

Rotating Finned Radiator of CPU—Based on the Boundary Layer Theory

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Abstract. This paper focuses on a new-type rotating ribbed radiator. Compared with the traditional heat pipe radiator, the device will make fan and fin integrative, which will weaken the thermal boundary layer attached on the fins. Thus, it could avoid the accumulation of dust, then the total thermal resistance of the whole process is reduced and the cooling effect is strengthened, so as to achieve the purpose of energy conservation and emission reduction.

1. Brief introduction of the radiator

To solve the problem of the air cooling—the weaken in the thermal boundary layer, we put forward a new-type heat radiating device innovative, that is to say make fan and fin integrative. Through this method, the volume of the radiator could be reduced and the thermal boundary layer is able to be weakened effectively through the optimization design of the blade shape.

In the market, the primary wind cooling method is guide heat to fins to increase the heat transfer area, at the same time realize the forced convection heat transfer in the cooling end with fan. In this way, there exists the formation of thicker thermal boundary layer at the end of the fins, which is the main resistance during the cooling process. And the existing wind cooling design own a weaker ability to dent thermal boundary layer, therefore the heat radiating capacity is far behind the theoretical value.

Based on the above consideration, the heat transfer process is improved. The heat transfer area is expanded by the phase transformation process on the plate whose heat distribution is even, and it is put in a vacuum cavity. And then the heat is transferred through the lubricating oil, revolving fins, finally the heat is dissipated into air by fins driven by the high-speed rotational motor. The key of the radiator is that all of the thermal resistances are in series, so we can minimize the thermal resistances of each part and the total thermal resistance. The energy saving property could be measured by power consumption, and we can reduce costs through the reasonable selection of materials and structure design.

The innovation lies in the combination of fan and fins to reduce the thermal resistance and enhance heat transfer. By modeling and experimental verification, we draw a conclusion that fewer power will be consumed to cool CPU to the same temperature by using the new-type radiator. And the design of rotating blades makes it possible to reduce the ash and to increase the service life.

2. Background and Significance

With the rapid development of CPU, the heating power of CPU increases obviously, which also contributes to the advancement of CPU cooling technology. With the help of modern advanced processing technology, in just a few years time, we have seen air cooling, water cooling, liquid cooling, heat pipe cooling and other cooling modes in CPU radiation field.

However, the radiator of CPU has not solved successfully, The escalating cooling demand makes the problem more and more outstanding. In fact, for the microelectronics industry, cooling technology is one of the main factors restricting the development of the industry. According to statistics, for electronic devices including CPU, 50 percent of failure problems are due to overheating. The heating power of early CPU chip is less than 10W, and there is no need of radiators. However, with the great improvement of basic frequency and integration after the 1990s, the power and heat

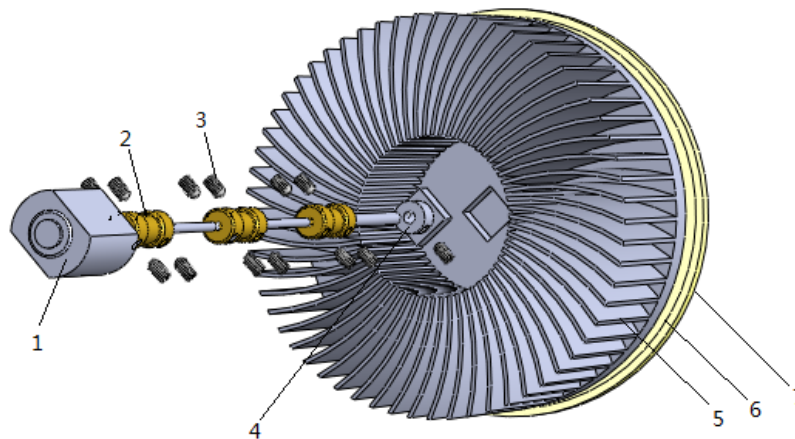
have improved significantly. In 2004 Intel launched the Pentium4 CPU with 3.6 GHZ basic frequency and the power is 115W, and the great power is a serious threat to the work and development of CPU. The shortcoming of the current mainstream CPU series (e.g. Intel i3/i5/i7) is the better of the performance, the greater of the power.

In the market, the primary wind cooling method is guide heat to fins to increase the heat transfer area, at the same time realize the forced convection heat transfer in the cooling end with fan. In this way, Thermal boundary layer will come into being on the end of fins, which consists of the main thermal resistance and prevents the heat loss. The weaken ability of the existing air cooling design on the thermal boundary layer is weak. But in some high performance cooling devices (e.g. Jet impingement cooling), it's of vital importance to dent the thermal boundary layer. There are some high power heat equipment transforming laminar flow into turbulent flow by increasing the fan speed, but this application is often very costly and the electric power is great. So we conclude that the heat radiating capacity of the existing radiator is far behind the theoretical value.

To solve the problem of the current air cooling—to weaken the thermal boundary layer, we put forward a new-type radiator, we combine the fan and fins to reduce the volume and seek the optimal blade shape to dent the thermal boundary layer.

3. Design Proposal

According to the design concept, we made great improvement on traditional heat radiating device, which consists of vacuum cavity plate, sleeve bearing, rotational fins, spindle and electrical machinery. The structure design is shown in Fig.1:



1- Electrical machinery 2- Coupler 3- Soker head cap screw 4- Axle sleeve
5- Rotational fins 6- Sleeve bearing 7- Vacuum cavity plate

Fig.1 Structure design

We combine the fan and fins to reduce the device volume, and as well as the special design to dent the thermal boundary layer, so the radiation efficiency is higher than the ordinary radiator.

The main heat transfer processes of the scheme are :

Heat conduction from CPU to vacuum cavity plate.

Heat conduction in vacuum cavity plate.

Forced convection heat transfer between vacuum cavity plate and sleeve bearing

Heat conduction in Sleeve bearing

Heat conduction between Sleeve bearing and Rotational fins

Heat conduction in Rotational fins

Forced convection heat transfer between fins and air.

4. Innovation and Characteristics

4.1 Improved the conventional radiator on the bottleneck

Compared with the conventional radiator, the fan and fins are combined, and the total thermal resistance is reduced.

The fin part is designed as the streamline type, through strict theoretical derivation, the optimal leaf shape design can ensure a smooth flow field.

The traditional radiator performance is limited by the thicker thermal boundary layer. In this device, fins are driven by a high speed rotating motor, so there is thermal boundary layer disturbance and the thickness of the boundary layer is dented, then heat transfer is enhanced.

4.2 The Improvement of Performance

Compared with the heat pipe type radiator, it has a larger amount of radiation, a lower power consumption and energy-saving quality. The volume of rotating ribbed radiator is reduced and the raw material consumption is dented, so it's very economical.

4.3 The reduction of ash compared with conventional devices

During the heat transfer process, centrifugal force generated with the rotational fins, which makes it possible to reduce the build-up ash. It could reduce the fouling thermal resistance and enhance the heat transfer, at the same time, it is possible to extend the time interval between regular dust abatement and prolong the service life.

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