The applications of the Tokodynamometer will have to be determined by use. At present it is clear that it will serve as a tool for research in studying uterine dyskinesias, pharmacological responses of the uterus, contraction patterns in labor, and so forth. It also seems clear that it will serve as a teaching aid to student obstetricians in analyzing types of uterine activity at and near term. It is conceivable that the Tokodynamometer may prove to be of prognostic value by indicating within the limits of statistical probability the relation of the contraction pattern observed in a uterus a short time before term to the subsequent clinical course of labor.

A detailed report of the construction of this unit, including wiring diagrams, drawings, and photographs will be made at a later date in another journal.

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Freezing Points of Cobalt and Nickel and a New Determination of Planck's Constant C_2

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The International Temperature Scale (*3*) adopted in 1927 by the Seventh General Conference of Weights and Measures is based on a number of fixed points, the temperatures of which are defined. The highest temperature of these is the freezing point of gold, defined as 1,063°C. Above the gold point the temperature scale is extended by means of Wien's law of radiation. In this range any temperature, t, is determined by the ratio of intensity, J_2, of monochromatic visible radiation of wave length λ cm., emitted by a black body at temperature t, to the intensity, J_1, of radiation of the same wave length emitted by a black body at the gold point, by means of the equation:

$$\log_e \frac{J_2}{J_1} = \frac{C_2}{\lambda}\left(\frac{1}{1{,}336} - \frac{1}{t + 273}\right). \qquad (1)$$

A value of 1.432 cm.-degrees was assigned to the constant C_2. The equation is valid only if the product $\lambda(t + 273)$ is less than 0.3 cm.-degrees.

The assignment of the value 1,063°C. to the gold point was based primarily upon the gas thermometer work of Holborn and Day (*7*) and of Day and Sosman (*4*). Day and Sosman extended the constant-volume nitrogen thermometer scale up to 1,550°C. by obtaining the temperatures of various fixed points, including the freezing points of copper, nickel, cobalt, and palladium. The present authors were very fortunate to have available for this work samples of nickel and cobalt from the same lots of these materials used by Day and Sosman. Thus, the freezing points of these materials on the International Temperature Scale could be compared directly with the values determined on the gas thermometer scale. Although this comparison of temperature scales was the primary object of the present work, the samples of nickel and cobalt were of such purity that the observed values of the freezing points are the same, within observational error, as those of the pure metals.

A detailed discussion giving the sources and the analyses of the metals used by Day and Sosman in their gas thermometer work is given on page 85 of reference 4. The analyses of the nickel and cobalt ingots made at the conclusion of the present work gave essentially the same results as those originally reported by Allen, of the Geophysical Laboratory.

The so-called crucible method was used in the freezing-point determinations. In this method the radiation from a hollow enclosure or black body immersed in the molten metal is observed with an optical pyrometer as the metal freezes. In the present work the metals were melted in a high-frequency induction furnace.

Beryllia and thoria were used as crucible materials, thoria proving more satisfactory because of its greater mechanical strength. Freezing-point determinations were made in an atmosphere of helium and *in vacuo*, since both metals oxidize readily at high temperature.

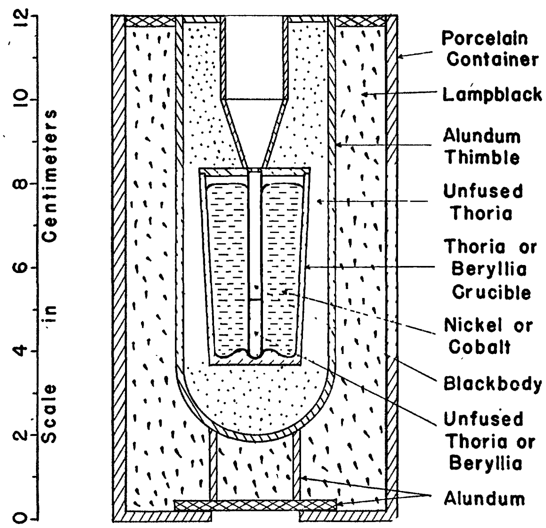

Fig. 1

Fig. 1 is a cross-sectional view of the crucible assembly. The 80-gram samples of nickel and cobalt were first melted in beryllia crucibles of the size and shape to be used in the freezing-point determinations. A hole was drilled axially in each ingot to accommodate the sight tube. The sample and its sight tube were placed in a refractory-oxide crucible and mounted in a larger porcelain container, as shown. The relatively coarse insulating material surrounding the crucible permitted the passage of gas around the sample, while the lampblack provided excellent thermal insulation. The assembly shown was placed inside a closed Pyrex tube having a Pyrex window sealed to the top with propylene phthalate. The Pyrex tube fitted closely inside the water-cooled coil of the induction furnace.

Before melting the sample in a helium atmosphere, the gas was passed slowly through the Pyrex enclosure for about 16 hours before heating, as well as during the actual heating. For the experiments *in vacuo*, the pressure within the enclosure was maintained less than 0.005 mm. of mercury by a mercury diffusion pump. A liquid-air trap between the diffusion pump and the Pyrex tube prevented mercury vapor from entering the tube.

