equilibrium. Without the hinge the movement at the top could not have taken place and the bridge would probably have broken down before the load had reached 300 tons.

The maximum compression stress is on calculation 2,320 lbs. per square inch under 423 tons load. At the vertical crack the tension stress was 350 tons, 400 lbs. per square

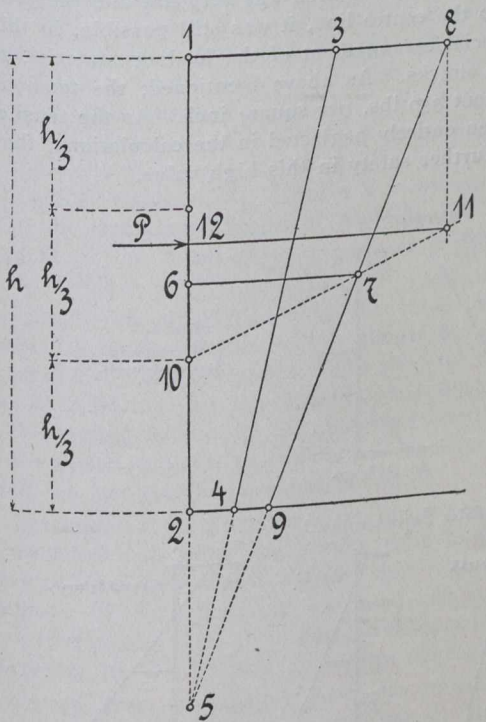

Fig. 7.

inch, and in the unloaded part of the arch the same stresses were found.

The object of measuring the elongations was to determine the position of the pressure line, the value of the acting stresses and to obtain information concerning the modulus of elasticity of the concrete. The main difficulty of those problems consisted in the circumstance that these quantities are exceedingly small, and that the modulus of elasticity is not a constant, but varies with the value of the stresses.

The modulus of elasticity was also fixed in another way independent of the measuring. Two blocks were cut out of the concrete in the arch, from which cubes were sawed with 12-inch side. For two of these not only the compression strength was measured, but at the same time the value of the decrease in length corresponding to each stage of the pressure, by means of which it was possible to determine the moduli of elasticity, thus giving a specially good occasion to test the value of the elongations, stresses and moduli of elasticity figured out after observations on the bridge itself by comparing the values directly found with those found by the cubes.

For the determination of the location of the pressure line and stresses in the arch the following method of procedure was employed:—

From the value of the compression or tension in the highest and lowest point in a section (1—2 in Fig. 7) of the arch (1—3 and 2—4) the position of the neutral axis (5) and from that the acting point of the normal force could be determined. The normal stress (6—7) in the centre line of the section was figured out from the normal force and the area of the section. The normal force could not be measured directly by means of the instruments, but must be taken from the above-mentioned pressure lines (Fig. 6) with corresponding force polygons, which can be designed exceedingly exactly on the basis of the very careful determination of the specific gravity of the concrete, the dimensions of the bridge and the position of the pressures in the hinges.

Assuming a rectilinear distribution of the stresses, the value of these can be found directly by drawing 5—7, which give the stresses 1—8 and 2—9. The acting point of the normal force (12) is located by drawing a line through 7 and the lowest third point, 10, and from the intersection point of the line 10—7 and 8—11 (1—2) a line 11—12 (6—7). The length 1—3 and 2—4 are in this case the sum of the variations in the length from the test-load and the weight of structure; these last-mentioned could not be further measured on the bridge, but should have been measured as the

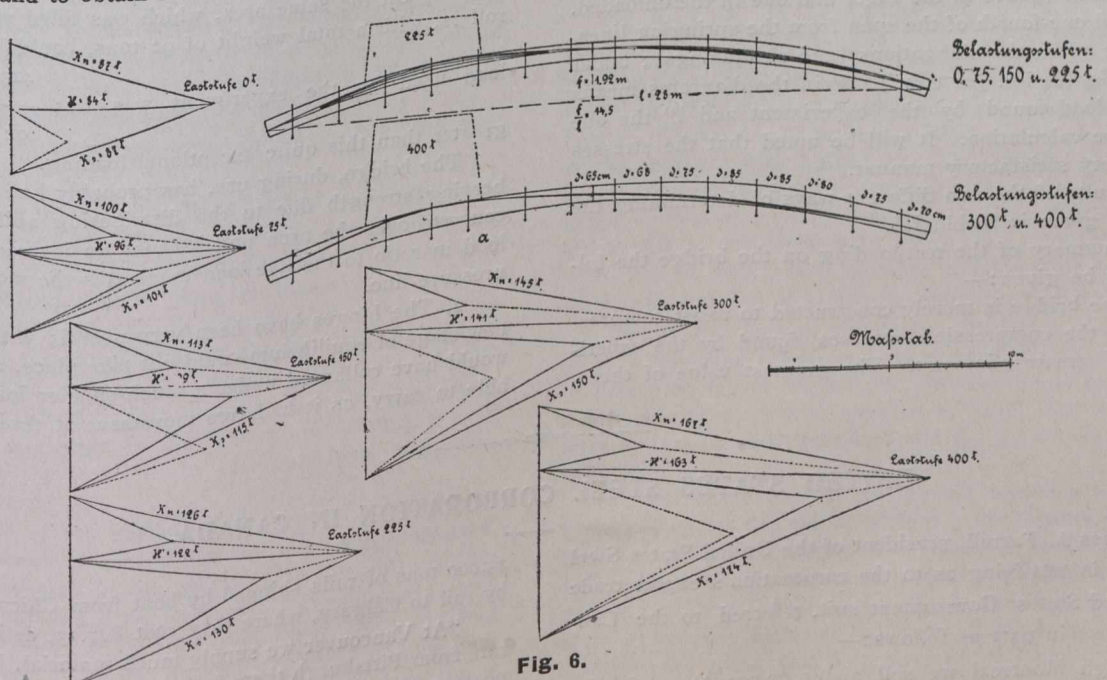

Fig. 6.

falsework was remote. It was, therefore, necessary to make certain assumptions in order that they might be figured.

The value of the normal force in the unloaded part of the bridge could be directly found in the force polygon, but