

## Vertical Cooling Device Using Heat-Pipe Based on Natural Convection "PowerKicker"

Furukawa Electric has recently developed and released "PowerKicker", a vertical cooling device using heat-pipe based on natural convection to be used for thyristors in railways' substations. The device features high efficiency, non-powered operation based on natural convection and small footprint along with the use of water that is a working fluid of global-environment friendliness.

Concurrently with the development of power electronics in late years, semiconductor power devices such as gate turn-off (GTO) thyristors, thyristors and diodes are used in railways' substations for power conversion of high output. These devices require some cooling means to remove the heat generated at the conversion.

Conventionally, boiling cooling device using CFCs or CFC substitutes as cooling medium were generally used in this industrial field together with heat-pipe cooling devices of horizontal type. However, there has been a growing requirement for a new cooling method in view of equipment's footprint reduction as well as global environment preservation to cope with the global warming problem caused by ozone depletion. To make a heat-pipe cooling system maintenance-free, it was normal practice to employ a horizontal-cooling scheme based on natural convection. Such a horizontal-cooling scheme, however, often caused problems of installation space because the heat-radiating fins had to be very long because of their poor heat radiating efficiency.

In an effort to solve this problem, Furukawa Electric has developed the PowerKicker that enables footprint reduction regardless of being a natural convection type, and put it into practical application. See Photo 1.

### 1. STRUCTURE AND FEATURES OF POWERKICKER

Conventional boiling cooling system as shown in Figure 1 creates problems about global environment preservation such as ozone depletion and global warming because its structure is such that heat-generating components are directly immersed in an electrical-insulating cooling medium such as CFCs or CFC substitutes consuming a large amount of such a cooling medium.

On the other hand, horizontal cooling device using heat-pipe based on natural convection as shown in Photo 2 can, since it uses heat-pipes as a heat-radiating compo-

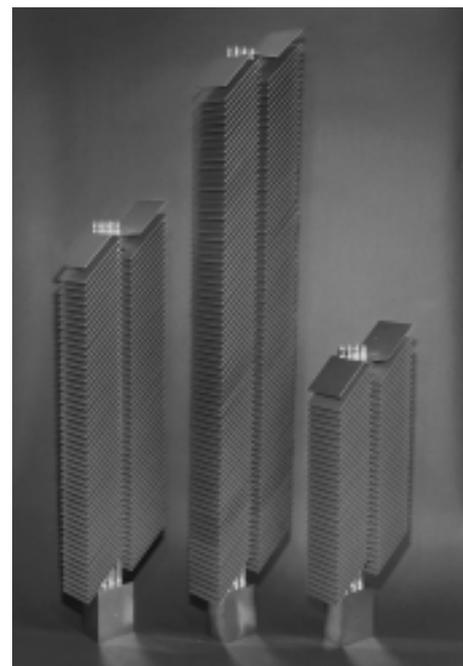


Photo 1 Vertical cooling device using heat-pipe based on natural convection "PowerKicker".

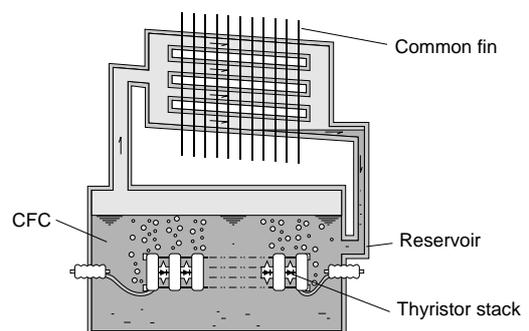
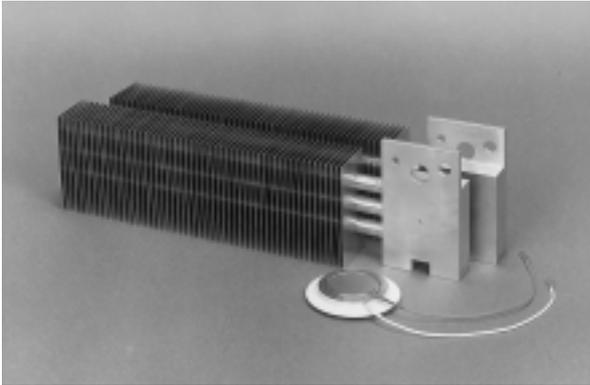


Figure 1 Conceptual image of conventional cooling device of evaporation boiling type using CFC reservoir. (Cross sectional front view)

nent toward the fins, not only provide high thermal conductivity due to the use of heat-pipes but also take global environments into consideration due to the use of deionized water as a working fluid. The heat-pipe is known for its high thermal conductivity, where the heat is received as

**Table 1 Specifications of PowerKicker products.**

Applicable heat dissipation	Dimensions (mm)	Thermal resistance
	Receiving block X Fin width X Total length	K/W (for a pair)
300 W	(140 X 110 X 68) X (120 X 242) X 850	0.12
500 W	(140 X 110 X 68) X (120 X 242) X 1155	0.072
800 W	(140 X 110 X 68) X (120 X 242) X 1580	0.044



**Photo 2 Typical horizontal cooling device using heat-pipe based on natural convection.**

latent heat of vaporization and is instantaneously transferred to the radiating end to be released as latent heat of condensation.

In such horizontal installation and in case of greater amount of heat generation, however, the length of heat-radiating fins sometimes reached 1 to 1.5 m, causing problems of extraordinary footprint and space for installation.

Furukawa Electric has been successful, solving the problems mentioned above, in the development and practical application of PowerKicker, a new vertical cooling device using heat-pipes based on natural convection.

The PowerKicker developed at this time has a simplified structure such that a heat receiving block made of copper and a set of heat radiating fins with special fin configuration are installed on the respective ends of multiple heat-pipes straight in shape. The new product efficiently receives the heat generated by the electronic components at the heat-receiving block using copper. At the heat-radiating end, a special fin configuration was developed and employed, in which the airflow in the heat-radiating fin set is not stagnated but enhanced, even under conditions of vertical installation, based on natural convection. Thus a vertical heat-pipe cooling device the performance of which is as good as that of horizontal cooling devices has been realized.

The features of this vertical heat-pipe cooling device are as follows:

1) Space saving

Owing to vertical installation, the installation space can be minimized in terms of projected ground area. Compared with our horizontal cooling devices, the space can be saved by as much as 50 %.

2) Contributive to global environment preservation

The use of deionized water as working fluid of heat-pipes contributes to preserving the global environment.

3) Ease of maintenance

Individual heat-generating component is mechanically sandwiched between the heat-receiving block of the heat-pipe cooling device. Thus, unlike in the case of cooling device of boiling type, check-up, repair and maintenance can be easily carried out in a short time.

## 2. SPECIFICATIONS AND APPLICATIONS OF POWERKICKERS

Table 1 shows the product specifications of three types of PowerKicker having a heat-radiation capacity of 300 W, 500 W and 800W respectively.

The PowerKicker of 800 W capacity has been introduced for cooling the electronic power devices of rectifiers in the railways' power substations and the delivery has just begun. In the future, it is expected that the product rapidly gain in popularity among many railways' power substations as well as other uses.

For more information, please contact:

Thermal Products Department, Electronics Components Division

TEL: +81-463-24-9721

FAX: +81-463-24-9786