

INVENTION TITLE

Direct Thermal Transport (DTT)

DESCRIPTION

Heading

Field of Invention

[Para 1] This invention relates to the transfer of thermal energy for the purpose of heating or cooling of systems.

Heading

Description of Related Arts

[Para 2] The transportation of thermal energy is needed in wide spectrum of fields. It is used in different applications on various types of control volumes, from man-made systems to general environments.

[Para 3] The purpose of this transportation is to achieve cooling or heating of the control volumes, to ensure functions, reliability, efficiency, safety, comfort, etc.

[Para 4] For simpler illustration, we shall take cooling, transfer of thermal energy from the target system, a source, as an illustration. However this invention shall also be applicable to heating. In heating, the thermal energy is transferred to the target system. For consistency, we still named the target system as source. The thermal energy has to be transferred, to or from, a vast reservoir, a sink.

[Para 5] The medium for transfer could be any, or the combination of phases, plasma, gases, vapors, liquids, solids. Where flowing is concern, we shall not consider solid alone. By definition, solid is not a fluid, cannot flow. Thermal transport within

solid is predominantly determined by material properties; only some slight improvement can be made by design. We shall consider fluids, like plasmas, gases, vapors, liquid; example of liquid like water, oil, sodium, etc; some may involve phase change or microstructure change; Examples where thermal transport making use of phase changes are refrigeration using volatiles like alcohol, fluorocarbons, etc; Nano fluids, involving nanometer-sized solid particles suspended in fluid are examples of mixed phase media, in this case including solids.

[Para 6] For easier understanding, we shall be using ambient atmosphere as the sink and air as the medium, for illustrations.

[Para 7] The sink is a vast volume of mass. Other than atmosphere, it can be lithosphere (a mass from the earth in the tapping of geothermal energy, for example), hydrosphere (pond, lake, ocean, etc) or a temporary mass that is to be disposed off at designated time (such as red hot chips in machining processes).

[Para 8] No matter how many intermediate stages the thermal energy passing through, eventually the thermal energy has to be deposited to the sink. The sink usually is the immediate ambient. This is because of the proximity, low cost of the ambient, the immense capacity, and tremendous ability of self-balancing, or recovery by the forces of mother-nature.

[Para 9] In general, all such systems can be divided into two classes: Direct Thermal Transport and Indirect Thermal Transport.

[Para 10] Direct Thermal Transport is one that transfers the thermal energy directly between the source and the sink without introducing additional media. Such as using

fan to move ambient air (air is the media, which come from atmosphere, the sink, and post process deposited back to the sink) to cool hot soup left in the air.

[Para 11] In the direct mode, it does not introduce intermediaries' volume, weight and cost. It does not incur additional intra-intermediaries and interfacial losses. It is most desired as a solution. However the concentration and intensity of the energy, the capacity and energy needed for transport, the constraints imposed on the access to the system, or the size of the whole system, may limit the application.

[Para 12] Many approaches to improve the efficiency, capacity of direct cooling have not been able to meet the performance requirements of advanced complex systems. In attaining the desired performance, one more recent, dramatic and creative, solution was implemented on an advanced Military Air-platform. Evaporative spray cooling for the aft power supply for EA6B Grumman EA6B Prowler supplied by ISR, which eliminates the need for heat fins. ["Heat is on for Cool Technology", Flight International, 22-28 July 2003, Pg 29] This is by spraying some liquid on the system and let the evaporated vapor escaped to the ambient directly. This is not exactly directly using the ambient fluid, but the evaporative fluid is directly, instantly and finally, deposited to the ambient, the sink. This is analogous to the clever design in cutting tools technology, where intense and concentrated heat from machining process, can be carried away by fly away chips.

[Para 13] Although the above example is not strictly direct, it just underlined how important, difficult and innovative, to improve the Direct Thermal Transport to attain the desired efficiency and capacity. Even with such inventive solutions, the necessity for the storage and supply of spray media, the energy and equipment necessary to generate the spray pose significant challenges in many applications, in particular

portable systems. Some necessary components in the spray could also be a potential source of contamination and corrosion, in particular in stringent operating environment. The potential accidental stoppage of the spray, thermal shocks, uneven cooling are major issues that could not be resolved easily, affordably. These would significantly affect the operation stability, and reliabilities. On a deeper realm, noise from high-pressure jet stream is a well-known issue.

