PROBLEMS IN APPLIED STATICS.

T. R. Loudon, B.A.Sc.

This series of problems began in the issue for the week, October 22nd, 1909. It is assumed that the reader either has an elementary knowledge of the subject of Statics, or is in a position to read some text on such theory.

The Equilibrium Polygon.

The Vector Polygon gives the magnitude, direction, and sense of the Resultant of a set of forces, but does not determine the true position of the line of action of this Resultant. The problem of locating the Resultant may be accomplished by means of what is termed the Equilibrium Polygon.

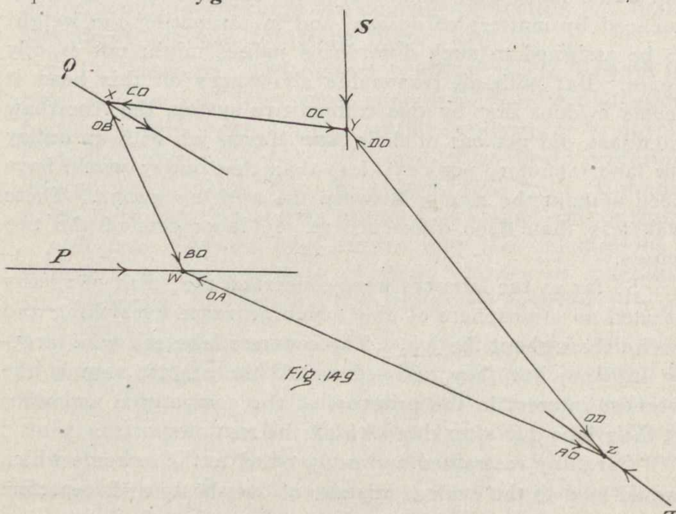

Fig. 149

Let P, Q, and S (Fig. 149) be any set of co-planar forces, the Resultant of which it is required to locate.

In a previous discussion, it was shown that the size and shape of the body acted upon can in no way alter the position of the line of action of the Resultant and Equilibriant of a set of forces; in other words, **the Resultant and Equilibriant are independent of the size and shape of the body acted upon.** This being the case, it will be shown that the position of the Equilibriant and Resultant may be determined by replacing the original body by an unbraced, free-jointed frame, the shape of which will give the desired information.

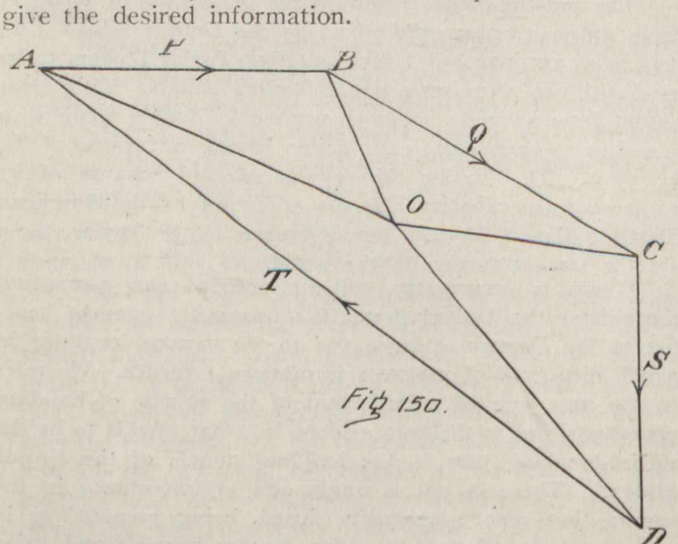

Fig. 150.

ABCD (Fig. 150) is a Vector Polygon for the forces P, Q and S. DA evidently represents the Balancing Force or Equilibriant of this set of forces.

It is evident that **if the Equilibriant can be located, the position of the Resultant will also be known,** for the Equilibriant and Resultant of a set of forces have the same lines of action.

Choose any point O in Fig. 150 and join it to A, B, C, and D; i.e., to the terminations of the lines composing the Vector Polygon.

It is evident, from Fig. 150, that since the lines AB, BO, and OA form a closed polygon, the three forces represented by these lines will be in equilibrium, provided their lines of action intersect at a common point. If these three forces are in equilibrium, such a condition of affairs could be expressed by saying that any two of the forces balance the third. For instance, the forces BO and OA may balance the force AB; i.e, balance the force P.

At any point W on the line of action of P (Fig. 149) introduce the forces OA and BO. These three forces are in equilibrium.

For the time being, any discussion as to how these forces OA and BO are exerted and what constitutes the body acted upon by the three forces, P, BO, and OA, will be dropped.

Produce the line of action of BO to intersect the line of action of Q at X, and at this point introduce the forces represented by CO and OB (Fig. 150). The line of action of OB evidently coincides with BO (Fig. 149). It is seen from a consideration of the triangle BCO (Fig. 150) that the forces OB and CO acting at X (Fig. 149) will balance the force Q.

Produce the line of action of CO to intersect the line of action of S at Y. At Y introduce the forces DO and OC represented by the lines DO and OC (Fig. 150). These forces balance the force S.

Produce the line of action of DO to intersect at Z the line of action of OA produced, and at Z introduce two forces, AO and OD, represented by AO and OD (Fig. 150).

Let the polygon WXYZ (Fig. 149) represent a frame having pin joints at W, X, Y, and Z. It is evident that the frame will be in equilibrium if some force be introduced at Z which will balance AO and OD. The force T, represented by DA (Fig. 150) evidently fulfils this condition.

Thus, it is seen that under the action of the forces P, Q, S, and T the frame is held in equilibrium, and since a given set of forces to be in equilibrium can only act, relatively to one another, in certain definite lines, the force T, the Equilibriant of P, Q, and S, has been located.

It is estimated that 115,000 automobiles were made in the United States last year. At an average of $2,000 the total value of these would be $230,000.000. This output is astonishing when it is remembered that the output of such cars was only 11,000 in 1903 and 30,100 in 1906. There were imported into the United States last year 1,645 cars, valued at $3,071,000 and exported 3,686 cars valued at $6,890,000. The exports have greatly increased during the past four years, while the imports have shown a decline. Imports showed 928 cars from France, 418 from Italy, 127 from Germany and 101 from England. The cars exported went to all the corners of the earth, to Africa, East India and to Australia, as well as to Canada, Europe and South America. Exports to the United Kingdom were valued at $2,000,000, to Canada at $2,400,000, to France at $846,000, to Mexico at $494,000, to South America at $240,000, to British Australasia at $303,000, and to Africa at $49,000