

Patent Application of
LIM Swee Keng
for

Title: Direct Thermal Transport (DTT)

INVENTOR'S REF: A1208-01

CROSS-REFERENCE TO RELATED APPLICATIONS Not Applicable

FEDERAL FUNDED RESEARCH Not Applicable

SEQUENCE LISTING OR PROGRAM Not Applicable

BACKGROUND OF THE INVENTION – FIELD OF INVENTION

This invention relates to transfer of thermal energy for the purpose of heating or cooling of target systems.

BACKGROUND OF THE INVENTION

In many instances, in man-made systems as well as for the general environment, the transportation of thermal energy is needed. The purpose of this transportation is to achieve cooling or heating of the target systems, to ensure functions, efficiency, safety or comfort.

To simplify the explanation, we shall take cooling as the illustration. However this explanation shall be equally relevant to heating except the direction of transport of the thermal energy is reversed. For easier understanding, we shall be using ambient air as the sink and air as the medium, for illustrations. However, the medium could be such as water, sodium, etc. The sink could be a volume of mass, such as a miniature container, the ocean, etc.

Cooling involves the transport of thermal energy from the source to the sink. In general can be divided into two classes: Direct Thermal Transport and Indirect Thermal Transport.

Direct Thermal Transport is one that transfers directly between the source and the sink. However the capacity and performance, the constraints imposed on the access to the system or the size of the whole system, may limit the application. Some of the latest development includes the use of evaporative spray cooling for the aft power supply for EA6B Grumman EA6B Prowler supplied by ISR, which eliminates the need for heat sinks. (Flight International, 22-28 July 2003). However the necessity of the storage and supply of media, the pressure and power necessary to generate the spray pose significant challenges in many applications, in particular portable systems. Any additive in the spray could also be a potential source of contamination, in particular in stringent operating environment. The potential stoppage of the spray, thermal shocks or uneven cooling may also pose a challenge to the operation stability, affect reliability of the device. Noise from high-pressure jet stream is a well-known issue.

Transport could also be done through the additional means of intermediaries. This is to improve access to the system, to improve performance or increasing the thermal transport capacity. These then become Indirect Thermal Transport. The intermediaries

could be one or the combination of fluids and solids. Coolant is one example of fluidic intermediaries. Phase Change Cooling is another approach. There are many researches in this area, amongst them, research done by Khandekar, Groll and Luckchoura. (Khandekar, S, Groll M and Luckchoura V., "An Introduction to Pulsating Heat Pipes", ElectronicsCooling Vol. 9, No 2 May 2003) Cooling Fins are examples of solid intermediaries. Some systems using advanced non-moving active intermediaries to move the thermal energy. They include materials that can be energised to have cold and hot junctions. Some of these materials are semiconductor. One example is the application of Cool Chips for Rolls Royce Engines Electronics. (Flight International, 22-28 July 2003). By active pumping thermal energy, the temperature at the hot junction of the chips may become higher. Due to this higher temperature difference, it therefore could transfer the energy more effectively to the ambient. But together with this advantage, back conducting of heat is becoming a problem. This is one of the major issues currently being investigated. Some difficult solution like vacuum junction is being developed for the Cool Chips. Cost, reliability and maintenance of vacuum are issues surfaced.

However, no matter how efficient the intermediaries perform, large surface areas in contact with the sink is unavoidable. In the case if the sink is ambient air, large volumetric flow rate of air is necessary to carry these thermal energy from the intermediaries to the air.

Many research and innovative ideas have been conceived, developed. But at the current states, it remains inadequate for the ever increasing sophisticated applications, portable systems and future systems.

The effective and efficient interaction between the sink and the source is much to be desired. Many air movers, such as Fans, could not reach the centre core of the source due to the physical configuration of the fan and motor (Lopantinsky, E and Waldman, M,

"Recognizing the limits of conventional axial hub-motor AHS devices", ElectronicsCooling Vol 9, no 3, August 2003). YSTech has developed a motor-axial-fan configuration (TMD) without centre motor. However, even TMD or non-axial fan (radial or mixed flow fan) the flow of air has significant leakage (Azar, K. and Tavassoli, B. "How much heat can be extracted from a heat sink?" ElectronicsCooling, Vol. 9 No 2, May 2003). Firstly, the leakage can be in the fan itself. Secondly when the air is blown normally to the fins, the resistance would restrict the effective flow of air. Thirdly, even when air is blown parallel to the heat fins, Azar and Tavassoli has shown that air does not have full contact with the heat fins to the full length. On top of leakage, the reach of the air to the heated surfaces and the interaction of the air with the heated surfaces are inadequate, due to resistance of flow, laminar flow, etc.

