and divide the weights in proportion to the powers of resistance. Having, in this way, determined the weight to be sustained by the truss, the parts can be proportioned in the manner previously explained.

It is very evident that an arch can be made to sustain the whole of the weight, for if a truss has settled it may be raised to any extent, by the addition of arches and suspension rods. In this case, the principle of proportioning the braces, so as to increase in arithmetical progression from the middle to the end, is no longer applicable; there is no more strain at the ends than in the centre, and but little at any point, and in this case the truss is of no other use than to stiffen the arch and carry the roadway.

Amount of counter-bracing which an arch requires.

That a very slight force is sufficient to counter-brace an arch, may be rendered evident, without a calculation in detail, by taking a more unfavorable case than could possibly occur in practice. Let A and B (Fig. 97) represent the skew backs of an arch, and leaving out of consideration the resistance of the lower chord, which adds greatly to the stiffness; suppose a weight of $1\frac{1}{2}$ tons per foot to be placed on one-half of the arch, the weight of the other half, being $\frac{1}{2}$ ton per foot, will leave 1 ton per foot to produce a change of figure. The effect of this weight will be represented, nearly, by one-half applied at the middle point (p). Let the span, $s = 160$ feet; and the rise of the arch, $r = 20$ feet, the weight at $p = (w)$ will be 40 tons. Let H represent the component of the weight, in the direction of the chord $A\,p$. At the centre, the value of this component would be $\frac{w}{4\,r}\sqrt{4\,r^2 + s^2} = 82$ tons, and as it is always less at every other point, the slight error will be on the safe side, by taking 82 tons as the force acting along $A\,p$. This force, and its equal at A, gives a resultant, acting upwards at m, which is expressed by $\frac{o\,n}{o\,p} \times 82 \times 2$. In the present example, $o\,n = 12$ and $o\,p = 60$ nearly; hence, the force at m, which acting upward must be resisted by the counter-braces,