2.2. *Method of RC balance.*

Two methods were adopted to establish the condition

$$R_s C_s = R_r C_r .$$

a) *Reference resistor at a fixed temperature.*

This method is a conventional one [1]. By means of the second channel, 30 kHz wide, centered at 455 kHz, the two noise signals were balanced.

b) *Reference resistor at an elevated temperature.*

This new method is appropriate to the high pressure use. The temperature T_r at the atmospheric pressure was equalized to the temperature T_s under high pressure, until N_s was consistent with N_r under the condition $R_s = R_r$. When $R_s = R_r$, the balance of the real parts of the parallel combination of R_s and C_s leads to the condition

$$R_s C_s = R_r C_r .$$

This balance condition was easily attained by means of an AC bridge.

2.3. *Sensing resistor.*

A ceramic-moulded solid carbon resistor made by Allen and Bradley was used as a sensing resistor. The resistor has advantages claimed for the use in the confined environment of high pressure and high temperature. The resistor was shielded completely by a copper tube as shown in Fig. 2. The estimated current noise of the sensing resistor by a grid current is 0.05 μV at most. The comparison between the thermal noise of the sensing resistor and that of he metal wire indicates a good agreement within the limit of error.

2.4. *Pressure generator.*

A girdle type press was employed in this experiment as the high temperature and high pressure generator. Fig. 2 shows the assembly of the pressure cell. The sensing resistor passing through the core of the anvil was brought into contact with the thermocouple at the center of the pressure cell. The temperature difference between the sensing resistor and the thermocouple was estimated within ± 0.8 K at 700 K. To avoid the induction noise arising from the heater, DC current from the battery was applied.

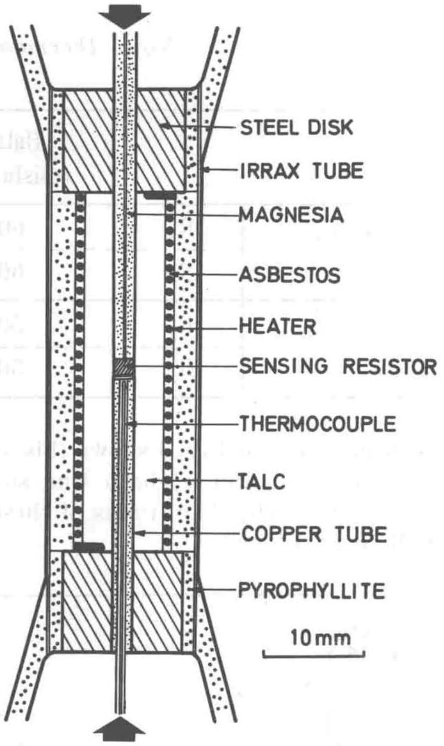

FIG. 2
Pressure cell assembly.

3. Results and discussion

3.1. *Experimental confirmation of pressure independence of the noise thermometry.*

The theoretical statement that the output of the noise thermometer does not depend on the pressure was confirmed experimentally up to 30 kbar at room temperature as listed in Table 1.

3.2. *Pressure effects on the outputs of Chr/Alu and Cu/Const thermocouples.*

The thermometry with the balancing method (b) was applied to the correction of Chr/Alu thermocouple at an elevated temperature. The precise balancing point of N_s and N_r was determined from reading the count-integrator over a period of 60 s. R_s was about 600 Ω under high pressure. The plotted points in Fig. 3 are the average values of 5 ∼ 10 measurements. The result was converted to the standard pressure correction of the thermocouple introduced into a hydrostatic pressure

TABLE 1

Noise thermometry under high pressure at room temperature

		Balanced resistance (Ω)	Temp. obtained by noise (K)	Temp. obtained by thermocouple (K)
Atmospheric pressure	R_s	601.1	294.2	294.5
	R_r	602.1	294.7	294.7
30 kbar	R_s	509.1	294.2	294.7
	R_r	509.9	294.7	294.7

bomb. A broken line in Fig. 3 shows this standard pressure correction, and a chain line shows the Hanneman's result [6]. The trends of these curves agree with each other.

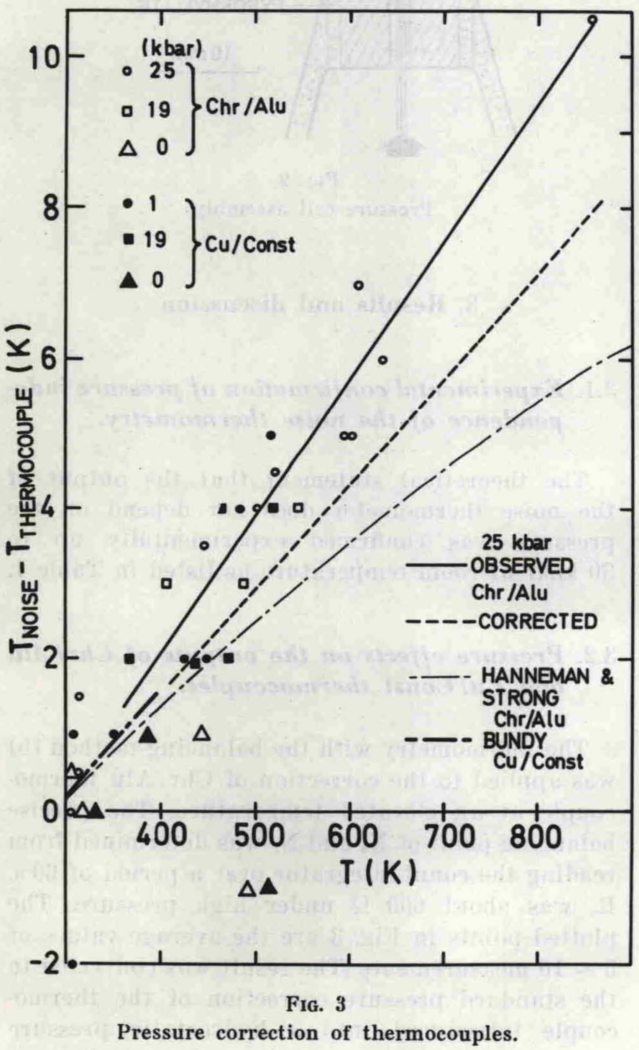

FIG. 3
Pressure correction of thermocouples.

As for the correction of Cu/Const thermocouple, the balancing method (a) was employed. The results are shown in Fig. 3. In this measurement, R_s was 800 Ω under high pressure, and the duration of integrating time is 60 s. The points represented are the average values of 5 ~ 10 measurements. The result almost agrees with the extrapolation of Bundy's measurement obtained by the Belt apparatus.

The outputs of the calibrated thermocouple and those of the noise thermometer showed agreement within the range of 0.1 % at room temperature and of 0.3 % at 900 K, under the atmospheric pressure for the integrating time of 15 min. In principle, the accuracy of the measurement is increased by the extension of the duration of integrating time, but in the high pressure experiment, the difficulty of maintaining the pressure and temperature conditions in the pressure cell may restrict the total accuracy of the experiment. For the full discussion of the problem, it is desired to make much more measurements by this technique at high pressures, far beyond 30 kbar.

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