[Para 14] These are some of the many research direction that have been worked on. These are typically ahead of patent filed, which would be of more refined ideas. Above are just some of the most dramatic, significant ones that may bring breakthrough. However, they are complex and likely to be inadequate. Therefore few solutions can boldly claim the name, even less so made widely known as Direct Thermal Transport.

[Para 15] Indirect Thermal Transport is one that passes the thermal energy from the source, through one or more intermediate material, media or systems, before passing to the sink. Two most commonly known examples of Indirect Thermal Transport are:

[Para 16] 1. Moving of transistor heats to heat fins (intermediate mode of transport, material and media – conduction, conductive material, vast surface on heat fins), and then using fan to blow air to cool the fins.

[Para 17] 2. The circulating of cooling water between internal combustion engines and radiator, and using fan to blow air to cool the radiator (intermediate mode of transport, conduction, interfacial conduction, convection [forced water flow], media – embedded pipes, cooling water, radiator fins; intermediate system – water pumps, radiator.). In this latter case, there are numerous, massive, complex intermediaries: the conductive conduits embedded in the engine body, pipes running the cooling water,

bent pipes embedded in the radiator, closely packed fins, water pumps, etc. Even with such massive inclusion, it eventually still needs the final transfer of thermal energy from the radiator, via ambient air blowing at the radiator fins.

[Para 18] In Indirect Thermal Transport, intermediaries are used to improve access to the system, performance or increase the thermal transport capacity. The intermediaries could be one or the combinations of fluids and solids. Coolant is one example of liquid intermediaries. Phase Changed Cooling is a further approach that involved more than one phase. There are many researches in this area, amongst them, research done by Khandekar, Groll and Luckchoura where complex meshes of miniature cooling pipes are used [Khandekar, S, Groll M and Luckchoura V., “An Introduction to Pulsating Heat Pipes”, ElectronicsCooling Vol. 9, No 2 May 2003 Page 38–41]. Another exhaustive means and approaches is via the introduction of nano-particles in liquids, Argonne National Laboratory is amongst some key sources. [“Nanofluids Takes the Heat” News Link, Federal Laboratory Consortium for Technology Transfer, February 2002 Vol 18, No 2, Page 7, <http://www.federallabs.org/ContentObjects/News/NewsLink>] [“Nanofluids Promise Efficient Heat Transfer”, News Link, Federal Laboratory Consortium for Technology Transfer, April/May 2002 Vol 18, No 4, Page 6 <http://www.federallabs.org/ContentObjects/News/NewsLink>]. This is done to improve the heat transport capacity. However, the possible impacts of nano-particles to machinery, to human, its stability stability, etc are issues not fully addressed. These just underlined the extreme measure taken to achieve improved thermal transport efficiency.

[Para 19] Some systems using advanced non-moving active intermediaries to move the thermal energy. One of the commonly used, widely known physical phenomenon,

are Peltier Effect devices. They include materials that can be energized 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. ["Heat is on for Cool Technology", Flight International, 22–28 July 2003, Pg 29]. By active pumping thermal energy, the difference between temperature at the hot junction and the ambient becomes higher. Due to this higher temperature difference, it therefore could transfer thermal 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. Rolls Royce uses difficult solution like vacuum junction for the Cool Chips. Weight, cost, on top of the reliability, monitoring and maintenance of vacuum are not simple issues to be overcome.

[Para 20] All the above in-direct solutions, no matter how efficient, how effective they are, in transporting energy from the source, they eventually would be cascaded into a stage, a final stage, to transport the energy to the sink. These typically are using expanded areas of good thermal conductor, called Fins, Cooling Fins, Heating Fins, Heat Exchangers, Radiator, etc.

[Para 21] This final stage is invariably the same as Direct Thermal Transport. Therefore it shares the same bottleneck AND performance ceiling, with current Direct Thermal Transport system.

[Para 22] We shall use Cooling Fins as a generic example.

