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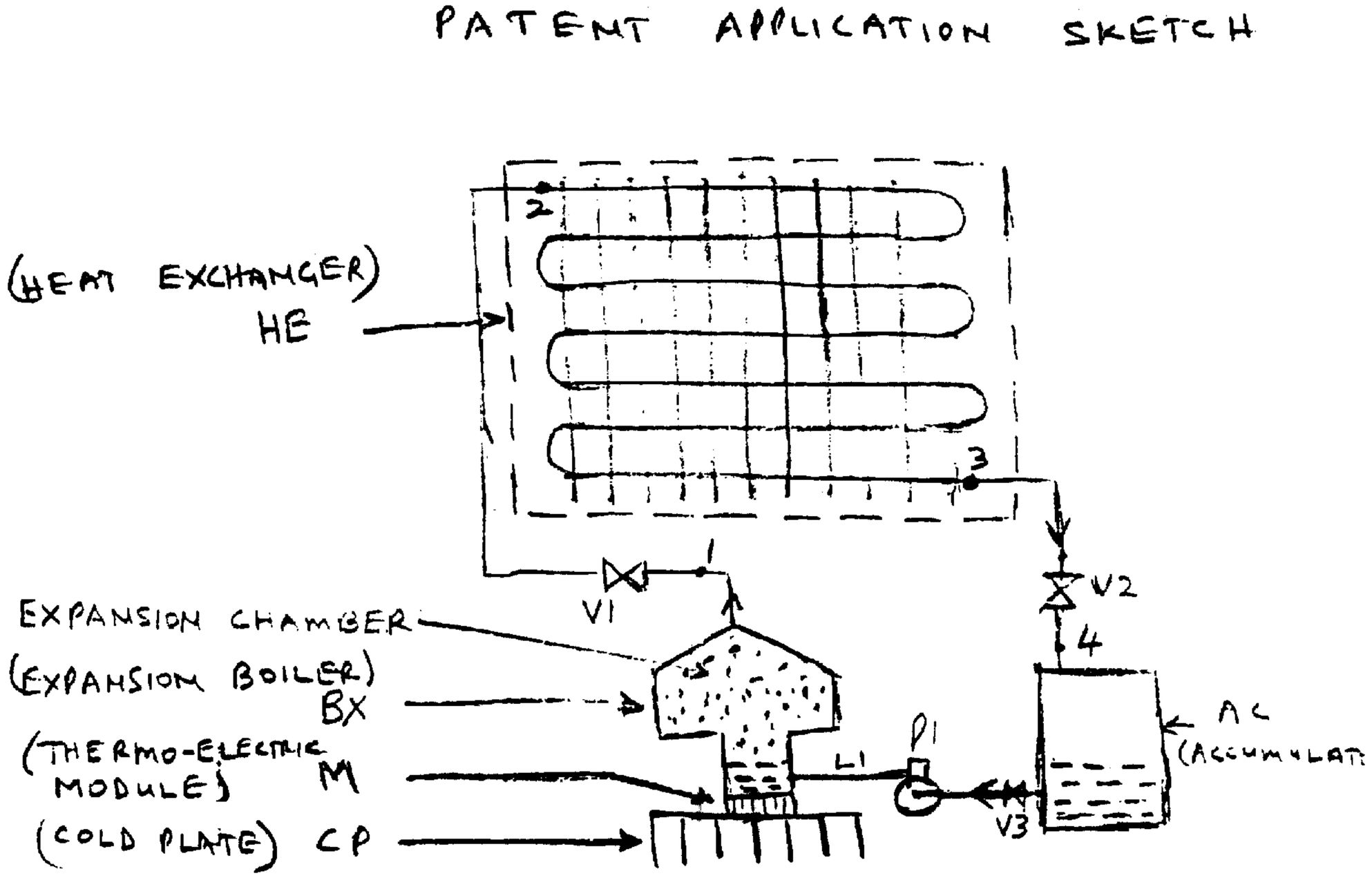
(54) **METHODE POUR UN SYSTEME DE REFROIDISSEMENT THERMO-ELECTRIQUE A DEUX PHASES**

(54) **METHOD FOR THERMOELECTRIC TWO-PHASE COOLING SYSTEM**



METHOD FOR THERMOELECTRIC TWO-PHASE COOLING SYSTEM

FIELD OF INVENTION

The present invention relates to a system of cooling thermoelectric module using liquid and gaseous states of any fluid.

BACK GROUND OF THE INVENTION

A thermoelectric module has cold and hot surfaces depending on the polarity of the power input. The hot side must be cooled in order to produce a cold surface on the other side.

