ings. Such a bank forms an obstruction to the view of a beautiful park vista, that might be a permanent source of pleasure. The railroad bank may be hidden with trees or shrubs and its unsightliness concealed, but if conditions would permit, a better way would be to depress the tracks and leave a clear and unobstructed view.

The city of Springfield, Mass., has a railroad bank running across the city, but some of the street crossings have been made quite attractive, like the one shown in Figure 2.

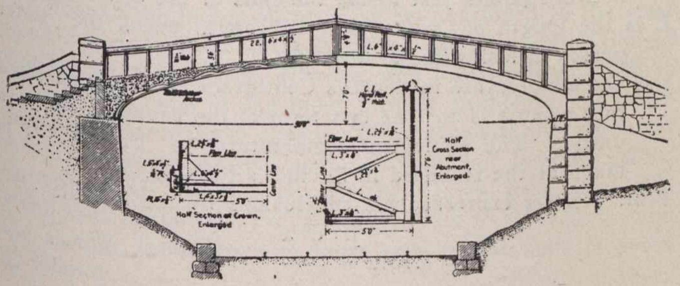

Fig. 4.—Foot Bridge, Madison, Wis.

The railroad is carried over Main Street on a stone arch, artistically designed with towers at either end and stone belt courses of different colors. The necessary head room underneath makes the use of an arch difficult in some cases, and when used, it must necessarily be a flat arch. The bridge at Springfield is so low at the springs that there is a sense of insufficient head room when walking on the sidewalk beneath the bridge. The extreme flatness of the arch also produces a feeling of insecurity and lack of strength which injures it aesthetically, for strength should, if possible, be emphasized in all bridges. Apart from the flatness of the arch, the general effect is quite satisfactory.

At Brockton, Mass., there are a number of ornamental overhead crossings, carrying lines of railroad over the

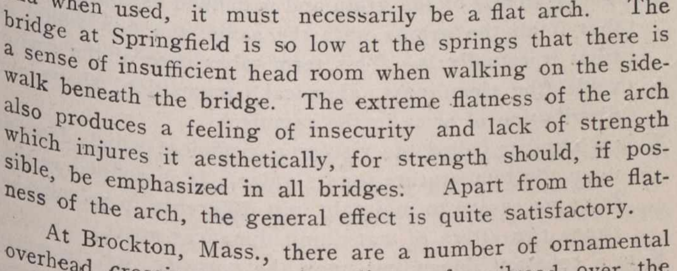

Fig. 5.—Park Bridge at Madison, N.J.

streets. These are built somewhat similar to that at Springfield, with stone arches, but at Brockton the long blank wing walls are unsightly and more prominent than the bridges themselves.

Garfield Boulevard, Chicago, is crossed by a set of railroad tracks which are supported by through plate girder bridges, shown in Figure 3. As the boulevard is quite wide, the bridge has three spans, and an effort has been made to relieve the straight overhead lines by using flat arches beneath the girders.

Other cities have treated the subject of grade crossing elimination in various ways, but generally either by track elevation or depression, as any great change in street grades is usually impracticable.

A plan used by the writer for grade elimination is shown in Figures 4 and 5. This bridge is in the park at Madison, N.J., and carries a foot walk over a double line of railway, which in this case is depressed instead of being elevated on an embankment. Similar treatment can be applied to street or highway bridges over railroad cuttings, either by lowering the railway or by grading up the street approaches instead of using steps, as in the illustration.

THE FLOW OF WATER THROUGH A POROUS MEDIUM.

By L. R. Balch.

The flow of water through a filter medium is a question of important practical application upon which our knowledge is so imperfect that a great deal of further investigating in the laboratory is required. The final object of such experimental research is to determine what factors influence the variation in results under various conditions, and what the effects of those factors are. In conducting the experimental investigations, the principal, and also the most difficult, thing is so to design the apparatus and conduct the tests that these various factors either be eliminated or be determined in effect. A large amount of work and a great deal of study is required before this can be accomplished. It often happens that, though an investigation promises to be comparatively simple, the additions and revisions found necessary as the work advances cause it to become quite complicated before satisfactory results are obtained.

Through the work done on this subject by Mr. Allan Hazen for the Massachusetts State Board of Health, and by Prof. C. S. Slichter, of the University of Wisconsin, a fair knowledge is had of the conditions influencing the flow of water through a soil column and of their effects. A number of conditions which have a very great effect on the rate of flow are quite difficult to determine, making the experimental work a matter of great care and thoroughness. The conditions which influence the rate of flow as shown by previous experiments will be taken up somewhat in detail.

The hydraulic gradient or difference in pressure from point to point, measured in the direction of flow, is the primary cause of the flow of liquid, and the greater the gradient, the greater will be the flow. The value of the hydraulic gradient is measured by means of gage tubes, similar to the piezometer tubes familiar to those acquainted with experimental hydraulics.

The porosity or amount of void space in the porous material has a great influence on the rate of flow, which varies directly with the porosity. In experimenting with a mass of spherical shot, Prof. Slichter found that a number of values for the porosity could be obtained with the same material, depending upon the arrangement or manner of packing. The minimum value was found to be 25.95 per cent. of the whole space occupied. The great effect of the porosity on the flow may be shown by a tabulation given by Prof. Slichter in Water Supply and Irrigation Paper No. 67, published by the United States Geological Survey. From this it appears that if the porosity of the same sample of sand is changed from 30 per cent. to 37 per cent., other conditions remaining the same, the flow in the latter case will be twice that in the former.

There are several methods which may ordinarily be used to determine the porosity of a sample of sand. Probably the

*From the Wisconsin Engineer.