[Para 23] Cooling Fins are examples of solid intermediaries. It is often mistakenly called Heat Sink, which they are actually not. They are merely an intermediate vessel to

sinking the heat from the source and then pass on to the ambient, through conduction, convection and radiation.

[Para 24] Only in special cases, the cooling fins temperature is raised above the source temperature. Some common current examples are systems using Peltier Effect devices as heat pumps to pump up the fin temperature.

[Para 25] Otherwise, generally the fins exhibit much lower temperature than the source, due to overcoming additional resistance introduced by the intermediaries. If the fins temperature drops, the temperature difference with the ambient, in terms of proportion, would drop dramatically. The thermal transport between surface and its ambient is directly proportional to the temperature difference. Therefore, when the temperature difference drops significantly, a lot more ambient air, or much more fins areas, or both, would be needed to remove the same amount of heat.

[Para 26] Many research and innovative ideas have been conceived, and some have been developed. But at the current state, it remains inadequate for the ever increasing sophisticated applications, portable systems and future systems.

[Para 27] The effective and efficient interaction between the sink and the source is the singular, most critical and constraining factor to improvement. Many air movers, such as fans, could not reach the center core of the source due to the physical configuration of the fan and motor. ["Recognizing the limits of conventional axial hub-motor AHS devices", Lopantinsky, E and Waldman, M, ElectronicsCooling Vol 9, no 3, August 2003, Pg 32.]. YSTech has developed a motor-axial-fan configuration (TMD) without center motor. [www.ystechusa.com, www.dansdata.com/tmdfan.htm, Tip-Magnetic Driving Fan by YS Tech] This removed one of the critical challenge of current fans used

in electronic cooling. This may be new to electronics applications, this is commonly known in aero-engine design as Shrouded fan.

[Para 28] However, even TMD or non-axial fan (radial or mixed flow fan) the flow of air has significant leakage, inefficiency at high speed as discussed in the same reference. Firstly, the leakage can be in the fan itself. Secondly when the air is blown against 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. [“How much heat can be extracted from a heat sink?”, Azar, K. and Tavassoli, B. ElectronicsCooling, Vol. 9 No 2, May 2003, Pg 30–36]. 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 to flow through tight space in the heat fins. It retards the flow into laminar flow. High Reynolds number flow, the most critical factor for effective convective heat transfer, cannot be attained easily.

[Para 29] Indirect Thermal Transport may have improve significantly the efficiency at the upstream, the speed it moves thermal energy to the penultimate stage. The critical issues of the effectiveness to transfer the energy to the sink, the final leg remains daunting. It could be even more so than Direct Thermal Transport. In most cases, due to the reduction of temperature differential between the final stage (e.g. at the Cooling Fins) 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.

[Para 30] In summary, many researches have been focusing on increasing surface areas, increasing intermediaries' capacity, increasing airflow. The aspect about the effectiveness of interaction between media (typically fluidic) from the sink with the

source surface deserves more work, fundamental and application work, than what is currently committed. The potential, therefore, is yet to be better explored.

[Para 31] The air blockage, air leakages and ineffective interaction between air and heated surfaces, are limiting the effectiveness of this final leg. In fact, if we study the temperature gradient on the cooling fins from the technology ends [“EMC and Thermal Design Conflicts”, David P Johns, Alexandra Francois–Saint–Cyr and Fred German, ElectronicsCooling, Vol 8, No 4, Nov 2002, Pg 18], and how animals used complex surfaces to keep the body warmth from the law of nature’s end, we are indeed working against the law of nature, by the introduction of cooling fins. The obvious indication is the trapped dust in the cooling fins of many current solutions. Dust is trapped by the fins! Thermal energy that is embedded on the surface, much more closely adhered to the fins than dust, can heat therefore be effectively, expediently carried away?

[Para 32] This is faced by both Direct and Indirect Thermal Transport systems.

[Para 33] There were many patents filed in even in the 1980s that show some usage of high swirl flow, (commonly understood and named as tornado like flow), to improve the efficiency of thermal transport between fluid and the source.