Indirect Thermal Transport no matter how efficient it may be at the upstream, no matter how rapidly it moves thermal energy to the final stage, to transfer the energy to the sink, the critical issues of the effectiveness of this final stage remain equally daunting. It could be even be more so than Direct Thermal Transport. In most cases, due to the reduction of temperature differential between the final stage and the sink, greater air movement or bigger surface areas, or both of them, are needed. Indirect Thermal Transport indeed created a bigger problem down stream.

In summary, while many researches have been focusing on increasing surface areas, increasing intermediaries' capacity, increasing airflow, the fundamental aspects about the effectiveness of air-surface contact are yet to be fully explored.

The air blockage, air leakages and ineffective interaction between air and heated surfaces, are limiting the effectiveness of this final leg. This is faced by both Direct and Indirect Thermal Transport systems. Even enhancements such as jet require significant energy to generate the jet. Further enhancement may require additives to generate effects

such as evaporations. For portable devices, in order to attain performance, operations, speed, size, etc, there is often no abundance supply of energy, space for storage of additives, etc. Localized cooling and potential thermal shocks are some of the other key challenges and hazardous factors.

BACKGROUND OF INVENTION-OBJECTS AND ADVANTAGES

Accordingly, besides being able to transfer thermal energy as designed, the objects and advantages of the Direct Thermal Transport (DTT) described in my above patent, several objects and advantages of the present invention are:

To simplify descriptions, we shall use cooling of a heated surface or surfaces (hereinafter, surfaces), as an illustration. The thermal energy is transported to the surfaces and is deemed as the source. The sink is the ambient air. Above patent would also include, but not limited to, heating, use of various types and/or phases of coolants, etc.

- (a) to provide adequate, but not necessarily complete, contact with the heated surfaces. It can be in many forms, including direct contact; it shall be called a cover for simplicity.
- (b) to provide one or more inlets on the cover for the entry of air;
- (c) to provide one or more passages, within the enclosure, to guide the air enter from the inlets, directly or over the surfaces, so that the air shall be heated by removing the thermal energy from the surfaces. Air shall gain high swirl in these passages.
- (d) to provide one or multiple outlets on the enclosure, for the air, after due contact with the surfaces;

- (e) to allow Secondary Inlet within each outlet, so that the vortices upon exit shall induce air from the ambient into the cover and further transport thermal energy from the surfaces.

Further objects and advantages are having an enclosed and controlled movement of air that scrub through the surfaces totally and with prolonged contact. This would ensure more thermal energy are transported per unit air used. The entry and exit of air are directed, this would significantly reduce disturbances to the surrounding environment. With a determined amount of air entry at the inlets, an additional amount of air would be induced at the outlets and enter from the Secondary Inlets. This is a significant advantage gained in this fluidic system. We could perceive it as analogous to mechanical advantage in mechanical system, amplifier in electronics system. Another significant advantage is that the entry from the Secondary Inlet, is directly from the sink air and is targeting at the core of the surfaces, this is what is most desired to achieve in many system design, but prior till to date, could not be easily achieved.

SUMMARY

In according to the present invention, a cover comprising one or more inlets, one or more passages and one or more outlets complete with Secondary Inlets.

DRAWINGS – FIGURES

In the drawings, closely related figures have the same number but different alphabetic suffixes.

Fig 1 shows the basic configuration of a rectangular cover with four entrances, four spirals and one single outlet. A Secondary Inlet is located within the outlet. It can be a path formed by the outlet flow, without material form.

Drawings – Reference Numerals

1. Cover
2. Inlet
3. Spiral
4. Outlet
5. Secondary Inlet

DETAILED DESCRIPTION – FIG 1 PREFERRED EMBODIMENT

A preferred embodiment of the thermal transport system of the present invention is illustrated in Fig 1 (Isometric view). To simplify the description, the system is described as a cooling system that cools a hot source. It is using ambient air as the coolant and the ambient as the sink.

The system has a cover 1 of solid or skin construction. The cover shall be attached to the surfaces of the source, enclosing around or embedded within the source.

One or more inlets 2 shall be arranged on the cover, where air from the sink can enter to the system. They can be natural or forced movement.

One or more passages 3, shall guide the air or coolant, from the inlet in a spiral path formed by the passage. The swirl of the air shall increase passing through the passage.

The air is then exit at outlet 4.

With a high swirl at the outlet, additional air is induced into the centre of the outlet. They shall enter through the Secondary Inlet 5 into the said system.

ADDITIONAL EMBODIMENT

Additional embodiment could include breathing holes on the cover 1.

Another embodiment could include vortices generator along the flow path of the air.

ALTERNATIVE EMBODIMENT

There are various possibilities with regards to the various mode of transport.

It could be used for heating.

The sink can be any bulk, such as reservoir of gases, water, oil or other liquids, sodium or other molten materials.

The passages can be spiral around any geometrical forms. It is not restricted to be layout only on a plane.

The cover can be constructed by comprising of more than one surface that wrap around the source.

The cover can be constructed by the boundary of the source.

The cover can be embedded within the source.

