ring is hinged at the crown and springings, the problem is considerably simplified, but, for varying loads, the introduction of hinges would have the effect of weakening the arch.

It is necessary, therefore, to make certain assumptions and to experiment on models of arches designed according to those assumptions, in order to see how far they are justifiable. It appears that, whatever assumptions are adopted, the arch, called the "Ideal arch," is much stronger than a circular or semi-elliptic arch of the same dimensions.

First Assumption.—The true line of pressure is that link polygon for the system of loads which deviates the least from the centre line of the arch ring. Arguments in favor of this assumption are wanting, and consequently the lines of pressure are not shown in the diagrams, but the stresses, if calculated, would be found to be only slightly in excess of those obtained according to the third assumption.

Second Assumption.—It is assumed that no arch ring is stable for symmetrical loading unless the link polygon, which touches the extrados middle third at the

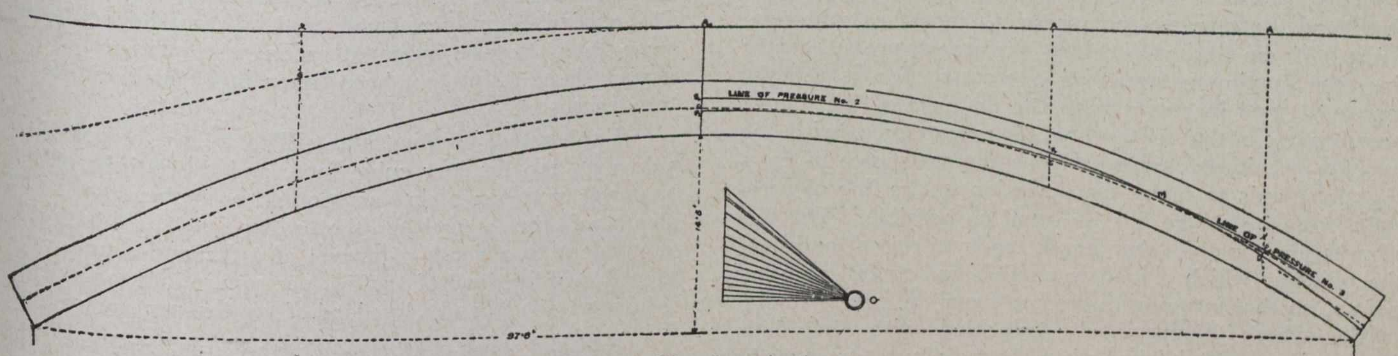

Fig. 1.—Circular Arch.

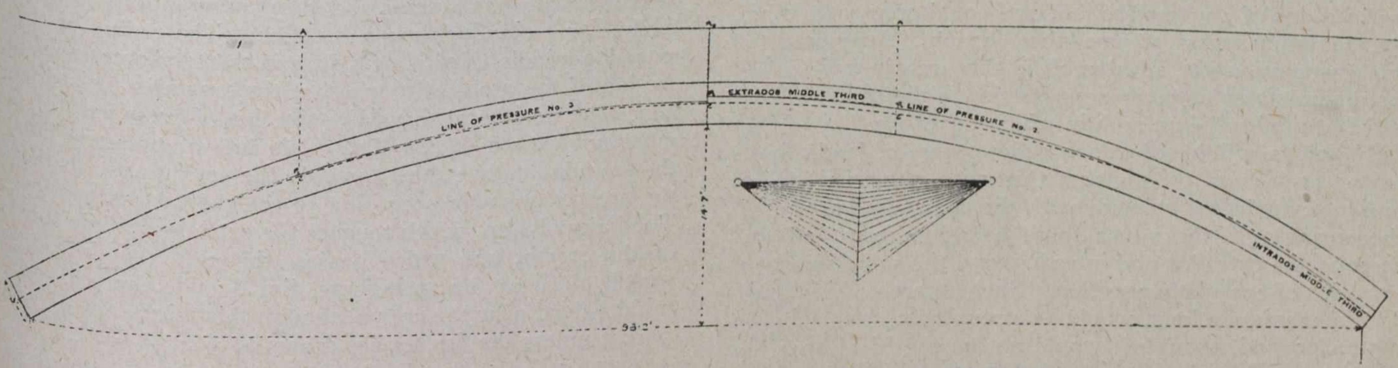

Fig. 2.—Ideal Arch. (Scales: Length, 12 ft. to the inch; load, 120,000 lbs. to the inch.)

Table I.—Illustrating the Advantages of the Ideal Arch Over the Circular Arch.

	Ideal Arch.	Circular Arch.
Span of centre line	100 ft.	100 ft.
Rise of centre line	15 ft.	15 ft.
Depth of gravel at crown	4 ft.	4 ft.
Span of intrados	98.2 ft.	97.8 ft.
Rise of intrados	14.7 ft.	14.6 ft.
Thickness of arch ring	3 ft.	4 ft.
Maximum compressive stress		
(a) Second assumption	76,300 lb.	The critical line of pressure cannot be drawn.
(b) Third assumption	40,500 lb.	40,500 lb.
Width of arch	20 ft.	20 ft.
Total quantity of gravel	17,720 cub. ft.	18,250 cub. ft.
Total quantity of material in arch ring	6,390 cub. ft.	8,450 cub. ft.
Total weight of arch	2,971,000 lb. or 1,322 tons.	3,360,000 lb. or 1,500 tons.
Appearance	Pleasing, owing to gradually varying curvature.	Uniform curvature contrary to laws of beauty.

Some writers define the "Ideal arch" as the arch in which the centre line of the arch ring is the actual line of pressure for the given load. This evidently assumes that the centre line, if it is a link polygon for the system of loads, is the true line of pressure. Generalizing this, the first assumption may be stated as follows:—

crown, lies entirely between the two middle third lines between the crown and springings. In order that this condition should be satisfied, the horizontal thrust must not exceed the product of the radius of curvature of the extrados middle third at the crown and the total load on a section of the arch, 1 ft. wide, of which the cross-section at the crown is the central line. If H denotes the horizontal thrust, ρ the radius of curvature, g_o and t the depths of the gravel and arch ring at the crown, and w_l, w_g, w_a the respective weights of the live load, gravel, and material of the arch ring, then H must not exceed $\rho\,(w_l + g_o\, w_g + t w_a)$. If such a line can be drawn it is evident that, by reducing the horizontal thrust, the line can be made either to touch the intrados middle third at or towards the springings, or to pass through the same middle third at the springings, and the line would then be the critical line or pressure.

Though the first signs of collapse in arches have appeared at points suggested by the critical line of pressure, it does not necessarily follow that the true line of pressure tended to approach that line of pressure previous to internal collapse. The apparent cause of failure is often different from the real cause, and the line of pressure may have taken up the position indicated by the critical line of pressure as a consequence of internal failure. Failure of the backing or insufficient depth of gravel at the crown would tend to concentrate the load