[Para 34] One of the strongest forces of heat transfer is manifested in tornado. And the most intense force of tornado is at the eye of the tornado, where very high vacuum is generated by the high swirl of fluid just immediate around the eye. This would induce a secondary entry of air into the eye of the tornado. A swirl must attain great enough swirl to be called a tornado. Tornado is most effective when we could generate high swirl with minimal effort/losses and could make possible the happenings of secondary entry at the eye.

[Para 35] Maruyama, Tetsuo's fin for heat exchanger (EP 62155495, Application Dec 27, 1985, Published Jul 10, 1987) uses fins in spiral form to guide air into the exchange chamber to cool the high fins on the heat exchanger. The flow of fluid is not by pressurized air at the entry, but by suction at the center exit of the spiral.

[Para 36] With the suction at the center of the spiral, the air is induced through the openings located on the peripheral of the spirals, passing through the spiral, and have to pass through some restrictive openings at the junction of the end of the spiral and bottom of the center openings. The flow is much restrained, slowed down with many stagnation pockets due to walls form by the fins. There is no particular noted action to improve the acceleration of flow. Formation of high swirl is also not facilitated. No secondary entry of air would therefore be induced.

[Para 37] From another angle, the maximum velocity and swirl is determined by the suction powers. Heating does not help in increasing the final exit state. The whole invention depends more on the conduction of heat to the high fins that form the spiral, than by the increased convection efficiency of a higher Reynolds number, high swirl flow.

[Para 38] This invention can be said to be a much improve way for configuring heat fin geometry. But less so for improving convection efficiency. Therefore it cannot attain significant enough improvement. It is not a Direct Thermal Transport as we see it.

[Para 39] Gluck, Joachim (EP0 687 006 A1, Priority Jun 8, 1994, Patentblatt Dec 13, 1995) uses a tall cylindrical containment with a center piped exit. Though it has some improvement over the previous patent, in that there is less restrictive exits at the

center and the action is by blowing at the peripheral entry. There is some focus to gain high swirl and improve the scrubbing of the sidewall. But there is no action forced against any concentrated, specified source surface. The thermal transfer therefore depends heavily on the thermal conduction to the sidewall and the magnitude of sidewall surface area. With such configuration, the advantage of having the air passes through a long, minimal resistance path directly over the source surface is not fully realized. Induced Secondary entry at the center is also not mentioned in this patent, if it is ever known, intended or achievable.

[Para 40] Opitz, Heinrich. et al. (EP 0 075 175 A2 Priority Sep 17, 1981, Patentblatt March 30, 1983) uses a circular thin cover with a center bent pipe opening for exit air. This invention has focused on forcing the flow of air to be in close touch with the source surface at the base. However, there was no mention of ability to achieve long contact length with the source surface. From the figures of the flow path presented, the flow in fact does not achieve significant increase in swirl, nor contact path length. With this invention, the thermal transfer coefficient could not attain significant improvement. Neither can secondary entry of air be induced.

[Para 41] Matsui, Shigeo (EP 0 245 110 B1, Priority May 9, 1986, Granted May 13, 1992. EP Publication May 13, 1992) focused on how to generate an artificial tornado by air-jet from long pipes. From the illustrations and equations presented, it apparently constrained only to design with pipes at 4 corners, and 4 corners only.

[Para 42] Matsui has identified two key contributions, by this configuration. 1 it would induce more air, from the side, on top of those actively pumped in through the pipes. 2. the air would gather velocity after leaving the pipes. It accelerates as it moves towards the center exit.

[Para 43] These are significant improvement over and above all the others previously mentioned.

[Para 44] However, there are two significant areas that were not dressed.

[Para 45] 1. There are multiple of air inlets from 4 corners and from various heights. There is no attempt to let the air scrub any particular surface, such as hottest surface, side wall, or base. Not all the air would even be in contact with the hottest surface before exiting the system. This is not important for volumetric air transport, such as cleaning the air in a controlled volume. But it is significantly inefficient for thermal transport for hot surfaces.

[Para 46] 2. There is no attempt to move all the air in the longest path that covers the whole control volume. Air from the top nozzle would escape in a much shorter path. This may be enough for system with abundance energy and air supply. But the potential of all the air is not fully exploited. Therefore, combined with point 1, the air would not achieve maximum velocity and contact length with the hottest surface. Also not all the air would gain highest possible Reynolds number. Without achieving highest Reynolds number possible, the potential of better, improved heat transfer coefficient would not be achieved.

