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Dr. Peter D. Keefe
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Dear Dr. Keefe:

At long last I have found a little time to study your proposal. The reprints of the earlier literature have been very helpful. However, I am puzzled by the cooling step that you say involves no work and no heat input. It should be possible to go from the superconducting phase at T_1, H_1 to a normal phase at T_2, but then one would have to reduce the field at T_2 to bring it into the superconducting phase. The adiabatic transition from T_1, H_1 to T_2, H_2 would require an input of work in the cooling step and there would be dissipation of heat in going from the normal to superconducting phases at T_2. The work input at the cooling step would be greater than the work output at the heating step, resulting in a net input of work going into heat.

Apparently you would like to have an adiabatic step from the superconducting phase at T_1, H_1 to normal at T_2, H_2, but I don't see how this can happen without violating the laws of thermodynamics. Further the minimum applied field, H_a must satisfy

$$F_s(T_1) + \frac{H_a}{8\pi} = F_n(T_2)$$

or

$$\frac{H_a^2}{8\pi} = F_n(T_2) - F_s(T_1)$$

with the condition $S_s(T_1) = S_n(T_2)$. Since $F_s(T_1) < F_s(T_2)$, H_a must be greater than H_2. This implies that the transition cannot take place at H_1, but there must be considerable "superheating" to the higher field H_a. When at T_2 the field must be reduced below H_2 to make the transition to the superconducting phase. Heat is then released to the low temperature resevoir. Since the transition takes place at H_a, work that must be done on the system as H_1 increases to H_a. This is more than the external work obtained as the system is heated.

Perhaps I have misinterpreted your ideas, but it seems to me that it is the assumption of no superheating that is at fault. It is a long time since I have thought about the thermodynamics of superconductors.

Sincerely,

John Bardeen

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