After all, this similarity of the two formulas is what one would expect when it is remembered that they are both empirical formulas based on measurements and experiments made on railway bridges. This is the point that the writer wishes to emphasize. It at present seems utterly impossible to express by means of a rational mathematical formula the effects of shocks, blows, jars, etc., which will be generally true for all structures and all manner of moving loads. Given a certain uniform type of structure and method of loading, it is quite possible to obtain a factor or formula which will give more or less accurately the equivalent static stress for moving loads but it would be rather a strange coincidence if the formula thus obtained for railway bridges should be found to be in any way suitable for any other structures, such as highway bridges not carrying street cars. Until it has been shown conclusively that railway bridge formulas or some modifications of them are generally true for all bridges they should not be so used, for the conditions of loading

(7) Every other uncertainty in the magnitude of the loads and their application, including possible derailment and future increase.

Effects somewhat similar to these will doubtless be produced in highway bridges by their loads, but the conditions are so entirely different that the results are quite modified. We have the heavy concentrated load producing maximum stresses in the floor beams, stringers and short spans; and the uniform or distributed live load of a much smaller order of magnitude which develops the maximum stresses in the trusses of spans above a certain length. But their liability to cause impact stresses is not the same as a train passing over a railway bridge, as a comparison with the above items will show.

(1) It is not necessary to consider such a thing as true impact due to high speed for a highway bridge. The experiments of the committee of the American Railway Engineering Association, mentioned above, found that impact stresses were inappreciable for speeds below 30

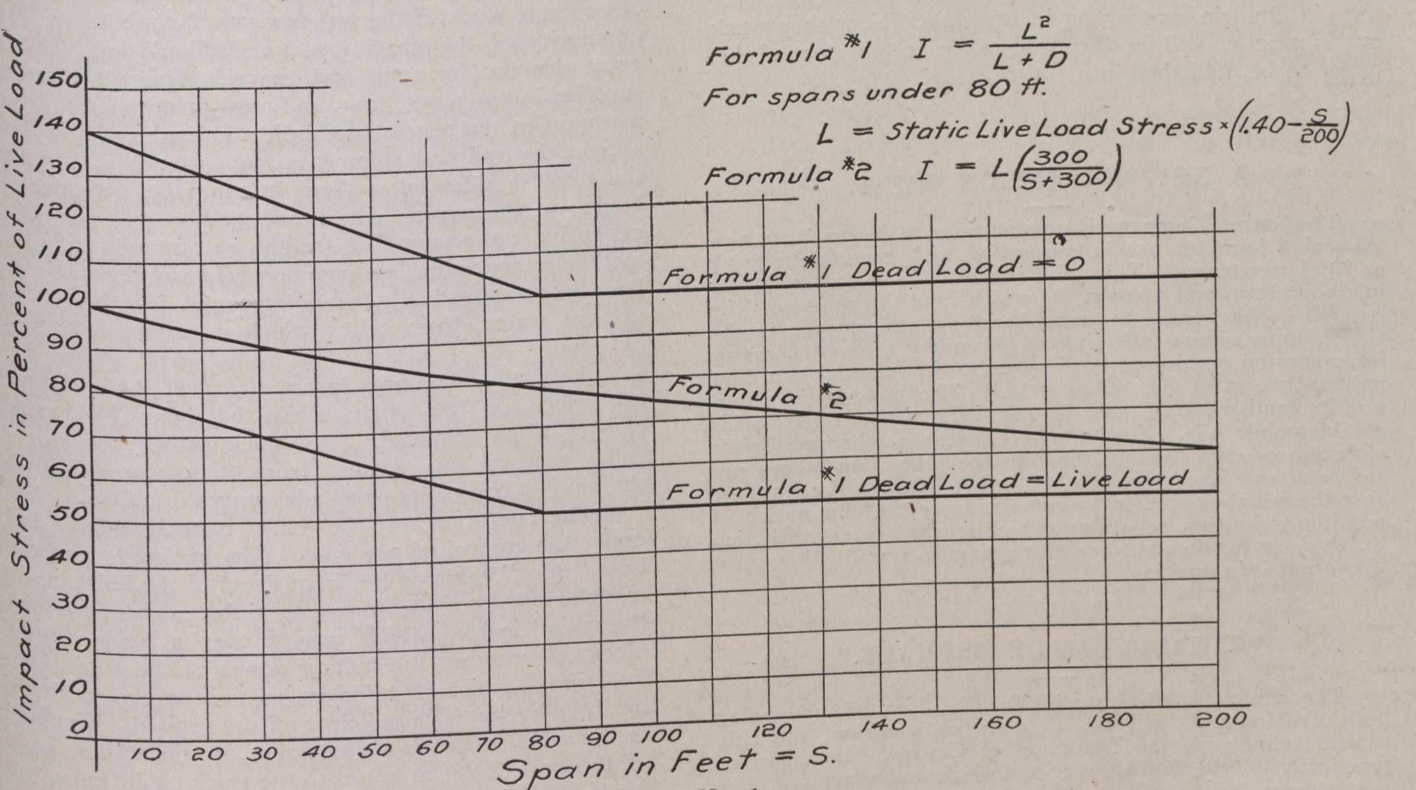

Diagram No. 1.

are very different, as may be seen from the following detail comparison.

The impact increment in the design of railway bridges is supposed to cover the stresses produced by the following conditions:

(1) True impact due to sudden loading caused by the maximum engine and train loads travelling at a high speed.

(2) Pounding of unbalanced parts of the drive wheels, etc.

(3) Pounding of wheels at open joints and of flat wheels.

(4) Swaying of engine and top-heavy tender and other loads.

(5) Vibration and jarring of machinery in motion; the "noseing" of the engine and jolting of cars.

(6) Rhythmic motion set up in the structure due to the synchronism of the blows from the train with the period of vibration of the bridge.

miles an hour. In highway traffic the only live load that exceeds this speed is the motor car. But the heaviest motor car is so much lighter than the road roller for which provision must be made that there is, in a properly designed bridge, an ample factor of safety for the high-speed car. It is true that the 20-ton motor truck is in sight, but its speed is about 10 or 12 miles an hour, and it is far from likely that they will be permitted to travel on highways at the rate of 30 miles.

(2) There is no analogy in highway bridge loads to the pounding of unbalanced drive wheels of locomotives. This is a very important consideration in railway bridges.

(3) The bumping of heavy loads over rough floors, stones, etc., may be compared to the pounding of wheels at open rail joints, but the conditions of highway bridge floors are often such as to aggravate this effect relatively beyond anything that occurs in a railway bridge.

(4) There is the same analogy in swaying of top-heavy loads, but this effect is also associated with the