THE DENSITY OF ALUMINIUM.*

By F. J. BRISLEE, D.Sc.

DISCUSSION.

(Held on Wednesday, November 26, 1913, MR. W. R. BOUSFIELD, M.A., K.C.,
VICE-PRESIDENT, in the Chair.)

Dr. R. Seligman said that some time having elapsed between the reading of this Paper and the discussion, he felt unable to go into the questions raised in any detail. It appeared that this Paper originated in some remarks of the speaker on Dr. Brislee's former Paper on this subject, although Dr. Brislee had not mentioned this. On that occasion the speaker had drawn attention to the fact that in spite of the immense amount of work done on the metal during rolling and drawing Dr. Brislee found no increase in density. Moreover, as Dr. Brislee also found no increase in density on annealing such hard-worked metal, the latter was not apparently in the amorphous and less dense state described by Beilby in other metals. The present results show that there is in fact an increase in density on annealing, thus removing the anomaly in the author's previous results to which the speaker had drawn attention. Aluminium is thus seen to fall into line with other metals, the hard-worked metal being amorphous and light compared with the denser crystalline annealed metal. These results were important also from the technical point of view, owing to the differences which had been shown to exist in the stability of the hard-worked and annealed metal.

Professor Alfred W. Porter, referring also to the author's observation that the density of aluminium was decreased by working, pointed out that increasing the pressure must always diminish the volume, otherwise the equilibrium at any instant would be unstable. There was a difficulty, however, in the case of the assumed Al cryst. $\rightarrow$ amorph.; because the transformation persists *after the pressure is removed*. The process was therefore irreversible (assuming that it occurs). This landed one in difficulties, which it was rather hard to express an opinion about. Some information would be useful: Does aluminium become hot when it is rolled? Is anything known about the increase or decrease of the amorphous variety with temperature? He believed that the increase in the *oxidized* surface would be more than sufficient to account for the observed change in specific volume.

Dr. F. J. Brislee (*communicated reply*): In reply to Professor A. W. Porter's questions, the temperature of aluminium certainly rises during rolling. As a rule, however, the rise is not very great, owing to the large rolls acting as coolers, hence it is difficult to say anything about the increase or decrease of the amorphous variety with the temperature. This is also rendered more difficult owing to the partial annealing which the metal undergoes during

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cooling, and with some metals this is sufficiently great to reduce the mechanical strength. In such cases the metal is cooled in water after passing through the rolls or dies to avoid the "auto-annealing." Finally, there is no increase in oxidized surface as suggested. The specimens referred to in the Paper were all annealed in a non-oxidizing atmosphere and the weights before and after annealing were practically identical, the maximum variations being only a fraction of a milligram. In some cases the specimens were cleaned and polished after annealing to remove any trace of oxide.