The optical pyrometer used was designed by Fairchild and Hoover (*5*). It was fitted with a 45° total-reflecting prism for sighting into the black body. Two separate pyrometer lamps were used during the investigation. For observations on the black body at the gold point, an assembly of the same dimensions as that shown in Fig. 1 was used.

The brightness ratio, J_2/J_1, was measured by utilizing a rotating sector disk. The sector had two openings and was made by mounting steel strips on an aluminum disk. The edges of the strips were ground, and lapped straight and aligned to be radial with the aid of a circular dividing engine. The transmission of the sector, as computed from the measurement of the openings with a circular dividing engine, was 2.625 per cent.

In addition to using the sector disk, an absorption glass was used to obtain temperature measurements at the freezing points of the metals. This had been calibrated repeatedly by comparison with sector disks over a period of about 20 years, and the calibration is considered well established.

TABLE 1

Lamp No.	Absorption device	Nickel		Cobalt	
		No. of freezes	Avg. value of freezing point (°C.)	No. of freezes	Avg. value of freezing point (°C.)
F-16	Glass	10	1,455.0	22	1,494.7
F-16	Sector	29	1,455.3	13	1,494.8
L-1	Glass	18	1,455.3	22	1,494.4
L-1	Sector	7	1,455.0	4	1,495.3
Weighted mean			1,455.2		1,494.7

About 60 freezes on each metal were made, with both authors serving as observers. The average number of pyrometer settings during one freeze was 7. About 10 freezes on each metal were made with the samples *in vacuo* and the remainder with the samples in helium. No significant differences were noted.

A summary of the determinations of the freezing points of nickel and cobalt obtained by use of equation (1) is given in Table 1.

In view of estimated uncertainties, the best values of the freezing points are taken as 1,455 ± 1°C. for nickel and 1,495 ± 1°C. for cobalt.

The ratios of brightness (J_2/J_1) of black bodies at the freezing points of nickel and cobalt to that of a black body at the gold point were found to be as follows: for nickel, where $\lambda = 0.6533\mu$, $J_2/J_1 = 41.40$; and for cobalt, where $\lambda = 0.6532\mu$, $J_2/J_1 = 54.99$.

Using the values of the freezing points of gold, nickel, and cobalt as determined by Day and Sosman, and the above values of the ratios of brightness, values of the constant C_2 in Planck's law of radiation can be calculated. For simplicity, Wien's law is used in the calculations, since it gives essentially the same numerical results as Planck's law in the temperature range investigated. Since the values of Day and Sosman for the temperatures of the various fixed points are on the constant-volume nitrogen scale, small corrections are necessary to convert them to the thermodynamic scale (*2*, *8*). Wien's law yields the following expression for C_2:

$$C_2 = \frac{\lambda \log_e \dfrac{J_t}{J_{Au}}}{\dfrac{1}{t_{Au} + 273} - \dfrac{1}{t + 273}}. \qquad (2)$$

In addition to the samples of nickel and cobalt used in the present work, Fairchild, Hoover, and Peters (*6*) have measured J_t/J_{Au} for a sample of palladium, which was compared with the palladium used by Day and Sosman and found to have the same freezing point to about 0.1°C. Table 2 lists the values of C_2 as derived from these points.

Since the adoption of the International Temperature Scale there has been considerable evidence to indicate that the value assigned to C_2 is low. The International Conference of Weights and Measures was scheduled to consider revision of the temperature scale in 1939, but failed to meet because of unsettled political conditions. One of the proposed revisions was to increase the value of C_2 to 1.436 cm.-degrees. Since 1939 there has been additional evidence that the value should be still higher.

TABLE 2

VALUES OF C_2 BASED UPON OPTICAL AND GAS THERMOMETRY

Fixed point	Temperature D&S gas scale (°C.)	Thermodynamic scale (°C.)	$\log_e \frac{J_t}{J_{Au}} \times 10^7$	C_2 (cm.-degrees)
Au	1,062.4*	1,062.6		
Ni	1,452.7*	1,453.1	2,433	1.436_4
Co	1,490.6*	1,491.0	2,618	1.439_6
Pd	1,549.4*	1,549.8	2,879	1.438_2
Mean				1.438

* These values are the unweighted means of the individual determinations of Day and Sosman and are slightly different from the weighted means reported by those authors.

Values of the constant C_2 may be computed by a number of methods. Wensel (*9*) discusses these methods and summarizes the values of C_2 as obtained from the various sources. The particular value of C_2 which was given the greatest weight was that derived from the atomic constants. In the most recent summary of the physical constants, Birge (*1*) concludes that C_2 equals 1.4384_8 cm.-degrees. Thus, the present results add to the evidence that the most probable value of C_2 is 1.438 cm.-degrees.

A more detailed paper on this subject will be published in the *National Bureau of Standards Journal of Research.*

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