[Para 47] It may be these small points, small but significant points that do not fully tap the significant effect of Tornados, both formation at the periphery and the highly intense flow at the eyes, to realize the high potential of direct, prolonged contact between the source and fluid from the sinks. And the fluid is not facilitated to gain the

higher speed and swirl as potentially possible. The higher efficiency of Direct Thermal Transport is therefore not yet released.

[Para 48] Many arduous searches amongst US patents on this approach have not been successful. Some most recent patent like US Patent 6883596 by Kim et al has demonstrated inventive ideas on fluid flow in refrigeration, but not significant effort on convective efficiency, such as improving turbulent, increasing swirl flows of refrigerants, of coolants, etc.

Heading

Summary of the invention

[Para 49] Accordingly, besides being able to transfer thermal energy as designed, the objects and advantages of the Direct Thermal Transport (DTT) described in this patent, demonstrated several additional important objects and advantages:

[Para 50] DTT can be applied to both heating and cooling. To simplify descriptions, we shall use a common cooling of a heated system in air as example for illustrations.

[Para 51] Most systems cannot be intruded, adulterated. The only way thermal energy is to leave the system would be through the surface. We called the target system surface as the source, atmosphere as the sink, ambient air as media.

[Para 52] It is noted that the surface can be singular or multiple, connected or disconnected, internal or external surfaces. It can be extended to complex systems, where some of the internal surfaces are accessible.

[Para 53] This invention consists of the followings:

[Para 54] 1. to provide adequate coverage, but not necessarily continuous, nor full, nor complete, contact with the source. It can be in various forms, or consist of multiple of units, that may not be of same geometry. It shall be called cover for simplicity. (Reference to singular entity is also applicable to multiple entities.)

[Para 55] 2. to provide one or more inlets on the cover for the entry of air; in cases where the source is not able to initiate and sustain a high swirl flow, the air must be induced at adequate speed to generate the subsequent effect. The air can attain such speed by using, but not limited to, turbo-machinery. The introduction of such machinery can be at more than one inlet, more than one such machinery. This would introduce the elements of fault tolerant and scalability for different operating capacity.

[Para 56] 3. to provide one or more passages, within the cover, to guide the air enter through the inlets, directly over the source. The air shall therefore not be able to escape before due contacts with the source. The passage shall be, generally smooth, so that it does not cause significant losses due to counter productive eddies, removal of stagnation pockets for flow. The passage shall be, increasing in curvature, in the general trend. The speed and swirl would increase tremendously even with nominal input speed and swirl. The passage may be consists of physical walls or virtually guided by the streams formed by the fluid flow. The physical wall shall be of adequate length to initiate, generate a sustainable high swirl flow. The passage shall induce the flow towards the exit.

[Para 57] 4. to provide one or more outlets on the cover for the air, after due contact with the surfaces.

[Para 58] 5. to allow Secondary Inlets within one, or more, or all outlets. Without material separation between inlet and exhaust air. The high vorticity flow of exhaust air shall induce air from the ambient into the cover, and coming into contact with the source. This additional, secondary inlet air would enhance further the transport of thermal energy from the source.

[Para 59] Further objects and advantages are:

[Para 60] a. Having an enclosed and controlled movement of air that scrub through the surfaces totally with prolonged contact.

[Para 61] 1. This would ensure more thermal energy be transported per unit air used.

[Para 62] 2. This would also lower unproductive eddies current that would induce stagnation of air, heat trapped, head-losses, during the said process.

[Para 63] 3. The high turbulent mixing would assist in reducing steep temperature difference within the system.

[Para 64] b. The entry and exit of air are directed, this would significantly reduce disturbances to the surrounding environment.

