asphalt mastic. Only one expansion joint was provided and this placed at bent 31 where the slab begins to narrow down from the seven-track to the two-track width at the easterly end. The joint was deemed necessary here for the reason that the narrow section would not offer the same tensile resistance to temperature changes as would the wider section. An accumulation of stress might reasonably be expected somewhere in the narrow section if no expansion joint were provided which might result in cracks of sufficient magnitude to impair the strength of the viaduct.

It might be noted here that the only cracks so far developed have occurred in the side panel under tracks 1 and

Fig. No. 7—View of the Central Avenue Bridge, Lackawanna R.R.

2 between bents 24 and 25. The principal crack starts at a point where the centre line of track 3 intersects the side of the drop panel of column in bent 24 and bows out slightly in the arc of a circle to about the third point of the panel, ending at the intersection of the centre line of track 1 with the side of the drop panel of column in the same bent; another break forms almost normal to this main crack radiating from it and continues parallel with and about four feet off the centre line of track 1. This crack extends completely through the centre of the large drop panel common to the two outermost columns of bent 25, but like the main crack does not seriously impair the strength of the slab.

A plausible explanation of the cause of the cracking which happened before any live-load was applied might be advanced. This section was poured July 14th, 1916. The waterproofing was laid during the following winter and it was on this panel that the kettles for melting the asphalts were placed, resulting in high temperatures in the slab. There is the possibility that the subsequent sudden cooling of the slab in zero weather caused the cracking above described. Sudden atmospheric changes of wide range are common in locality around Buffalo.

This hypothesis is not advanced so much in an endeavor to substantiate the writer's previous remarks—that the constant tensile resistance of the slab under ordinary conditions has the effect of preventing cumulative action of the stresses at any particular section—but is given rather for its value as a warning in anticipation of what may occur to any concrete bridge slab if too much heat is applied locally in extreme cold weather to comparatively thin slab for whatever may be the purpose.

South Orange Station Viaduct

The second application of the flat-slab construction made by the Delaware, Lackawanna and Western Railroad solved in a very acceptable manner one of the perplexing problems encountered in grade crossing elimination through populous sections. The difficulty develops when it becomes necessary to acquire abutting property for the expansion of tracks and station facilities, in which case the property is usually rated at an exorbitant value.

This condition prevailed in connection with track elevation work through South Orange, N.J., where the acquisition of more right-of-way would have been necessary for an additional third track and island platform together with a new station if the latter were to be built in the usual manner alongside. The necessity of purchase was obviated advantageously by the adoption of a flat slab viaduct, 79 ft. in width and 426 ft. in length, under which the station and all its appurtenances were built within the confines of the original right-of-way. (See Figs. 3, 4 and 5.)

The proximity of South Orange Avenue, a county highway, was an important consideration in favor of the slab construction since the easterly end of the viaduct is carried over this main thoroughfare. Included in the facilities provided under cover of the slab are a concourse connecting the station with the avenue and its trolley line, parking space for vehicles, a baggage platform and a heating plant apart from the station.

In addition to the three tracks, the viaduct carries an eastbound platform 14 ft. 4½ ins. in width and a 25-ft. island platform between the middle or express track and the westbound local. The 25-ft. width was fixed by clearance requirements on either side of the shelter houses built on the platform.

There are many advantages in addition to that of economy to be gained by this type of construction. It permits of more effective architectural treatment; because of its shallow floor depth the track can be laid in ballast which is a very important consideration in track construction; there are no girders projecting above the deck to encroach upon the lateral clearance of the motive power or to interfere, as in this case, with the construction of the platforms; the rigidity of the structure is noteworthy since no noticeable vibration is developed with the simultaneous passing of heavy locomotives at high speeds on

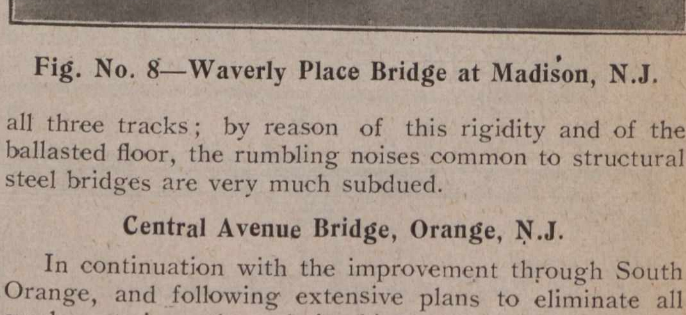

Fig. No. 8—Waverly Place Bridge at Madison, N.J.

all three tracks; by reason of this rigidity and of the ballasted floor, the rumbling noises common to structural steel bridges are very much subdued.

Central Avenue Bridge, Orange, N.J.

In continuation with the improvement through South Orange, and following extensive plans to eliminate all grade crossings through its highly developed suburban sections in New Jersey, the Lackawanna Railroad has elevated tracks through the adjoining City of Orange. Here twenty-three more or less dangerous crossings have been eliminated. In this work concrete was used almost exclusively in the construction of bridges.

The same advantages that accrue from the use of flat-slab construction covering large areas prevail for smaller structures. Fig. 5 and Fig. 6 illustrate its application to