the gain of the amplifiers. The multiplier (a commercial type manufactured by G. A. Philbrick, Inc.) is followed by an amplifier and an RC integrator of variable integration time (22.5 to 90 seconds). The output of the integrator was fed into a recorder via a cathode follower to permit better registration of the time average of the signal.

R_0 and R_2 were carefully cooled to liquid helium temperatures and then their d-c. value was measured with a Wheatstone bridge (R_1 and C_1 were disconnected). R_1 was set to approximately the value at which balance $[\mathrm{Re}(\overline{v_0 v_2^*}) = 0]$ was expected and C_1 adjusted such that $R_1C_1 \simeq R_2C_2$. This was accomplished by connecting Z_1 and Z_2 in series and applying pulses across Z_1 and Z_2. C_1 was then adjusted until the shape of the pulses across the impedance Z_1+Z_2 and Z_2 were identical. This procedure adjusted the time constants τ_1 and τ_2 to approximately 10%. Similarly τ_0 and τ_1 were adjusted and the average setting of C_1 was used when R_1 was varied to achieve balance. If the change in R_1 was large τ_1 had to be rebalanced and R_1 reset. The temperature (room temperature) of R_1 was read on an ordinary mercury thermometer placed on the outside of the resistance box and the value of R_1 was read from the dial setting of the resistance box. The temperature of the helium bath was then calculated from equation (5).

The temperature of the helium bath was sometimes kept constant to better than 1 millidegree K by a temperature regulator (400 c.p.s.) similar to that of Boyle and Brown (1954). A stirrer was sometimes used to equalize the temperature, and the vapor pressure of the helium was measured on a mercury manometer with a cathetometer. A German silver tube (8-mm diameter) extending into the liquid surface was connected to the manometer. The temperature determined from equation (5) was then compared with the "1958 ^{4}He scale of temperatures" (Van Dijk and Durieux 1958; Brickwedde 1958).

III. ERRORS AND LIMITATIONS OF THE THERMOMETER

1. Errors Which Can Be Represented by Noise-Current Sources in Shunt with the π Network

These errors can be divided essentially into two groups: (*a*) errors due to the grid currents, (*b*) errors due to the finite input admittance.

(*a*) The grid current is made up of three parts; electrons arriving at the grid (I_1), electrons emitted from the grid by photoelectric emissions (I_2), and positive ions arriving at the grid (I_3). All three currents are independent of each other. The grid of the triode acts like the anode of a diode; for I_1 it acts like the anode in the exponential part of its characteristic and for I_2 and I_3 it acts like the anode of a saturated diode. Therefore the shot noise due to the grid current is:

$$\overline{i_g^2} = 2e(I_1+I_2+I_3)\,df. \tag{6}$$

The net grid current is $I_g = I_1 - I_2 - I_3$ and thus $\overline{i_g^2} \geqslant 2eI_g\,df$.

(*b*) The real part of the dynamic input admittance which is a function of frequency consists of three components: the ohmic loss in the input circuit, the cold loss of the first stage (leakage around the bulb of the tube, losses in