[Para 65] c. With a high speed, high swirl exit air, an additional amount of air would be induced at around the center of the outlets and form the Secondary Inlets. This is a significant advantage gained in this fluidic system. We could perceive it as even superior to mechanical advantage in mechanical system, amplifier in electronics system. This is because in those cases, mechanical advantage is gained at the decreased of velocity ratio; amplification of electronic signal at the consumptions of more electrical power. Whereas, in this case, the exit energy is tapped to further enhance the system performance in a simple, concise manner. Another significant advantage is that ambient air, the coolest, from the sink, is directly and forcible impinged at the center of the heated surface, typically the hottest. This is what is most desired to achieve in many system design. Prior till to date, cannot be easily

achieved. Many current solutions resulted in undesirable highest temperature at the center of the target systems.

[Para 66] 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.

Heading

Brief Description of The Drawings

[Para 67] In the drawings, closely related figures have the same number but different alphabetic suffixes.

[Para 68] 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 an aperture formed by the outlet flow, without material separation.

Heading

Detailed Description of The Invention

[Para 69] A preferred embodiment of the thermal transport system of the present invention is illustrated in Fig 1 (Isometric view) [Fig 2 (Sectional 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.

[Para 70] The followings describe a target system using a singular DTT. Plural units of DTT on target system can also be done.

[Para 71] 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.

[Para 72] 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 flows. One or more air movers can be used. When more than one air movers is used, scalability and fault tolerant are achieved.

[Para 73] One or more passages 3 (singular passage would also be applicable to multiple passages). The curvature of the passage shall, in general trend, increase monotonically. The passage shall guide the air, from the inlet in a spiral path formed by the passage (which may be formed by the flow itself, with or without material separation). The speed, swirl of the air shall increases significantly, as the air passes through the passage in this configuration. This would make possible the next claims.

[Para 74] The air is then exit at outlet 4.

[Para 75] With a high swirl at the outlet, additional air is induced into the center of the outlet. They shall enter through the Secondary Inlet 5 into the said system.

Heading

Additional Embodiment

[Para 76] Additional embodiment could include vortex generators, turbulators, along the flow path of the air, on any appropriate side of the cover, passage. Fig 3.

[Para 77] Another additional embodiment could include breathing holes on the cover 1. Fig 4. It can be consists of single or multiple of holes, located at top, bottom, sidewalls or as made possible by the geometry of the cover or source.

[Para 78] There are various possibilities with regards to the various mode of transport.

[Para 79] 1. It could be used for heating.

[Para 80] 2. The sink can be any bulk, including lithosphere, (such as using geothermal heat source for heating), hydrosphere (such as pond, lake, ocean), other liquid reservoirs (such as sodium), atmosphere and other gaseous or vapor bulk (such as natural gas sump, naturally exists or man-made storage). Other sinks may include cosmic space for space and bio-bodies in medical application.

[Para 81] 3. Though DTT conceived with the purpose, understanding and able to improve the efficient usage of ambient fluids, this invention can also be extended to improve efficiency of thermal transport where no ambient fluids are available, or when intermediary fluids are used. An example is to improve transport of thermal energy from space system, via intermediaries, to the radiator to dissipate thermal energy to the cosmic space. This can also be used to transport thermal energy, between systems embedded within living bodies, such as bio-medical devices.

[Para 82] 4. The passages are not restricted to be layout only on a plane, they can be spiral around any geometrical forms (Fig 5,6,7). The entries and exits can utilize existing aperture(s) on target systems or specially perforated access where there is none, inadequate or inefficient accesses available.

[Para 83] 5. The cover can be constructed by comprising more than one surface that wrap around the source. (Fig 5,6,7)

[Para 84] 6. The cover can be constructed by the boundary of the source. (Fig 7)

[Para 85] 7. The cover can be embedded within the source. (Fig 7)

[Para 86] 8. In applications where Secondary Inlet is undesirable, or impractical, Secondary Inlets can be omitted.

Heading

Operation Description Fig 1

[Para 87] An Efficient System needs to be most simplified. In DTT, the air is moved through the inlets 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 Secondary Inlet 5, which is about the center of 4.

Heading

Advantages

[Para 88] From the description above, a number of advantages of my Direct Thermal Transport become evident:

[Para 89] 1. It takes in air in a manner that the inlet location, direction and speed are easily determined. This helps to ensure only desirable amount of air with desired condition is inducted.

