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Dynamic Stresses on Welded Steel Structures.

Dynamische Beanspruchungen bei geschweißten Stahlkonstruktionen.

Actions dynamiques sur les constructions soudées.

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The object of this contribution is to draw attention to a difficulty which, in the writer's opinion, arises in regard to the study of dynamic action on welded structures.

Generally speaking the effect of moving live loads on bridges and building frameworks is to bring into play forces of inertia. Such forces call for a "live" resistance, or resilience, in place of the usual kind of statical resistance which is exerted by materials. It may be observed that in the case of butt welded connections the resilience is always considerable, amounting to at least 8 kg/cm². In practice still higher vlues are obtained, being of the same order as the resilience of the parent metal, approximately 12 kg/cm². From this point of view it would appear, then, that the average resistance of a welded structure, taking full account of the presence of joints, is high enough to ensure that such a structure will behave well under live loads of the kind which may give rise to impact.

The writer has in fact found this to be true as regards the swing bridge at Brest, which, after having undergone strengthening operations, was subjected to tests under the direction of Mons. *Cavenel,* Ingénieur en Chef des Ponts et Chausseés, and Mons. *Lecomte,* Ingénieur des Ponts et Chausseés. These tests yielded very satisfactory results, it being found that after the strengthening work the vibration was considerably reduced.

For some time past a good deal of importance has also been attached to fatigue tests. It is known that if a solid — particularly steel — is subjected to forces which are repeated a great number of times fracture may occur even though the limiting resistance or even the elastic limit has not been reached. This fact obviously implies a serious danger due to dynamic action and the question is indisputably one which deserves the closest examination. The writer is of opinion, nevertheless, that this danger should not be exaggerated, for it is a fact that the majority of framed structures are not subjected to repeated loading of the kind that occurs in mechanical engineering.

A very complete investigation of this problem which has been carried out in France by Mons. *Dutilleul,* Ingénieur du Génie Maritime, indicates that lack of fatigue resistance in welds is always attributable to the presence of air bubbles, or in other words, to the porosity of the metal. In the present state of knowledge on the subject it appears, to the writer, dangerous to adopt as a criterion of quality of welding something which depends partly on chance, and he is of opinion that the resilience is the most important characteristic to consider.

In any case, whether it is resilience or fatigue resistance that is the most important element, there remains the over-riding necessity of ensuring that the weld bead shall be given a shape which will not tend notably to increase the

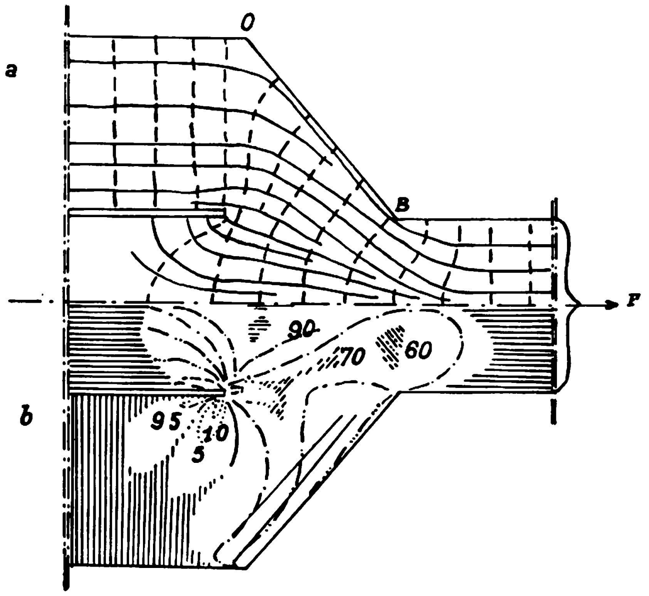

Fig. 1.

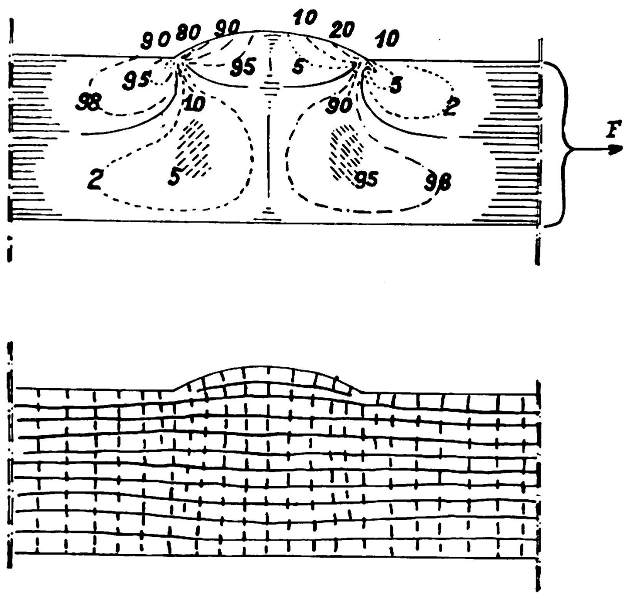

Fig. 2.

risk of rupture. On this subject, as Messrs. *Kommerell* and *Graf* have shown, valuable data can be inferred from the study of lines of principal stress under static loads.

The two illustrations here given go to confirm this argument, representing as they do the lines of force in a transverse weld and in a butt weld (Figs. 1 and 2). These were obtained by the use of polarised light applied to a celluloid model shaped and stressed in the same way as the welded piece. The photographs show very clearly that it is important to minimise any disturbance of the flow of the lines of force. For instance, in the case of the butt weld it may be observed that an excess of thickness may be harmful, in that it perceptibly increases the amount of strain suffered at one of the faces of the specimen.