Physics. — *Measurements of the electrical resistance of pure indium, thallium and gallium at low temperatures and of the magnetic disturbance of the supraconductivity of thallium.* By W. J. DE HAAS and J. VOOGD. (Comm. N°. 212*d* from the Physical Laboratory at Leiden.)

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§ 1. *Introduction.* The change of the electric resistance of indium and thallium at very low temperatures has been investigated by W. TUYN and H. KAMERLINGH ONNES[1]).

For our investigations on the magnetic disturbance of the supraconductivity we had at our disposal resistances of very pure indium and thallium and the spectroscopically pure gallium. Our measurements gave the definite result that this last metal too belongs to the supraconductors[2]).

We investigated the resistance of these pure metals and of thallium the longitudinal magnetic disturbance of the supraconductivity at different temperatures.

§ 2. *Indium.* We used the resistance *In*-1-1928, made of very pure indium from Ad. Hilger Ltd., London. For the measurements short indium wires were soldered to its extremities. We measured the resistance at the boiling point of helium and at some temperatures in the neighbourhood of the transition point of indium. In table 1 we give the values of the resistances divided by the resistance at 0° C. (R/R_0) for these temperatures.

The temperatures were derived from the vapour pressures of the helium bath with the aid of the vapour pressure curve[3]).

TABLE 1. *In*-1-1928.

T °K.	p_{helium} in mm Hg.	R/R_0
4.24	774	0.00904
3.38	311.5	0.00894
3.37	310.2	0.00204
3.37	309.4	0

1) Comm. Leiden N°. 167*a*.
Comm. Leiden N°. 160*a*.
2) Comm. Leiden N°. 199*d*.
3) W. H. KEESOM, SOPHUS WEBER and G. SCHMIDT, Comm. Leiden N°. 202*c*.

In order to make comparisons with earlier measurements easy we give the vapour pressures separately. The value R/R_0 at the boiling point of helium is 0.00904 and the resistance vanishes between 311 and 309 mm. pressure of the helium vapour.

For the purest indium, investigated by TUIJN and KAMERLINGH ONNES the value of R/R_0 was 0.03390 at the boiling point of helium and its resistance vanished between 309 and 305 mm pressure of the helium vapour. The transition point evidently rises somewhat when the purity is increased.

For *In*-1-1930 the resistance vanishes within a smaller temperature interval than for the indium samples examined previously. Probably this has to do with the monocrystalline character of *In*-1-1930 which became evident by the investigation of the magnetic disturbance [1]).

§ 3. *Thallium.* We made a wire by pressing the liquid thallium, obtained in a pure state from Ad. Hilger Ltd., into a glass capillary. This capillary tube was somewhat wider at the extremities into which two platinum wires were melted.

After crystallisation of the liquid thallium we called this resistance *Tl*-1-1930. The tube was hermetically closed so that the thallium could not oxidize.

We determined the change of this resistance in liquid hydrogen and in liquid helium. The results of the measurements have been given in table 2.

The value R/R_0 at the boiling point of helium is somewhat lower than in the case of the purest sample examined by TUYN and KAMERLINGH ONNES.

The transition point however is the same.

TABLE 2. *Tl*-1-1930.

T °K.	p_{helium} in mm Hg.	R/R_0
20.41		0.03051
18.06		0.02298
16.21		0.01765
14.24		0.01263
4.22	759	0.000537
2.38	60.1	0.000408
2.35	56.9	0

§ 4. *Gallium.* From the pure gallium, kindly put at our disposal by Prof. JAEGER, Groningen, we made some resistances, one of which was *Ga*-5-1928.

[1]) Comm. Leiden N°. 187*d*.

For the measurements copper wires were welded to the gallium wire. The results of the resistance measurements between 91° K. and 4° K. have been given in table 3. In a previous paper we communicated already

TABLE 3. *Ga*-5-1928.

T°K	R/R_0
90.55	0.2625
74.83	0.1925
57.07	0.1170
20.43	0.00906
18.72	0.00687
16.58	0.00462
14.04	0.00265
4.23	0.00031

the change of the resistance of this pure gallium below 4° K. and especially its vanishing between 1°.07 K. and 1°.05 K.[1]).

§ 5. *Investigation of the longitudinal magnetic disturbance of the supraconductivity of pure thallium.* W. TUYN investigated already the temperature dependance of the transverse magnetic disturbance of the supraconductivity of thallium[2]).