[Para 90] 2. It directs 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 with the source over a longer path. It shall be able to carry more thermal energy away.

[Para 91] 3. The source can be enveloped by the flow path or vice versa. This gives significant flexibility to design, configuration of systems.

[Para 92] 4. The flow path in general, is smooth. However, other special profile may be introduced, to improve performances, turbulent mixing, or overcome constrains.

[Para 93] 5. The flow path has, in general trend, monotonic increase in curvature. This would increase the speed and swirl of the flow.

[Para 94] 6. As the speed and swirl of air increase, the pressure would drop. At appropriate locations where pressure has dropped adequately, perforation on the cover, would enable induction of more air, or breath-in of additional air.

[Para 95] 7. The air is entrapped and therefore, even highly pressurized air could be moving at very high speed and generate high turbulent and strong swirl. These are

important key to improved thermal transfer between the source surfaces and the flowing fluid. Premature air escape, leakage is minimized.

[Para 96] 8. High speed and strong vortices would prevent clogging of the passage, which is one of the issues that many conventional systems could not overcome.

[Para 97] 9. 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 minimize negative effect to the immediate surrounding.

[Para 98] 10. Additional fresh air is induced by the resultant high swirl, strong vortices at the outlet, there are two key advantages to this:

[Para 99] a. More air than primary entry is participating in the thermal transport process. This is a multiplying effect for a small air intake.

[Para 100] b. The secondary 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 center-directing intake would improve the thermal transport significantly for the usually hottest center spot, surrounded by other heat sources.

[Para 101] 11. Smaller air volume is needed therefore smaller air-mover is needed. Savings in cost, space and energy are therefore achievable. Less air intake also reduces dust induced into the system.

[Para 102] 12. With improved effective thermal transport, thinner and smaller system could be used for the same thermal load rating of subject system.

[Para 103] 13. Multiple passages can be configured together. This is a significant fault tolerant design into the whole invention.

[Para 104] 14. Multiple air-inlets, which may be supported by multiple air-movers, can be incorporated. This would remove single point of failures and make scalability possible for different level of thermal transport.

Heading

Conclusion, Ramification and Scope

[Para 105] Accordingly, the reader will see that this invention has substantially improved the interaction of sink and the source. The fundamental approach opens up a host of flexibility for various design and requirements, spanning many applications and opens up ways and means for refinement, optimization.

[Para 106] This patent applies to thermal transport, not limited to cooling. The sink, media are not limited to atmosphere and air.

[Para 107] In addition, the invention opens up possibility for:

[Para 108] 1. Directed input would simplify many systems design where the inlet air quality needs to be better controlled.

[Para 109] 2. Multiple air-movers could be used with one or more passages. This would remove single point of failure and thus achieve better fault tolerant.

[Para 110] 3. For different operating conditions, none, one or more air movers could be activated to cater for the system requirements. This introduced scalability, would significantly improve performance and save energy.

[Para 111] 4. The directed output would reduce the harms to components, systems neighboring to it.

[Para 112] 5. The high speed and high swirl of the air, would improve the thermal transport efficiency between the surfaces and the air.

[Para 113] 6. The high speed and high swirl of the air, would clean up the passage.

[Para 114] 7. The higher speed and higher temperature exhaust would raise the economic values of waste heat and make waste heat recovery for subsequent use an economical, viable consideration.

[Para 115] 8. It could take in thermal energy from any of the faces. This gives flexibility for complex system or multi-system design.

[Para 116] Thus the scope of the invention should be determined by the appended claim and their legal equivalents, rather than by the example given.

What is claimed is:

[Claim 1] A Transport System having openings for guiding media entry, for the media traveling through long appropriately guided passage, assist the media to gain speed and increase swirl, while increase interaction, reaction, transport among target surfaces, media. and exit with very high speed and swirl.

[Claim 2] Openings for guiding media entry in Claim 1 further provides means for improving the control over the source, condition and quantity of media into the system.

[Claim 3] Openings for guiding media entry in Claim 1 further provide means for managing, optimizing the interaction with the surrounding.

[Claim 4] Openings for guiding media entry in Claim 1 further provides the means to make more efficient usage of higher speed, higher pressure media, actuators, sources.