At present, to achieve this, a heat sink is used on the the hot side which is cooled by forced air or liquid in one phase state. This posses heat transfer limitations due to the small space and also due to the geometry of utilization especially if the system is to be used in a portable cooler or freezer. And more so, heat transfer in one phase is not as high as that of combined two phases. In the former, it is only sensible heat; and in the later, sensible and latent heats . Thus, a very high heat transfer efficiency is achieved using combined phases..

It is therefore an object of this invention to provide a novel way of heat extraction from the hot side of the thermoelectric module.

SUMMARY OF THE INVENTION

The invention provides a means of cooling the hot side of the module using a fluid that evaporates when it is, directly or indirectly, in contact with the hot side of the module.. The fluid in the liquid state is put in a small container which is hereby referred to as the regenerative boiler. On one side of the boiler is placed the hot side of the module. The liquid absorbs rapidly the heat from the hot side, and reaching the boiling point, absorbs more heat at this temperature as latent energy of phase transformation of the liquid into gaseous state. The hot side of the thermo-electric module is controlled by the fluid transformation temperature. And the lower the hot side temperature, the lower the cold side would be. This chained effects control the cold side temperature and produce increase in heat extraction efficiency.

The vapour now flows into an apparatus which is a cooling heat exchanger (condenser). The heat exchanger can be fitted with appropriate control valves to maintain a required flow volume and direction. For static installation where the system is not moved once it starts working, this is enough and sufficient with or without the control valves But for mobile systems, a means must be provided to prevent the liquid from moving into an area where it should not settle. This means could be a circulating pump, control valves, or gravity heat exchanger (gravity

condenser).

From the heat exchanger (condenser) the vapour is condensed back into liquid which flows back directly or indirectly to the boiler.
Other variations may require some equipment/s between condenser and bolier (such as an accumulator); and between boiler and condenser depending on the intended use.

As mentioned earlier for mobile units, a pump can be located between the accumulator and the boiler. Also one or more of the flow control valves can be located between the condenser and the accumulator, between the accumulator and the boiler; and also between the boiler and the condenser. Another method of preventing liquid from settling in any undesired position but to return to the same desired position even after the apparatus has been moved or turned around is to use gravity condenser . Gravity condenser ensures the condensed liquid flows down the condenser by gravity to the accumulator or directly to the boiler.

Figure 1 shows all the components of the method and apparatus.

DESCRIPTION OF THE INVENTION.

From figure 1, a thermoelectric module has a cold plate attached to the cold side surface by any mechanical means including welding the surfaces together. The cold-plate is kept cold relative to its ambient temperature. Hence heat flows from the ambient at higher temperature to the cold plate at lower temperature.

Through the thermoelectric module, the heat extracted from the ambient is transferred to the hot side of the module. To the hot side flows the energy (electric power) supplied to the thermoelectric module and heat from the ambient. This is the combined heat to be removed.

On this hot side, a container which is a regenerative boiler is placed on it, with the appropriate fluid as described earlier. The container is attached mechanically or welded to the surface of the module. The fluid absorbs the heat, boils and evaporates.

From the boiler, the vapour flows into the condenser. A control valve may be provided between the boiler and the condenser to ensure that there will be no return of vapour or liquid back to the boiler. At point 2 the vapour enters the condenser where sensible and latent heats are removed. At point 3 the fluid must completely be turned into liquid. The condenser must be sized to achieve this in some cases or to achieve other desired thermo-physical conditions depending on application..

From the condenser, the liquid flows into the accumulator. Between the condenser and the accumulator, another control valve may be added (v2).

Between the accumulator and the boiler, control valve can also be inserted with or without the circulating pump. A circulating pump P1 moves the liquid directly into the boiler or through a

cap line of a diameter much smaller than any other line diameter in the system. The function of the cap line is to drop the pressure so that the boiler receives fluid at a very low pressure but at a high velocity. The low pressure lowers the boiling temperature while the kinetic energy of the speed increases turbulence which increases heat transfer and heat extraction from the hot side of the module.

With the fluid returned into liquid state in the boiler, the process repeats.

Although the two-phase cooling apparatus has been described for usage in thermoelectric system, the cooling apparatus, in part or in whole, could be used in other cooling systems. For example, it may be used to replace compressor cooling system.

Those of skill in the art will also appreciate that other variations and modifications may be made to the present invention without departing from its spirit and scope.

PATENT APPLICATION SKETCH

FIG. 1