railway is going on rapidly throughout the country, the total saving of expenditure by the adoption of the better bridges will be considerable.

In one of his letters, Mr. Waddell said that, if desired, he would be willing to express his opinion how to correct the defects of our railway bridges. But as no one has made this request, I now ask Mr. Waddell whether he will have the kindness to give us his opinion.

My last letter was written in order to show your readers what is the opinion of an eminent English engineer: this one will give the opinion of an eminent German engineer, Mr. Charles Bender, who published lately a treatise on "Principles of Economy in the Design of Metallic Bridges."

In the preface he says:—"The system of competitive design, combined with competition prices, has produced in the United States the most economical and the most serviceable form of a single-span bridge. But there are other forms, such as arches, cantilever-trusses and arches, and for the greatest spans, stiffened-wire suspension-bridges, of which the merits and proper proportions are less generally known, and outside of the United States the question as to the most economical form of truss is not yet everywhere settled."

In the fifth chapter he says:—"The strains calculated under the supposition that plate-girders are homogeneous beams, or that the joint-points of skeleton-structures are mathematical hinges, are termed primary strains.

Those strains which arise from the fact that the joints are more or less rigid, or which are caused by the gravity-lines of the members of a structure not meeting in the mathematical joint-points, are termed secondary strains.

These strains are caused by flexures of the members which in the calculation of the primary strains were supposed to remain straight lines.

These moments of flexure may not amount to any considerable percentage of the moments of flexure of the whole structure, and yet they may cause considerable additional local strains.

The correct intersection of gravity-lines of the members can be secured, and this principle should not be neglected in the lateral and transverse wind-bracing or in the attachment of the floor beams.

The secondary strains arising from rigid connections are unavoidable, and the question arises how great they may be, how they can be diminished, and how they must be provided for."

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"We cannot enter into the subject, but we shall state the principles of the theory of secondary strains:—

The more nearly the structure is designed to contain the minimum volume of material, or, what is the same thing, the less the sum of deflections of its joint-points, the smaller the secondary strains must be.

Hence the good rule to use the greatest practicable depth of truss."

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"The longer the distance between connecting points the smaller the secondary strains will be.

Hence the good rule to use long panels and not to shorten artificially the members by inter-riveting the web-members where they cross each other.

The more nearly the tensile members are made to resemble mere flexible strings the more easily can they be bent without great strains; the less,