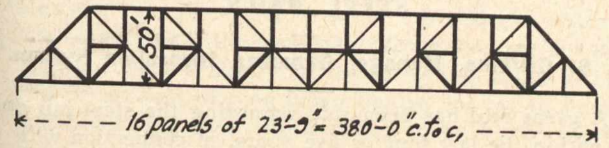
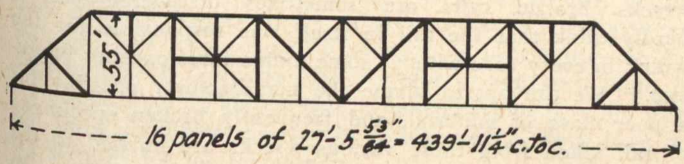
temperature stresses, since large masses of metal require a longer time to change their temperature than smaller ones; that the top chord was ineffectively supported laterally from the fact that only at main panel points, or in the case of large trusses at intervals of nearly sixty feet, could positive lateral support be relied upon; that it was unable, from the great length of panels, to resist destruction by collision, since the stiffness of the chords and floor system over such great lengths was insufficient to hold the structure up. In spite of these objections, the truss is extensively used, and is regarded in America as the standard form for very long spans. In the case of the Delaware River Bridge, built at Bridesburg, Pa., in 1896, containing three 533 ft. spans, the bending stresses which might be induced in the main members by the secondary members were offset by special means. The end panels of the bottom chord were shortened one inch, and the other chords and posts by amounts sufficient to produce under dead load alone an initial bend in the reverse direction, so that when the maximum stresses were developed, the members would again become straight.



(a) New Westminster Bridge, 1904



(b) Bellefontaine Bridge, 1895

Fig. 4 - Baltimore Trusses

The principles governing the choice of depth for trusses of moderate span apply in general to those of long span. Though a depth at the centre of one-seventh to one-fifth of the span is desirable for good appearance and economy of material, it must sometimes be reduced, in high trusses, due to the overturning effect of the wind tending to reverse the tension in the bottom chord of the windward truss. Eye-bars provide no adequate resistance for this, and unless a stiff bottom chord is used, the depth should be chosen so as to avoid stress reversal. By increasing the distance between the trusses, the permissible depth might be correspondingly increased. The objection has been raised that to erect very deep trusses expensive travellers of considerable height have to be built specially for the particular case at hand. This is no longer urged, since very large trusses are now erected completely by derrick cars using extension booms. In Great Britain much shallower trusses are used than in this country. Depths of from one-tenth to one-seventh of the span are seldom exceeded, with the result that the appearance is somewhat marred, and considerable deflection is obviated only by the lavish use of material. In trusses with curved top chords, due to the decrease of depth near the ends, the diagonals make varying angles with the horizontal, and, where this variation is marked, the effect is not pleasing. Examples of this may be seen in Fig. 5 (a), (d) and (e), which represent, respectively, trusses used in the Sixth Street Bridge, Pittsburg; the Plattsmouth Bridge, Plattsmouth, Neb., and the South Tenth Street Bridge, Pittsburg.

Within reasonable limits, the longer the panels in a truss, the greater the economy of material, be the structure of moderate or of the largest size. Floor panels of considerably over thirty feet have been used, as in the case of the Cornwall Bridge, Fig. 3 (a), where they were 33 ft. 5½ in. The prevalent practice is to make the main panel length (i.e., the horizontal projection of a main diagonal) approximately equal to the centre depth, generally slightly less, thus giving the diagonals their economic inclination of about 45 degrees. In the case of Pratt trusses with curved top chords, panel lengths considerably less than the centre depth, sometimes less than one-half of it, have been used, the economy of inclining the top chord offsetting the lack of economy involved in short panels and steep diagonals. Examples of this may be seen in Fig. 3. British engineers adopt much smaller panel lengths for their trusses than is customary in this country, thus giving the impression of great weight and closeness of articulation. A pleasing inclination for diagonals should govern, to some extent at least, the choice of panel lengths. The appearance of "flatness" should be carefully avoided. Examples of this defect may be seen in the second main diagonals in Fig. 5, (a) and (d). "Steepness" of diagonals is much less displeasing to the eye than "flatness."

The curvature of top chords is a matter which particularly concerns long-span bridge trusses, since in spans of moderate length the economy of chord inclination is doubtful. Much attention has been given to the amount of curvature most desirable, and, though many mathematical investigations have been made, the results are not of very great value, since certain unwarranted assumptions are usually made in such calculations. In general, it may be said that the inclination of chords should not be great enough to render the web system excessively light and vibratory, or to make stress-reversal in the web members possible. As the stiffening of web members or the use of counters becomes necessary, the economy of great chord inclination is correspondingly offset. In trusses of the bowstring type, as shown in Fig. 5 (a), flimsy web members result, and sometimes it is necessary to counterbrace every panel to resist the distorting effect of moving loads.

The appearance of the truss outline should also be given some weight in adopting a particular curvature for the chords. With trusses of considerable centre depth and an inclination of top chord, which reduces the depth to the minimum permissible at the hips, unless the hips are well defined by sufficient steepness of end posts, the feeling arises that the trusses are about to "snap off" at the ends. This is the impression given by Fig. 3 (b) and Fig. 5 (a), and the trusses of the Columbia Bridge at Hamilton, Ohio, Fig. 5 (c), contain a suggestion of the same kind. With a small hip depth in Petit trusses, it may at the same time be necessary to carry the end-post and one or two of the main diagonals near the ends over one floor panel only in order to avoid the appearance of "flatness," while the remainder of the main diagonals are each carried over two floor panels, or one main panel. The effect is not pleasing, as may be seen from Fig. 5 (d) and (e), but more particularly in the latter case, where two main diagonals at each end cover only one floor panel each. In Fig. 5 (c) this effect has been largely obviated by sharp curvature in the chord near the ends. Uniformity of curvature is desirable for aesthetic reasons also, as may be seen from a study of the trusses shown in Fig. 5. The great trusses of the Louisville and Jeffersonville Bridge, built over the Ohio River in 1893, and which, it is believed, are the longest simple bridge trusses ever constructed, exhibit a defective outline in the top chord, due to sharp changes from the horizontal to the inclined sections of the chord. These trusses, which are 546½ ft., c. to c., are illustrated in Fig. 5 (b). Probably the most pleasing truss outline shown in Fig. 5 is that of the trusses of the channel span of the Pittsburg and Lake Erie Railroad bridge at Clairton, Pa., built in 1904, and shown in Fig. 5 (f). It conveys at once the impression of strength and graceful relation of its members to one another, prime requisites in a tastefully designed structure.

In general, long-span simple truss bridges are of the pin-connected type, and in the United States almost exclusively so. The controversy which was waged some thirty-five years ago between the advocates of pin-connected struc-