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A CONVENIENT LOW TEMPERATURE HEAT SINK FOR ELECTRICAL LEADS

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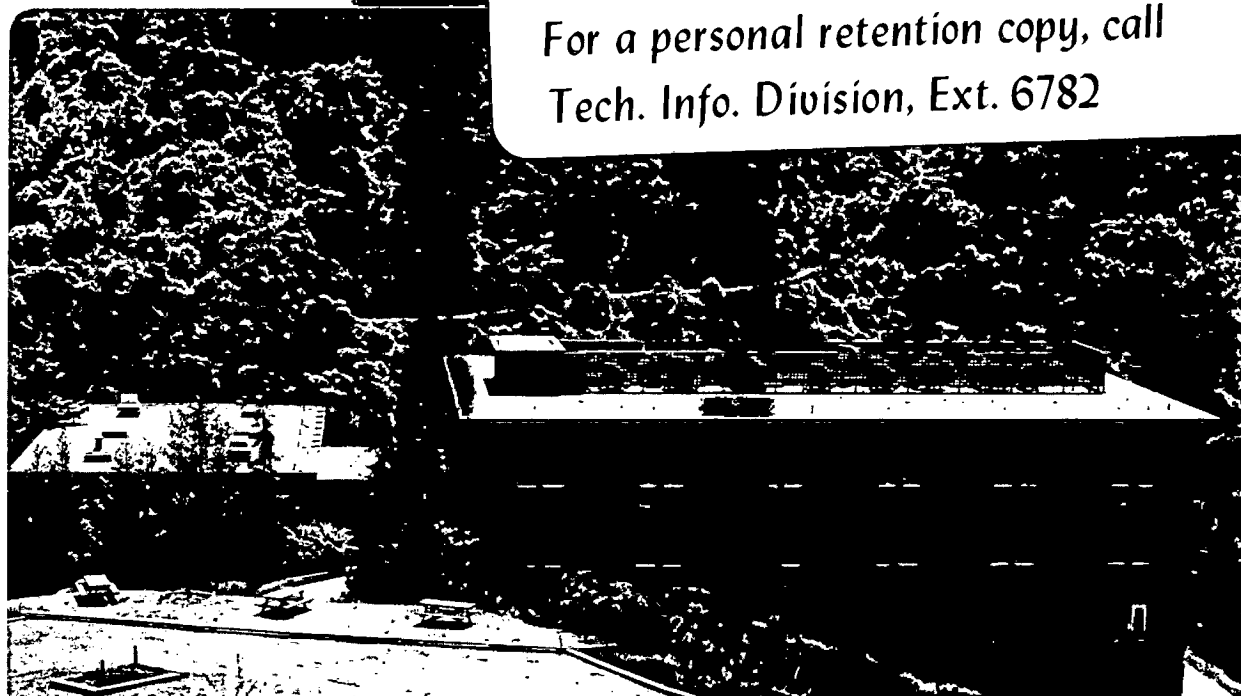
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W.R. McGrath and P.L. Richards

December 1981

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A CONVENIENT LOW TEMPERATURE HEAT SINK FOR ELECTRICAL LEADS

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Abstract

We describe a simple, efficient method for heat sinking electrical leads in a vacuum cryostat. This method employs commonly available materials. Thermal conductances as high as 20mW/K with an electrical resistance greater than  $10^9$  ohms have been measured.

In many low temperature experiments, heat sinks must be provided for electrical leads which pass through a vacuum space from high to low temperatures. Without adequate heat sinking, heat flow down the leads will raise the temperature of the device under study. The requirements for an adequate thermal contact which also provides electrical insulation are especially severe for low resistance and/or high current leads. A number of practical methods for heat-sinking electrical leads have evolved. Many of these methods, however, have low thermal efficiency, are difficult to install, occupy excessive space, or have poor mechanical properties. We have developed a convenient, efficient method for heat sinking electrical leads which appears to be a significant improvement on techniques commonly in use.

Our heat sink depends on the use of a thin insulating layer with large area. The insulator is stycast 2850 FT epoxy cured with 24 LV catalyst.<sup>1</sup> This epoxy is widely used in low temperature experiments because it approximately matches the thermal expansion coefficient of many metals. To achieve this match the epoxy contains small glass beads. As a consequence, a thin, electrically insulating layer with high resistance is formed when two smooth metal surfaces are epoxied together.

Figure 1(a) shows a typical arrangement of heat sinks which was easily assembled using commonly available components. It consists of a PC board with 1.5 mm wide copper strips<sup>2</sup> epoxied to a 1.5mm thick by 10mm wide aluminum strap. The aluminum strap and PC board were clamped together firmly in a small vise while the epoxy hardened. The epoxy layer produced had a thickness  $\approx 0.05\text{mm}$ . Each  $1.5 \times 10\text{mm}^2$  heat sink had a measured thermal conductance of  $\sim 20\text{mW/K}$  and an electrical resistance  $> 10^9$  ohm at 4.2K. These values are consistent with the

manufacturers specifications of thermal conductivity ( $1.42 \times 10^{-2}$  W/cm K) and electrical resistivity ( $5 \times 10^{16}$  ohm cm) at 25C. The capacitance across a heat sink was  $\sim 20$  pF. For dc signals these capacitances are of little importance, but they place restrictions on high impedance or high frequency ac measurements. To retain the full performance of the heat sink, it is necessary to mount the strap carefully to the cryostat. If made improperly, a simple screw joint with a heat sink compound<sup>3</sup> can produce a thermal resistance significantly larger than that of a single epoxy heat sink.