We extended this research by measuring for different temperatures the longitudinal disturbance for the resistance *Tl*-1-1930. The results of the measurements are to be found in table 4.

In an increasing magnetic field the resistance is restored to its normal value within a small range of field intensity. If the field is again decreased, first a wide hysteresis shows itself and then the resistance vanishes discontinuously in a few steps.

The character of the transition figure suggests the idea that the resistance *Tl*-1-1930 has a monocrystalline structure. We did not investigate this in detail.

In table 4 we also give the value of the magnetic field for which in an increasing field the resistance is restored to half of its normal value ($HW\frac{1}{2}$).

As was found in an other investigation the value of this field is very useful to indicate the way in which the magnetic disturbance depends on

[1]) Comm. Leiden N°. 199*d*.

[2]) Comm. Leiden N°. 191*b*.

TABLE 4. *Tl*-1-1930.

H	R	Remarks	T °K.	p_{helium} in mm. Hg.	$HW\ 1/2$
31.2		resistance comes back	2.13	34.4	31.4
31.4	0.000056				
31.7	072				
32.1	108				
34.2	110				
42.8	108				
31.7	108				
30.8	110				
28.3	0	resistance vanishes suddenly			
68.5	0		1.78	12.4	70.0
70.0	0.000036				
70.6	109				
75.0	107				
85.6	109				
128.4	108				
68.5	109				
66.3	109				
64.4	0	resistance vanishes suddenly			
85.6	0		1.56	5.6	91.6
91.6	0.000061				
92.4	108				
96.3	108				
128.4	108				
87.7	108				
85.6	0	resistance vanishes suddenly			
110.0		resistance comes back	1.35	2.05	110.6
110.6	0.000053				
111.3	108				
171.2	108				
109.1	108				
104.4	0	resistance vanishes suddenly			

the temperature [1]). The measured half values are plotted in fig. 1 against the temperature. For comparison we calculated the same values for mercury

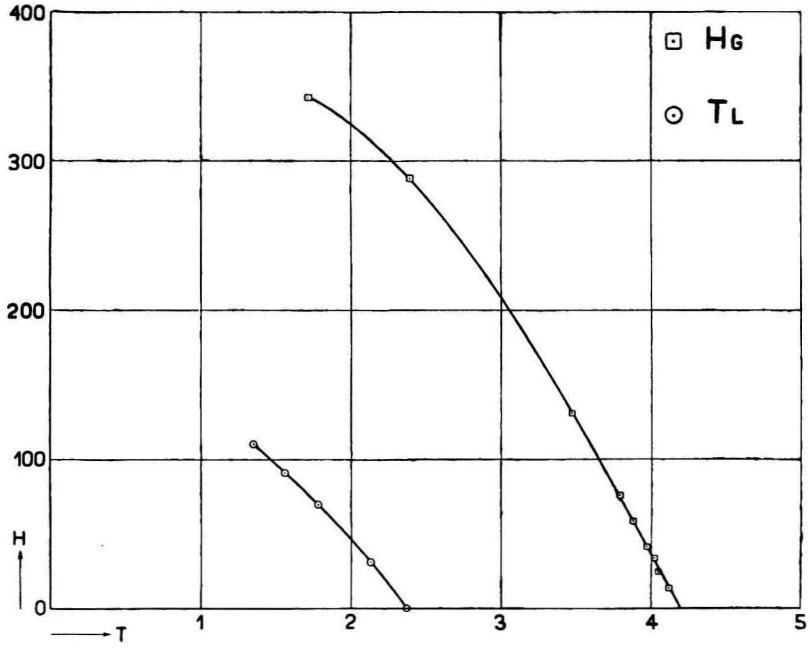

Fig. 1.

from measurements of W. J. DE HAAS, G. J. SIZOO and H. KAMERLINGH ONNES, the temperatures of which we corrected with the aid of the new vapour pressure curve for liquid helium [2]).

For mercury the curve magnetic half value — temperature begins at the transition point as a straight line, but below 3° it is curved more and more towards the temperature axis.

For thallium this curvature sets in directly below the transition point already.

Therefore the cause of the curvature is present in mercury below 3° K. only and in thallium is already present at the transition point.

We gladly express our thanks to Mr. J. M. BLOM for his help during the measurements.

[1]) Comm. Leiden N°. 212c.
[2]) Comm. Leiden N°. 180d.