NOTE ON THE CRYSTALLINE STRUCTURE OF ELECTRO-DEPOSITED COPPER.

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Mr. Cowper-Coles, in his "Notes on the Rapid Electro-deposition of Copper," mentions on p. 224 (*Trans.*, Vol. I.) an explanation due to me—though doubtless by an oversight he omitted to say so—which makes it clear why a spiral scratch or groove on the mandril causes the copper deposited on it to part easily so that a long ribbon can be obtained. Mr. Cowper-Coles, in this paragraph, continues to confuse molecular and crystalline structure, and the drawing he gives in illustration is exactly the opposite of what actually occurs. If it had not been for this I should not have brought the matter up again.

My explanation was that the direction of the lines of crystallisation of an electro-deposited metal are the same as in a casting made on surfaces having the same inclination, *i.e.*, the crystals form at right angles to the surface on which the deposit or the casting is made. It follows that when the crystals which form on surfaces more or less at an angle to one another meet, there will be want of continuity in the two sets of crystals, and a line of more or less weakness will have been developed.

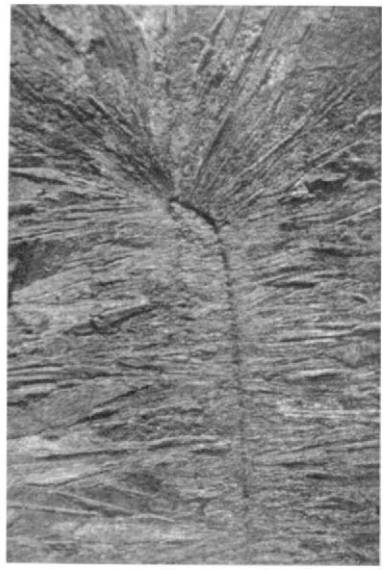
To make this clear to you I have had a piece of Mr. Cowper-Coles's copper deposit for making wire polished* and etched with nitric acid in alcohol (illustration 1). You will see at once the effect the groove on the mandril has on the direction of the crystals of the deposit. There is, in fact, a complete break in the continuity of the metal. To compare with this I have had photographed a casting composed of 50 copper + 50 zinc (illustration 2). You will observe that crystals from the opposite long sides, which must be approximately parallel, do not even then merge one into the other, but show a break. These examples amongst other things point to the importance of avoiding sharp angles in castings and deposits when strength and not rupture is aimed at.

I have also here to show you photo-micrographs of a cathode plate which has been deposited on a thin strip of electro-deposited copper (illustrations 3 and 4). The crystals of the original strip have been continued in some cases in the cathode plate. This was the side of the strip which had not been in contact with the surface on which the strip was deposited and so had a clean crystalline face. The way the crystals follow the curvature of the strip is very apparent.

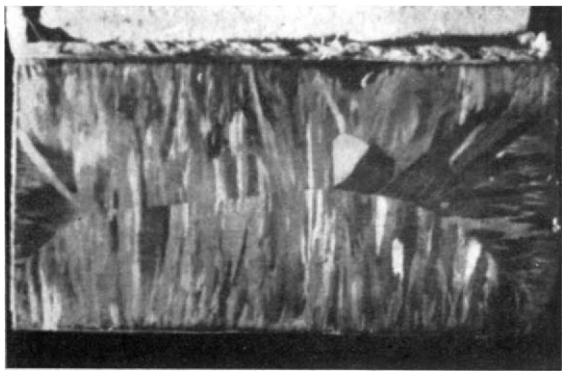
Another photo-micrograph (illustration 5) illustrates what happens when the electro-deposited copper is annealed. The long crystals of the deposit are completely broken up and become largely twinned. To compare with that, I give you a photo-micrograph of a rolled copper rod which has been annealed (illustration 6). We may learn from these that brittleness due to

* In order to polish the strip without rounding the edges, I had white metal cast round it.

No. 1. × 20 DIAM.



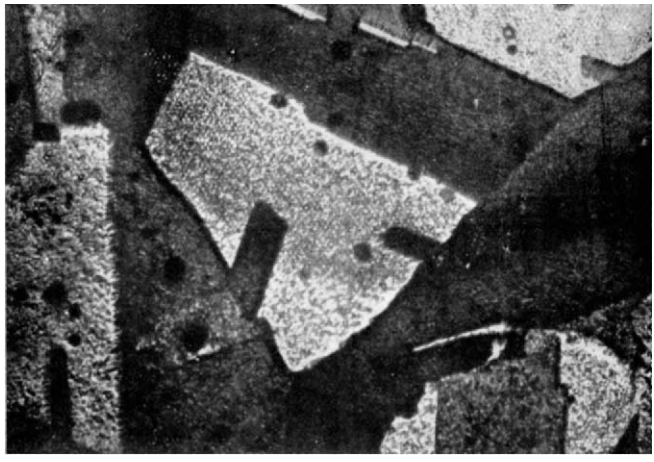
No. 3. × 15 DIAM.



No. 2. × 2 DIAM.

No. 4. × 15 DIAM.

No. 5. × 50 DIAM.



No. 6. × 300 DIAM.

the direction in which crystals form in castings and electro-deposits may be modified and probably completely removed by suitable annealing. This, however, would be the case only when there was a line of weakness and the continuity was not entirely broken, otherwise the unequal expansion caused by the heat would make matters worse rather than better.

I may be wrong, but I am under the impression that these are the first photo-micrographs of electro-deposited copper, at any rate good ones, which have been published, which somewhat astonished me when my attention was called to the fact by my assistant, Dr. Desch, who has been very successful in showing up the points I required.