We have found it convenient to make use of the strip-type socket connectors<sup>4</sup> designed for use with PC board, as is pictured in Figure 1(b). In this configuration, the PC board can be epoxied face down on a flat strap, or on a ridge machined directly in a cold surface of the cryostat. Electrical contact is made with either strip connectors or Micro-Klip terminals<sup>5</sup> through holes in the PC board. This allows devices in the cryostat to be easily plugged into the heat sink.

In conclusion, we have described a simple method for heat sinking electrical leads in a vacuum cryostat.

Acknowledgements

This work was supported by the Director, Office of Energy Research, Office of Basic Energy Sciences, Materials Science Division of the U. S. Department of Energy under contract No. W-7405-Eng-48.

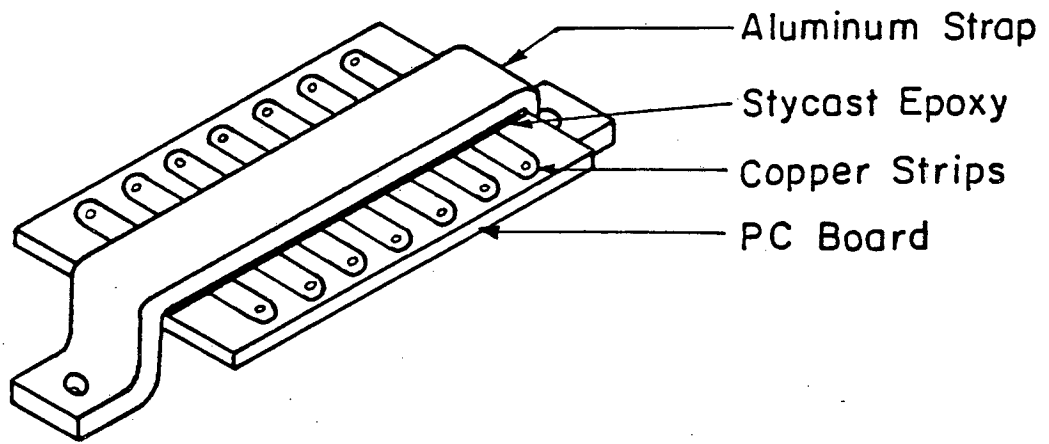
References

1. Emerson and Cuming, Inc. Canton, MA. Technical bulletin 7-2-7A contains additional information on Stycast.
2. We use precut patterns from Bishop Graphics, Inc., Sunnyvale, CA.
3. G. C. Electronics, Rockford, IL. Type Z9 silicone heat sink compound.
4. Samtec, New Albany, IN. Part numbers: SS120G1A, TS120GA.
5. Vector Electronic Co., Inc. Sylmar, CA.

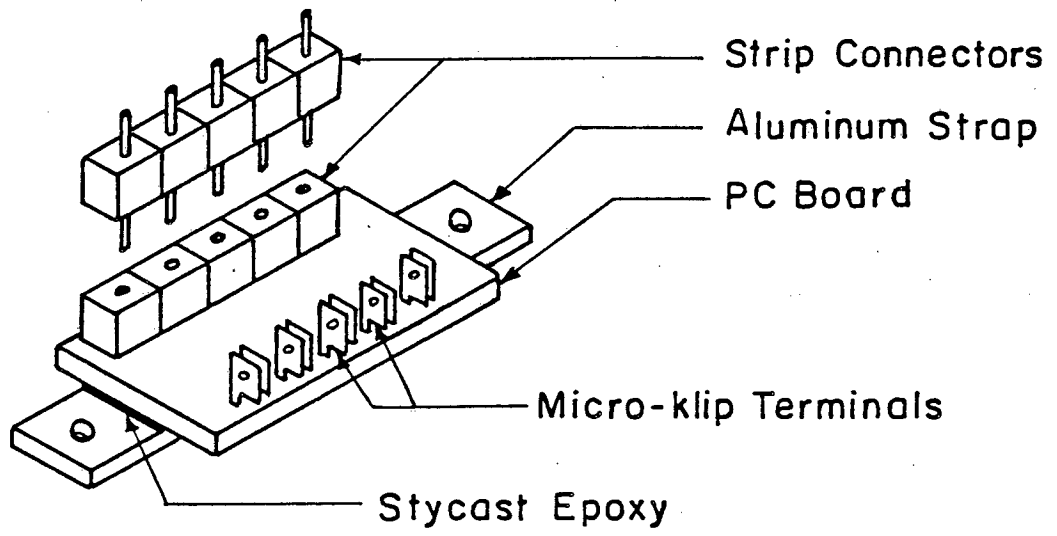


Figure Captions

Fig. 1 Two useful arrangements of heat sinks. Arrangement (b) shows two different types of connectors which may be used with these heat sinks.



(a)



(b)

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