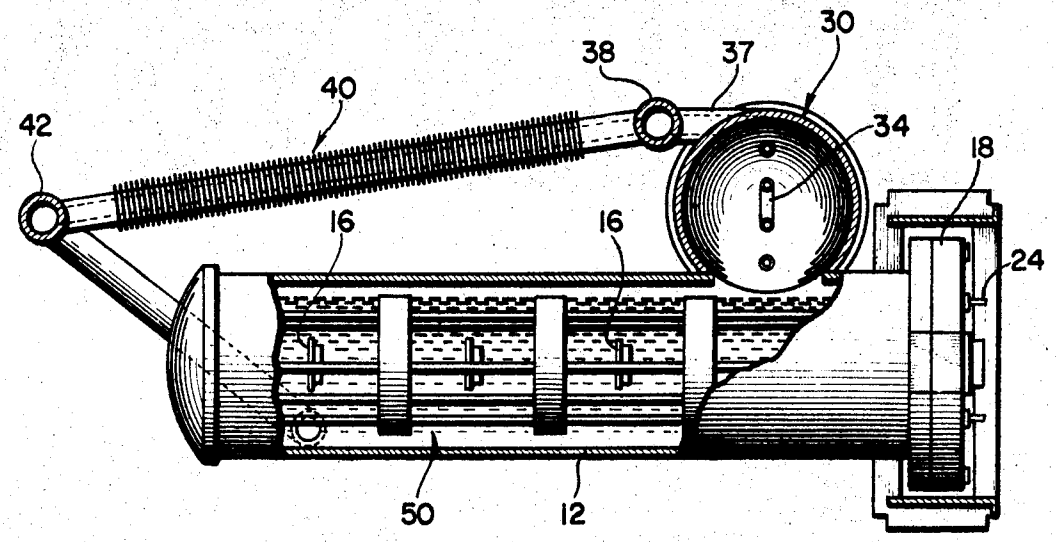


FIG.3



COOLED ENCLOSURE

BACKGROUND AND SUMMARY OF THE INVENTION

The use of solid state devices such as silicon controlled rectifiers and diodes has been increasing in large power applications. Such applications would include, for example, power inverters for converting DC electrical energy to AC energy and related motor controls which vary the frequency of the AC supplied to the motors and accordingly vary the speed thereof. Such applications are increasingly important in transportation equipment, particularly for driving air conditioning compressor motors for such equipment.

One particular troublesome problem is the dissipation of the heat generated by the aforementioned solid state components. The maintenance of these devices at constant, relatively low temperature is essential for the proper operation of the same. Not only do high temperatures adversely affect their performance, but even variations in temperature in the moderate range affect control and often result in erratic performance.

It is an important object of this invention to provide a cooled enclosure for housing semi-conductor devices and similar solid state components in a refrigerant cooled chamber. The devices are preferably completely immersed in a refrigerant which boils at a relatively low temperature and suitable means are provided for condensing the vaporized refrigerant and returning it to the main supply enveloping the heat generating devices. The industry has previously been reluctant to use any direct liquid cooled system because of the fear that contact with liquid would ruin the SCR's. However, I have discovered that the use of conventional halogenated hydrocarbon refrigerants such as R-12, R-22, R-114 etc. have no deleterious effect. These refrigerants are stable, non-corrosive and have a high dielectric coefficient, all such factors being required in the particular environment.

An important feature of the invention is the use of an alternate flow path for refrigerant vapor through a secondary, air cooled heat exchange system so that the primary heat exchanger can be discontinued when the ambient air is effective to condense the refrigerant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, with certain portions being broken away, of the improved enclosure forming the subject of the present invention;

FIG. 2 is a cross-sectional view taken generally along the plane of line 2—2 of FIG. 1; and

FIG. 3 is a cross-sectional view taken generally along the plane of line 3—3 of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. 1 there is shown a cooled enclosure 10 comprising a plurality of generally cylindrical shells 12 defining primary chambers 14 in which the solid state components 16 are disposed. Each shell is closed by cap members 18 and 20 at opposite ends thereof, the front cap member 18 being secured to the shell by means of fasteners 22. The electrical bus bar connections 24 also extend through the front cap to a source of electrical power and logic circuits (not shown) housed in casing 26.

Extending transversely across each of the shells 12 and in fluid communication therewith is a primary heat exchanger 30 including a shell 32 and a tube 34 arranged therein through which a cooled medium such as water or refrigerant is circulated. The openings between the primary heat exchanger 30 and the individual shells 12 are designated at 36 (FIG. 2). Connected by conduit 37 to the primary heat exchanger is a vapor collecting header 38. A plurality of secondary heat exchangers 40 interconnect header 38 with a second header 42 through the length of the assembly. Each of the heat exchangers 40 is preferably provided with a finned surface 44 or other means for promoting heat transfer between ambient air and vapor flowing through the tube. Condensate collecting header 42 is connected to the lower portion of the shells 12 by means of conduit 46 and condensate return pipe 48 which connects with each of the shells.

The solid state components 16 are submerged within a liquid refrigerant bath 50 maintained at any desired level. It has been found that such devices will operate very efficiently if they are completely submerged within the bath.

OPERATION

During normal operation, the primary heat exchanger 30 is supplied with a cooling medium which flows continuously through coil 34. As the solid state devices 16 are energized they liberate great quantities of heat which is passed through heat sinks into the body of liquid refrigerant 50. The refrigerant boils and flows into primary heat exchanger 30 where it condenses on the coil 34 and drops back as a liquid through communicating openings 36. Under some conditions, when atmospheric air is cool enough, the primary heat exchanger 30 may be discontinued. The air flowing over the surface of the secondary heat exchanger tubes 40 is effective to condense fluid which passes into header 38 and down through the tubes into the condensate receiving header 42. The liquid refrigerant then is collected in the header and transferred to the shells through conduits 46 and 48.

While the invention has been described in connection with a certain specific embodiment thereof, it is to be understood that this is by way of illustration and not by way of limitation; and the scope of the appended claims should be construed as broadly as the prior art will permit.

What is claimed is:

1. A cooled enclosure for housing heat generating devices comprising: a plurality of spaced, generally cylindrical shells defining primary chambers in which said heat generating devices are located; a primary heat exchanger extending traversely of said shells and communicating therewith through openings adjacent the top of each said shell, said heat exchanger including a coil through which a liquid coolant is adapted to be circulated; a vapor collecting header connected to said primary heat exchanger; a condensate collecting header; a plurality of air-cooled heat exchangers interconnecting said vapor collecting header and said condensate collecting header, said heat exchangers being provided with a heat transfer surface for promoting heat transfer between ambient air and vapor flowing through said heat exchangers; means for returning condensate from said collecting header to said shells; and a body of halogenated hydrocarbon refrigerant in said primary cham-

bers in contact with said heat generating devices whereby refrigerant vapor generated in said primary chambers may be condensed in said primary heat exchanger or alternatively by said air-cooled heat ex-

changers when said ambient air is effective to condense said refrigerant without operation of said primary heat exchanger.

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