[Claim 5] . Openings for guiding media entry in Claim 1 further provides the means to initiate, guide the media direction, to improve the contact with target surfaces so as to improve interaction, reactions, transport, among target surfaces, media.

[Claim 6] Appropriately guided passage in Claim 1 further provides the means for managing interaction with surroundings, among media.

[Claim 7] Appropriately guided passage in Claim 1 further provide the means for more efficient usage of higher speed, higher pressure media, actuators, sources.

[Claim 8] Appropriately guided passage in Claim 1 further provide the means to intensify the interaction, reaction, transport, among surfaces, media.

[Claim 9] Appropriately guided passage in Claim 1 further provides the mean for gaining higher speed, higher swirl of the media. When media evolve into self-guiding vortices, physical passage wall no longer necessary – faster downstream contacting slower upstream, and thereby accelerate upstream.

[Claim 10] Gaining higher speed, higher swirl of the media in Claim 9 further provide the means for lowering the pressure of the media, downstream.

[Claim 11] Lowering the pressure of the media downstream in Claim 10 further provide the means for increasing speed, swirl.

[Claim 12] Lowering the pressure of the media downstream in Claim 10 further provide the means for media to cling closer to the target surfaces, increase interaction, reaction, transport among target surfaces, media.

[Claim 13] Lowering the pressure of the media downstream in Claim 10 further provide the means for inducing more media into the flow, further increase interaction, reaction, transport among target surfaces, media.

[Claim 14] Gaining higher speed, higher swirl of the media in Claim 9, Claim 11 further provides the means to improve the reaction, interaction, transport among target surfaces, media.

[Claim 15] Gaining higher speed, higher swirl of the media in Claim 9, Claim 11 further provides the means to reduce media laminar insulation, low speed, stagnation of media thereby increase interaction, reaction, transport among target surfaces, media.

[Claim 16] Gaining higher speed, higher swirl of the media in Claim 9, Claim 11 further provide the means for self-cleansing of the passages, which provides the means to mitigate choking of passages.

[Claim 17] Gaining higher speed, higher swirl of the media in Claim 9, Claim 11 further provide the means, to improving perturbation for media mixing, reaction, even out steep temperature difference among target surfaces, media; increase interaction, reaction, transport among target surfaces, media. .

[Claim 18] Means for even out steep temperature difference in Claim 17 further provide the means for mitigating shocks, cracks.

[Claim 19] Long passage in Claim 1 further provides the means to magnify effects from Claim 6 to Claim 18.

[Claim 20] Long passage in Claim 1 further provides the means to have multiple openings, multiple units of actuators, induces multitude of media into the system.

[Claim 21] Magnifying effects in Claim 19, more actuators, media in Claim 20 provide the means to multiply Claim 6 to Claim 18.

[Claim 22] A transport system having means for multiple passages.

[Claim 23] Means for multiple passages of media in Claim 22 further provide the means to isolation of critical components, mitigate risk of passage choked, passage collapsed, enable maintenance of passages, etc.

[Claim 24] Means for multiple passages of media in Claim 22 further provide the means to target media at extreme heat loads concentration, skewed heat-load, and actively provide additional means to preemptively isolate, overcome extreme skewed distribution of energy.

[Claim 25] Means for multiple passages of media in Claim 22 further provide the means to apply different material for media, wall.

[Claim 26] Means to apply different material in Claim 25 further provides the means for reactions among these materials in close proximity, including electro-chemical reactions.

[Claim 27] A Transport system having means for attaining High speed, High swirl at exits.

[Claim 28] Means for attaining High Speed, High Swirl in Claim 27 at exits further provides the means to inducing, starting and directing secondary entry of fresh media.

[Claim 29] Means for starting and directing secondary entry of fresh media in Claim 28 further provide the means to target these at control spots, even spots otherwise surrounded, blocked.

[Claim 30] Means for attaining High Speed, High Swirl in Claim 27 at exits further provides means of directed media that facilitate management of interaction with surrounding.

[Claim 31] Means for attaining High Speed, High Swirl in Claim 27 at exits further provide the means of using it for actuation, energy recovery with improved efficiency.