provided all the resistance values and other temperatures are known.[3] Consider the network of Fig. 1. By straightforward network analysis one obtains for v_0 and v_2:

$$v_0 = \frac{Z_0}{Z_T}[i_0(Z_1+Z_2)-i_1Z_1-i_2Z_2] \tag{2a}$$

$$v_2 = \frac{Z_2}{Z_T}[i_0Z_0+i_1Z_1-i_2(Z_1+Z_0)] \tag{2b}$$

where

$$Z_T = Z_0+Z_1+Z_2, \quad Z_0 = R_0/(1+j\omega C_0R_0), \text{ etc.}$$

and v_0, i_0, etc. are complex vectors. If one multiplies v_0 and v_2 and takes the time average over the product, then one forms:

$$\text{Re}(\overline{v_0v_2^*}) = \text{Re}\left\{\frac{Z_0Z_2^*}{|Z_T|^2}[\overline{|i_0|^2}Z_0^*(Z_1+Z_2)+\overline{|i_2|^2}Z_2(Z_0^*+Z_1^*)-\overline{|i_1|^2}|Z_1|^2]\right\}, \tag{3}$$

where

$$\overline{|i_0|^2} = 4kT_0df/R_0$$

(the Planck factor is assumed to be unity), similarly $\overline{|i_1|^2}$ and $\overline{|i_2|^2}$. The time average of the products $\text{Re}(\overline{i_0i_1^*})$, etc. are zero because the resistors are independent noise sources. The product $\text{Re}(\overline{v_0v_2^*})$ appearing in equation (3) corresponds to the direct multiplication of the physical voltages v_0 and v_2. From equation (3) one sees that if either $R_0C_0 = R_1C_1 = R_2C_2$ or $(\omega R_nC_n)^2 \ll 1$ the product $\text{Re}(\overline{v_0v_2^*})$ can have a positive or a negative sign provided $T_1>(T_0+T_2)$. For either of the above conditions the value of R_1 required to make $\text{Re}(\overline{v_0v_2^*}) = 0$ can be calculated from equation (3):

$$R_1 = \frac{T_0R_2+T_2R_0}{T_1-T_0-T_2}. \tag{4}$$

In this experiment R_0 and R_2 were both kept in the helium bath so that $T_0 = T_2$. R_2 and R_0 were matched to better than 1/2%, and T_1 was in an isothermal bath at room temperature. If T_1 and the resistances are measured, T_0 can be calculated from

$$T_0 = T_1\frac{R_1}{R_0+2R_1+R_2}. \tag{5}$$

II. THE THERMOMETER AND EXPERIMENTAL PROCEDURES

The first requirement for an absolute noise thermometer of the kind described above is to find some resistors which are stable at liquid helium temperatures, whose values are preferably reproducible for several experiments, which produce no noise in addition to thermal noise, and whose resistive component

[3]This idea was proposed by Dr. J. B. Garrison to Prof. A. W. Lawson of Chicago University (verbal communication by Prof. R. E. Burgess).