Letters to the Editor.

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A New Phenomenon in the Change of Resistance in a Magnetic Field of Single Crystals of Bismuth.

FROM many investigations it is well known that bismuth shows very variable behaviour. We have investigated a very pure specimen; Hilger's bismuth was purified still further. The crystals made from this material proved to be excellent. With X-rays they show very sharp interference spots or lines, and when compressed nothing could be observed of the phenomenon of 'cracks' as described by Borelius, Lindh, and Kapitza (*Proc. Roy. Soc.*, A, vol. 119, p. 366; 1928). From these crystals we measured the change of resistance in the magnetic field at different temperatures.

First we determined the change in resistance of several crystals having the principal axis parallel to their length. The current flows in the length direction of the crystal. The rod is put in the magnetic field with its length (that is, principal axis) at right angles to the lines of force of the field, and it is possible to turn it round an axis coinciding with the principal axis.

We determined the curves giving the change of resistance as a function of the intensity of the magnetic field, when one of the binary axes was either parallel to or at right angles with the field. These curves show a very complicated form, extremely so if the binary axis is at right angles with the field.

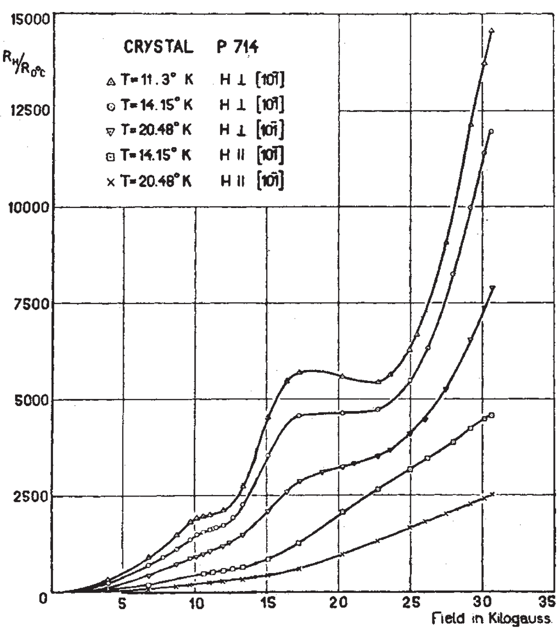

FIG. 1.

In Fig. 1 these curves are given for the temperatures 20·48° K., 14·15° K. and 11·3° K. The abscissæ are the intensities of the magnetic field; the ordinates are the values of $R_H/R_{0°\,C.}$ R_H is the resistance in the magnetic field at low temperatures; $R_{0°\,C.}$ the resistance without a field at 0° C. It will be seen that the curves do not show a parabolic part in the beginning which gradually changes into a linear part at higher field strengths. It has been found that the whole phenomenon strongly depends on temperature: at higher temperatures the curves become more and more simple. This can already be seen at 20·48° K. Here the first flat part found at about 9·5 kilogauss, and prominent at 11·3° K., has nearly disappeared. Measurements at higher temperatures, for example, 64·25° K. and 77·40° K., show a very simple curve, just as has been found hitherto at all temperatures.

In order to investigate the phenomenon more thoroughly we measured the change of the resistance, keeping the field constant, but changing gradually the angle between a binary axis and the lines of force, and

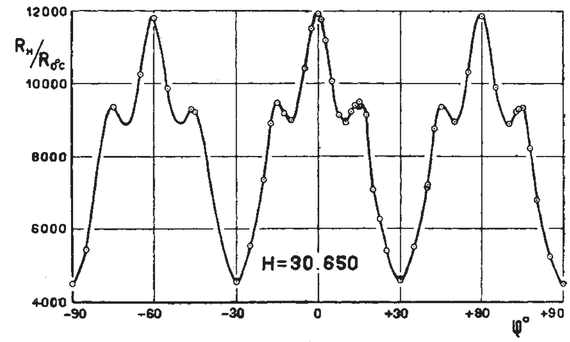

FIG. 2.

reading the resistance and the angle after each displacement. In Fig. 2 the abscissæ are the angle ϕ, between the crystallographic direction [112] in the crystal and the lines of force, ordinates are the values of $R_H/R_{0°\,C.}$ at those different angles, in a field of 30·650 gauss at a temperature of 14·15° K. This curve does not show cosine form, but gives a much more complicated relation of the resistance to small changes of the angle. Simple cosine curves have been found only at very low field strengths. At higher temperatures we do not find the complicated form.

We are now investigating some crystals having two different orientations. Both these orientations have the principal axes at right angles with the length of the crystal. For the first orientation, the length coincides with the direction of a binary axis (and with the axis round which the crystal can be turned, it being also at right angles with the lines of forces and coinciding with the direction of the current). For the second one all this is the same, but the length coincides now with the direction of a bisectrix of two binary axes. Here, too, we investigated the change of resistance with temperature, field strength, and angle of the principal axis with the field. The most important result of these investigations is that the curves have much in common with those given above for the other orientation (Figs. 1 and 2).

Here, too, we find at low temperatures that the resistance in the field changes rapidly with small changes of ϕ. This phenomenon disappears only when we pass to high temperatures and to weak magnetic fields. Of course the form of the curve giving $R_H/R_{0°\,C.}$ as a function of ϕ is in this case quite different from the one given in Fig. 2.

The results are very much influenced by the purity of the material used for the crystals. As an indication of this purity, it may be stated that our crystals show at 1·3° K. a resistance having a value of some thousandths of that at 0° C. At 11·3° K. the resistance in a magnetic field of 31 kilogauss is 922·000 times higher than that without the field.

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