

Citation:

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plate the way in which of late we have made the connections for the compression tube for piezometer determinations.

If we compare this figure with plate I, fig. 1, of Comm. N°. 84, March '03, where the same parts are designated with the same letters, and also with the description of it given in Comm. N°. 84, then no further explanation is required. The upper end of the level glass C'' , is bent in order to immerse C''_{31} in the oil vessel C'_{33} . The cocks and connections which are not kept under oil, as for instance C_6 , are those where a leak must show itself by the outflow of mercury.

Physics. — Communication N°. 94^c from the Physical Laboratory at Leiden by Prof. H. KAMERLING ONNES. "*Methods and apparatus used in the cryogenic laboratory. VII. A modified cryostat.*"

(Communicated in the Meeting of May 27, 1905)

§ 1. In several Communications I have described cryostats based on the use of baths of liquefied gas evaporating at ordinary or lower pressure. For those cryostats where, as described in Comm. N°. 14, Dec. '94, I succeeded in maintaining during any desired time a bath of $\frac{1}{4}$ to $\frac{1}{2}$ liter of liquid oxygen for measurements at a constant low temperature by means of a circulation, no vacuum glass at all was used. The whole method had been worked out before DEWAR's investigations showed that the vacuum glasses were fit above all for storing liquid gases.

Nor were any vacuum glasses used in the improved cryostats of large dimensions described in Comms. N°. 51, Sept. '99, and N°. 83, Feb. '03. When we started the measurements for which these cryostats were used, we could only obtain sufficiently trustworthy vacuum glasses which were blown to fit exactly when we were satisfied with small dimensions.

Since, however, excellent vacuum glasses which are also of large dimensions are made to fit, especially by R. BURGER at Berlin, it will be possible in many cases to find vacuum glasses of the proper size and the just mentioned methods of arranging will be especially reserved for those cases where we want vertical walls of plane parallel glass, or when the bath must be of excessively large dimensions¹⁾.

In Comm. N°. 83 III § 6 we have already described a cryostat of small dimensions constructed by means of a vacuum glass. The

¹⁾ Comp. the end of VIII of this Series of Communications.

annexed plate shows such a cryostat in a vacuum glass of much larger dimensions (9 c.m. internal diameter) which during some years has satisfied high requirements.

The apparatus has served for measurements ¹⁾ with a differential thermometer of which one reservoir was filled with hydrogen the other with nitrogen, for a comparison of a thermoelement with the hydrogen thermometer (cf. Comm. N°. 89) and for measurements on the isothermals of diatomic gases (cf. Comm. N°. 69, April '01 and N°. 98, April '02). If the plate is compared with Comm. N°. 83 no much further explanation is wanted. The same letters designate the same parts. The connections of the cryostat with the regulating apparatus for *constant* temperature are the same as on Pls. I, V and VI of Comm. N°. 83. The stirring apparatus to obtain a *uniform* temperature is moved by an electromotor as is the case with the cryostat represented there. During the measurements with the differential thermometer the temperature was regulated according to the indications of a thermoelement Θ (which is described in detail in Comm. N°. 89 published lately). In the comparison of the thermoelement Θ with the hydrogen thermometer one of the thermometer reservoirs on the annexed plate was replaced by a resistance thermometer (double cylinder according to Comm. N°. 93, Pl. I, fig. 2, with improvements which will be described later on). Moreover in the measurements of isothermals the piezometer (cf. Comm. N°. 69, Pl. I) was put in the place of the second thermometer reservoir.

In order to secure a symmetrical distribution of the current in the bath mica screens, (which also serve for insulation) are used if necessary (for instance in the resistance thermometer), and a tube similar to the thermoelement Θ was mounted symmetrically with the latter.

