Letters to the Editor

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NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 483.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Superconductivity of Thin Films of Mercury

SHALNIKOV¹ in a recent letter has reported some results on the superconductivity of lead and tin films prepared by evaporative deposition. We have recently obtained some measurements on the superconductivity of mercury films which were prepared

The accompanying figure illustrates the dependence of this 'onset' field upon temperature for three different films with thicknesses as shown. The field changes by a factor of more than fifteen as we pass from the thinnest to the thickest film. For comparison, the critical field for bulk mercury is appended ; it coincides satisfactorily

with the critical field for the film 9.12×10^{-5} cm. thick. But it must be pointed out that even for this thick film considerably greater fields are needed to restore the resistance completely, whereas for the bulk metal the transition is sharp.

Shalnikov gives details of the destruction of superconductivity by large currents. We have not investigated the effect of high current density on the films because of the difficulty of correcting for the temperature gradient through the glass surface arising from the power dissipated in the film. This may give rise to large temperature differences: for example, assuming a current of 60 ma. traverses a film 0.5 cm. broad deposited on a pyrex surface 0.1 cm. thick, we find that a temperature difference could exist of nearly 0.9°C . per ohm of a square patch. (Thermal conductivity of pyrex extrapolated from Stephens' results³.) Shalnikov does not mention

by a technique developed by Lovell and one of us². A long series of preliminary investigations showed that films deposited at 64°K . and annealed at 90°K . were practically uniform and coherent if more than 400 Å. in thickness. Their resistivity also closely approached that of the bulk metal. So far, therefore, we have confined our measurements of superconductivity to annealed films exceeding the above thickness.

In agreement with Shalnikov's results for annealed lead and tin, we find that their transition temperature in zero magnetic field (4.14°K .) closely approximates to that of the bulk metal (4.17°K .). We attribute no significance to this small consistent difference of 0.03°K ., since the films are deposited on one side of a pyrex wall which is cooled on the other side by liquid helium, and temperatures are estimated from the vapour pressure of the helium bath. A temperature difference of this order can easily arise from absorption of heat radiation on the outer face of the pyrex.

We find, also in agreement with Shalnikov, that the films show very high magnetic threshold fields. If the field is applied parallel to the plane of the film, complete restoration of resistance takes place over a considerable range of magnetic field, but the first onset of resistance is quite sharp.

the magnitude of the correction made for this effect. It might be very large for the thinnest films, at any rate when the current is being reduced to give the transition from the normal to the superconducting state.

At first sight it appears that, since no power is dissipated in a superconducting film, there should be no heating effect at any currents when the film is cooled with no current flowing. But the possibility still exists that some section of the film, say, in the neighbourhood of the current leads, may be non-superconducting. Heat will be developed here and will spread by conduction so that successive sections of the film show normal resistance, and the process will be cumulative. Thus we feel that the interpretation of Shalnikov's results for the critical current should be accepted with some reserve.

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¹ Shalnikov, *NATURE*, **142**, 74 (1938).

² Lovell, *Proc. Roy. Soc. A*, **157**, 311 (1936); Appleyard, *Proc. Phys. Soc.*, **49**, 118 (1937), Extra Part.

³ Stephens, *Phil. Mag.*, **14**, 912 (1932).