THEORETICAL MECHANICS OR THE SCIENCE OF DYNAMICS.

Lesson I.

We have to deal in practice with a great variety of forces, of which the following are examples :

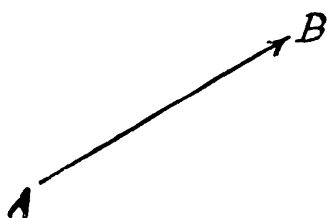
1. The force of gravity or weight as the weights of the different pieces of a structure, or machine, and the loads upon them.
2. The force of the wind.
3. The pull of a bolt, or of a link, etc.
4. The force of steam, etc.

We have also to consider the resistances opposed by bodies to being stretched, or compressed, or bent, or otherwise distorted.

When any of these resistances is called into play, the body is said to be subjected to *stress* which must not be confounded with strain.

The *magnitude* of a force is the number of units of force which it contains, the most common units employed being pounds or tons ; thus if one pound be the unit, a force of 4 pounds has a magnitude *four*.

To reprepresent graphically a force in magnitude and direction, we must draw a straight line in the direction in which the force acts, and lay off upon it as many units of length, as there are units of force in the force.

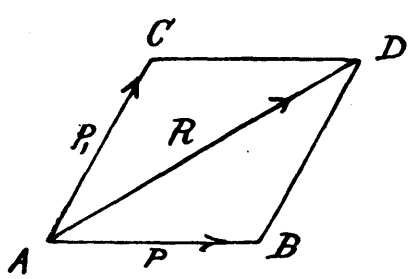


— Fig. 1. —

Thus as in Fig. 1, if our scale be 1 inch per 100 lbs., the line A B whose length is $1\frac{1}{2}$ inches will represent a force of 150 lbs. acting in the direction or parallel to A B. A force is represented graphically in magnitude, direction, and point of application when a straight line is drawn *from the point* where the force acts, *in the direction* in which it acts, and as many units of length are laid off upon the line as there are units of force in the force.

Thus, if the line in Fig. 1, were drawn to represent a force in all three of these particulars, we should conclude that the force was one of 150 lbs. and that it acted at the point A, and in the direction A B.

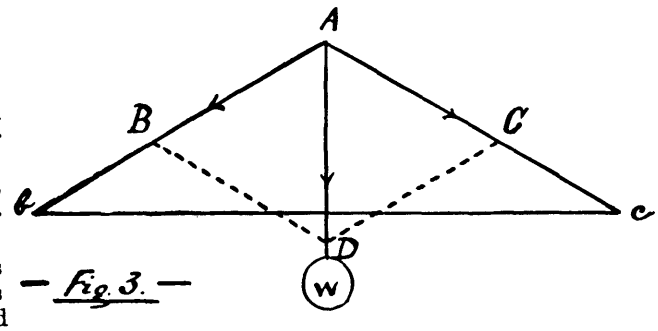
The resultant of a set of forces is that single force which should produce the same effect as the entire system of forces.



— Fig. 2. —

PARALLELOGRAM OF FORCES.

If two forces P and P P, represented in magnitude and directed by A B and A C respectively, (see Fig. 2) be applied at the same point, their resultant will be represented in magnitude and direction by the diagonal A D, of the parallelogram of which A B and A C are adjacent sides. Thus if A D (see Fig. 3) represent



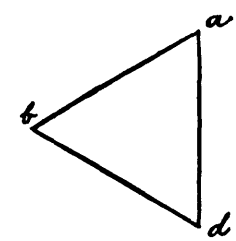
— Fig. 3. —

a weight applied at A on the roof truss A *b c*, the magnitude of the thrusts, caused by this load, along the rafters A *b* and A *c* will be represented by A B and A C respectively, formed by drawing D C parallel to A B and D B parallel to A C.

In this particular case we find by measurement that A B = A C = A D, so that if the load be 1,000 lbs. and A D be drawn to scale to represent it, we shall have A B and A C measuring the same as A D or each 1,000 lbs. also.

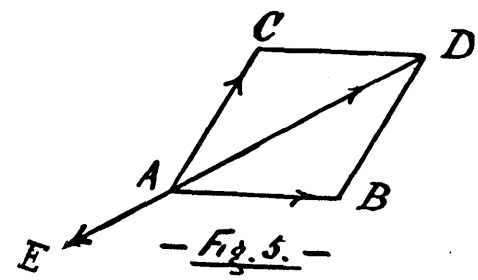
The pressures A B and A C as shown in the figure, are the forces exerted *by the load* on the *rafters* A *b* and A *c* respectively.

We might however just as well have drawn only one half the parallelogram A B C D, or the triangle A B D, or one equal to it, as *a b d*, (Fig. 4) where *a d*



— Fig 4. —

represents the load at A ; *d b* represents the *stress* in the rafter A *c* that is the force exerted at A by that rafter to resist the load, and *b a* represents in the same way the stress in A *b*.



— Fig. 5. —