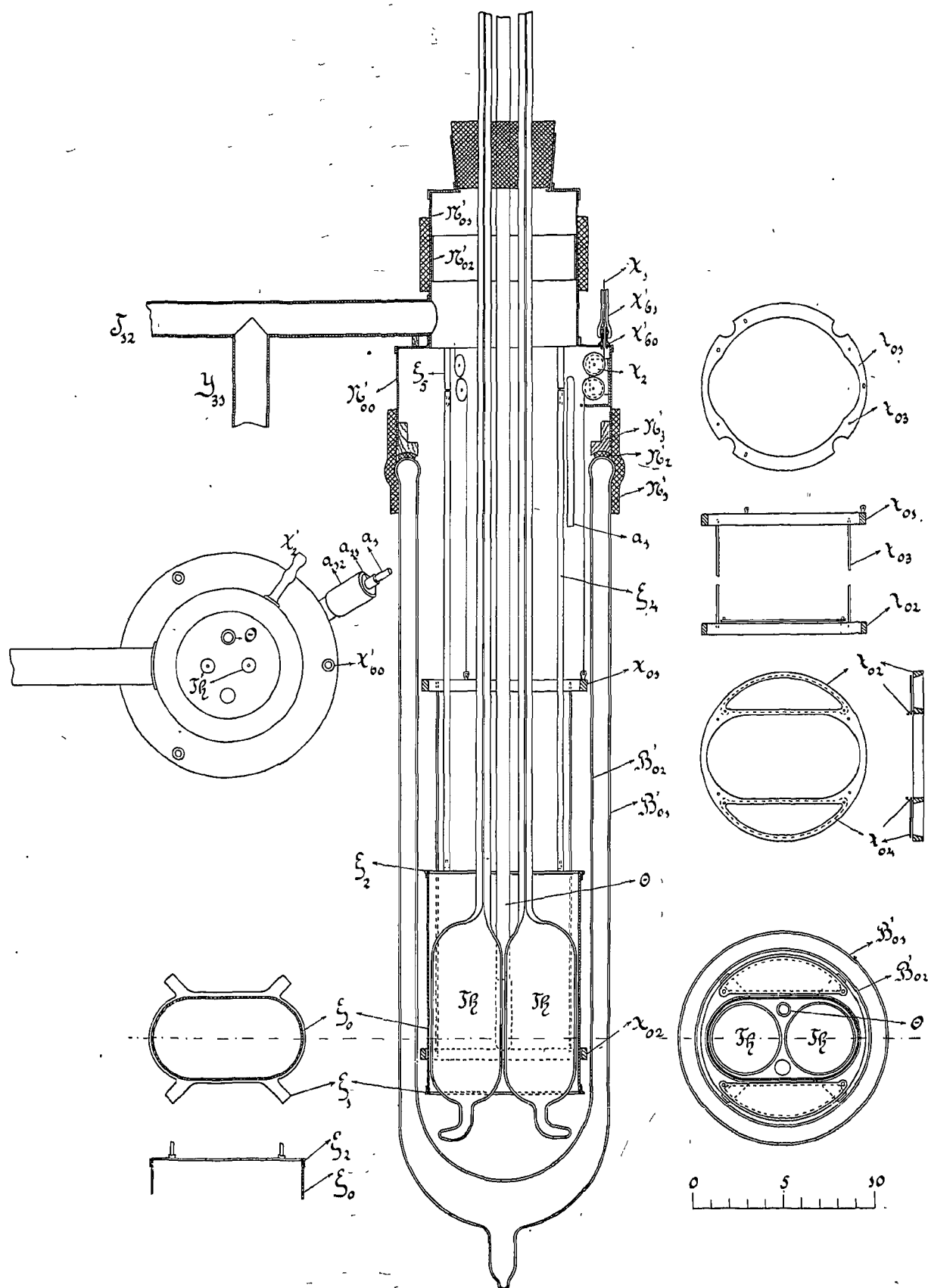
The agreement between the mean temperatures of the measuring apparatus and the temperature indicator is further promoted by making the mean height of the two equal.

As with the cryostats of Comm. N°. 83 we can reach by means of this one a constancy to within 0.01°C . For everything relating to this I refer to Comm. N°. 83.

A silvered vacuum glass being used, there was arranged a float (not to be seen in the figure) to show the position of the level of the liquid.

The stopper and the way in which the thermoelement is fixed

¹⁾ The completion of the calculations of these measurements, on the subject of which we shall soon publish a communication, requires some new determinations and the application of some corrections.



into it is given only schematically in the figure. In the same manner as the tube a_1 the thermoelement is easily introduced and moved up and down through a tube arranged for this end.

The controlling rod for determining the mean temperature of the capillary of the thermometer or piezometer could be omitted in these measurements.

§ 2. The working of the cryostats described in the last section and in former communications is based upon the cooling caused by evaporation at the surface of the liquid. Although the temperature in those apparatus is almost everywhere uniform there yet remains a colder layer at the surface and a warmer one at the bottom. In some measurements it is very disturbing that the temperature at the top of the bath is somewhat, though very little, lower than elsewhere. In a following communication I hope to be able to give drawings of a cryostat where the bath is surrounded from the bottom upwards by vapours of a lower temperature than that of the bath, so that if we regulate the pressure there is a continual heating instead of a continual cooling at the surface and the normal condition that the temperature of the upper part of the bath is higher, is reached.

Physics. — *“Methods and apparatus used in the cryogenic laboratory. VIII. Cryostat with liquid oxygen for temperatures below -210° C.”* Communication N°. 94^a from the Physical Laboratory at Leiden by Prof. H. KAMERLINGH ONNES.

In Comm. N°. 83 IV (March '03) I have described how in one of my cryostats constant temperatures between -195° C. and -210° C. (in round numbers) are maintained by means of liquid nitrogen. Whereas between -180° C. and -195° C. (in round numbers) oxygen is the proper liquid for cryostats, for the range between -195° C. and the freezing point of nitrogen the latter substance offers the advantage that its vapour pressure is several times larger than that of oxygen and that the quantity of it which evaporates at the same quantity of heat supplied, can be taken up by a vacuum pump of a much smaller capacity. Moreover if for evaporation purposes we are obliged to use the same vacuum pump which also serves for the methylchloride or ethylene, the difficulties are much less with nitrogen than with oxygen. All these reasons made us formerly prefer nitrogen for temperatures below -195° C. For temperatures below the freezing-point of nitrogen, however, we are