NOTES FROM THE RESEARCH LABORATORY, GENERAL ELECTRIC COMPANY.*

THE MECHANISM OF FRACTURE IN STEEL.

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[ABSTRACT.]

MICROSCOPIC examination shows that steel is crystalline in nature and heterogeneous in composition. Each constituent has its own physical and chemical characteristics, and the results which we get from the test bar are really summations of the physical characteristics of the constituents. Alternating stress is one of the most accurate methods for the determination of the true elastic limit.

The photograph illustrates very satisfactorily the difference in strength and the manner of fracture between large single crystals of the same steel which differ only in orientations. Crystals may have widely different strengths, which depend on the relation of the direction of orientation to the applied stress.

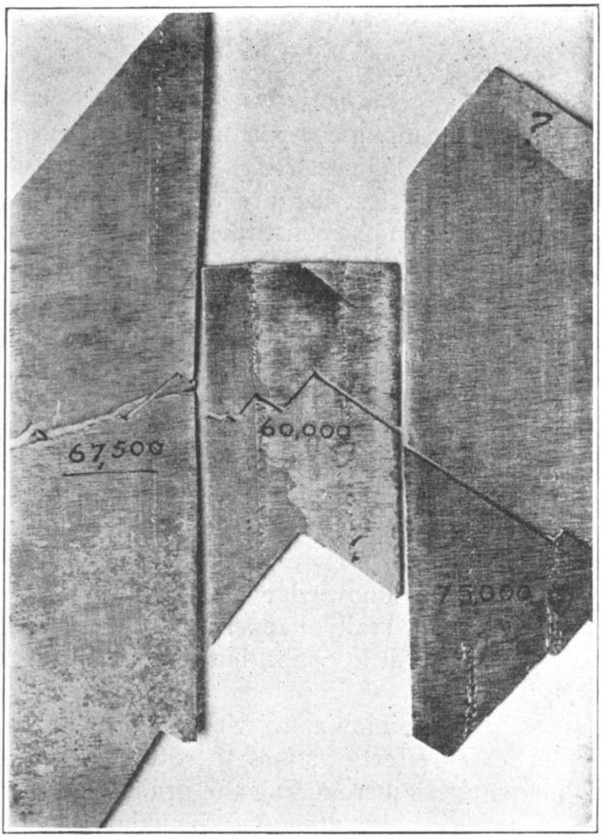
Howe's modification of Rosenhain's amorphous theory seems to offer the most plausible explanation of the greater strength of the grain boundaries. Thompson's surface tension theory adds very little to our knowledge and rather complicates our conception as to what really happens. That surface tension actually exists, there is little doubt, but it does not appear to be a determining factor.

The author's own opinion as to what happens in the fracture of steel is: " The first effect of stress, therefore, is to cause a flow of amorphous material surrounding the grains, indicated micrographically by a ridging along the grain boundaries and a molecular yield in the space-lattice of the crystals. When the elastic limit is reached the amorphous cement, as determined by the strength and amount of it, breaks transversely, owing to its weakness in that direction, and the load is suddenly thrown upon the crystal. The plastic yielding, due to slipping, causes a sudden drop in the applied stress, which, after sufficient intercrystalline amorphization takes place, again causes the applied stress to rise,

* Communicated by the Director.

but this time with considerable elongation. This is what the stress and strain diagram shows us actually happens. The unbroken part of the intercrystalline cement is not weakened and so still supports the crystal laterally."

The longer path of the intergranular cement, as compared



with internal shear, accounts for the fact that we do not have intergranular fracture in the case of suddenly applied loads. The strength of the grain boundaries, therefore, can be accounted for on the mere assumption that the amorphous boundary material is somewhat stronger than the crystalline phase without complicating our conceptions with further unnecessary assumptions.