In applications where Secondary Inlet is undesirable, or impractical, Secondary Inlet can be removed.

OPERATION DESCRIPTION FIG 1

The air is moved through the inlet 2, and guided along the passage 3 and passing through the outlet 4 to the ambient. Additional air shall enter, through the induction of the exit air through outlet 4 and enter through the centre of 4, Secondary Inlet 5.

ADVANTAGES

From the description above, a number of advantages of my Direct Thermal Transport become evident:

- (a) It took in air in a manner that the inlet location, direction and speed are easily determined. This help to ensure only desirable condition and amount of air is inducted.

- (b) It directed the air to have full and long path of contact with the source surfaces before exit. Full body of the inlet air would be in close contact over the long path, it shall be able to carry more thermal energy away.
- (c) The source can be enveloped by the flow path or vice versa. This give significant flexibility to design, configuration of systems.
- (d) The flow path is having low resistance to the flow. Less energy is needed to move the air.
- (e) The air could be moving at very high speed and generate high turbulent and strong vortices. These are important key to improved thermal transfer between the source surfaces to the air.
- (f) High speed and strong vortices would clean up the passage, which is one of the issues that many conventional system facing, clogged air passage.
- (g) Strong vortices are helpful in directing the exhaust gas rapidly and affirmatively away from the system. Thus exhaust gas would be easier to manage and would have no negative effect to the surrounding.
- (h) Additional fresh air is induced by the resultant strong vortices at the outlet, there are two key advantages to this:
 - a. More air than entry is participating in the thermal transport process. This is a multiplying effect for a small air intake.
 - b. The air is directed at the core of the surfaces, which in many cases would be most difficult to cool by conventional method because of limited direct access. This centre-directing intake would improve the thermal transport significantly.
- (i) Smaller air volume is needed therefore smaller air-mover is needed. Savings in Cost, space and energy are therefore achieved.
- (j) With improved effective thermal transport, thinner and smaller system could be used for the same thermal load rating of subject system.

- (k) Multiple passages can be configured together. This is a significant fault tolerant design into the whole invention.

CONCLUSION, RAMIFICATION AND SCOPE

Accordingly, the reader will see that this invention has substantially improved the interaction of air and the source. The fundamental approach opens up a lot of flexibility for various design, optimization and applications.

In addition, the invention opens up possibility for

- (a) Directed input would simplify many systems design where the inlet air quality can be better controlled.
- (b) Multiple air-mover could be used with one or more passages. This would remove single point of failure and thus achieve better fault tolerant.
- (c) For different operating conditions, none, one or more air movers could be activated to cater for the system requirements. This would significantly improve performance and save energy.
- (d) The directed output would reduce the harms to neighbouring component, systems.
- (e) The high speed and high swirl of the air, would improve the thermal transport efficiency between the surfaces and the air.
- (f) The high speed and high swirl of the air, would clean up the passage.
- (g) The higher speed and higher temperature exhaust could be useful for some auxiliary functions.
- (h) It could take in thermal energy from any of the faces. This gives flexibility for complex system or multi-system design.

Thus the scope of the invention should be determined by the appended claim and their legal equivalents, rather than by the example given.

ABSTRACT:

A thermal transport system is designed to improve the effectiveness of interaction between the source and the sink. It could be used for heating or cooling applications. The inlet and outlet are configured and defined, so that the control of the inlet quality and quantity, disposal of the exhaust (example, heated air) could be better managed. The air is passing through one or more passages to generate high vortices over a long path. These would improve the total amount of thermal energy transport with the same amount of air and temperature different. Additional air is induced into the core of the system to improve the total system performance. With the improved effectiveness, a more direct thermal transport system is thus achieved.

CLAIMS:

I claim:

1. A Thermal Transport System having means for guided entry of air.
2. Guided entry of air provides means for controlling the source, quality and quantity of air into the system.
3. Means for guiding the air through long and closer contact with heated surfaces, to improve the thermal transport between the heated surface and the air.
4. Means for practical usage of higher pressure, lower volume air movers, which are typical characteristics for miniaturized movers.
5. Means for gaining higher speed and higher swirl is provided to improve substantially the effectiveness of thermal transport between the heated surface and the air.
6. High speed and high swirl provide the means for self-cleaning of the passages, which remove the risk of choking the passages.
7. Means for multiple passages to improve total airflow.

Patent Application of LIM Swee Keng for
"Direct Thermal Transport " continued

Page 13

8. Means for placement of multiple air movers is provided, to single or multiple passage configurations, to remove single point of failure.
9. Means for inducing secondary entry of fresh air is made possible by the higher swirl and velocity of the exit air.
10. Means for directing the secondary entry of fresh air to the core of the heated surfaces.
11. Means for improving the directional property of exhaust air to reduce effect to surround environment.

A1208-01 Direct Thermal Transport (DTT)

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Patent Application of LIM Swee Keng for
“Direct Thermal Transport ” continued

Page 14