The Mechanics of Textile Processes

By W. Scott Taggart

Ex.—A beam (neglect its weight) is 16 ft. long between its supports. Weights of 5, 3 and 7 tons are placed so that the 5 tons is 4 ft. from the left-hand support, the 3 tons is 6 ft. from the left support, and the 7 tons is 7 ft. from the right support. What is the pressure on each support?

First find the pressure on support A, Fig. 132. Let $x =$ this pressure. This means that we must find the moments of the forces round B. As the pressure on A acts upwards it will tend to turn the beam clockwise round B, so will be positive, or +. The three weights will all tend to turn the beam anti-clockwise round B, so the moments will be negative, or —.

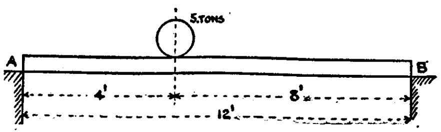

FIG. 131.

Moments of A will $= x \times 16$ ft. $= 16x$ ft. tons.
" 5 tons " $= 5 \times 12$ " $= 60$ ft. tons.
" 3 " " $= 3 \times 10$ " $= 30$ " "
" 7 " " $= 7 \times 7$ " $= 49$ " "

$$16x - 60 - 30 - 49 = 0$$
$$16x = 139$$
$$x = 8\ 11/16 \text{ tons.}$$

So that the pressure on A = 8 11/16 tons.
and " " B = 15 — 8 11/16 = 6 5/16 tons.

Ex.—A beam 10 ft. long is supported at a point 3 ft. from one end. If a weight of 3 tons is placed on one end, what force must be applied at the other in order to obtain a balance? Neglect the weight of the beam.

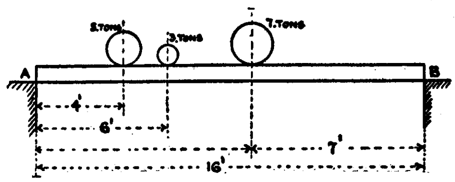

FIG. 132.

Sketch the conditions of the problem as in Fig. 133. F is clearly the point round which the beam will turn if any movement takes place. The 3 tons at A will turn it anti-clockwise, and the x tons at B will turn it clockwise, so that the moment of the 3 tons round F—the moment of x tons round F = 0.

$$(3 \text{ tons} \times 3 \text{ ft.}) - (x \text{ tons} \times 7 \text{ ft.}) = 0.$$
$$3 \text{ tons} \times 3 \text{ ft.} = x \text{ tons} \times 7 \text{ ft.}$$
$$9 = 7x$$
$$x = 1\ 2/7 \text{ tons weight at P.}$$

The whole of the weight on the beam will be supported by F, so that F is carrying 3 + 1 2/7 = 4 2/7 tons.

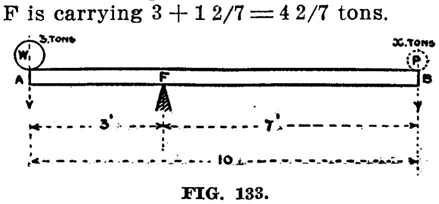

FIG. 133.

Ex.—A bent lever as in Fig. 134 is weighted at A by a freely hanging weight of 20 lb. What weight, hanging from B, will balance the lever if AF is 12 in. and BF is 6 in. long? AF is inclined to the horizontal at 45° and BF at 60°.

First draw the lever to scale, as in Fig. 134, to the particulars given in the question. Both weights W and P will hang vertically. The distance they act from the fulcrum F will be measured on a line through F at right angles to the direction in which the weights are acting. This line is CFD. The moment of weight W round F will therefore be Wx, and the moment of weight P round F will be Py.

$$\text{Then } Py - Wx = 0$$
$$Py = Wx$$
$$P = Wx \div y.$$

W = 20 lb. By scale it is found that $x = 8\tfrac{3}{8}$ in. and $y = 3$ in. The weight P must be calculated.

$$P = (20 \times 8\tfrac{3}{8}) \div 3 = (20 \times 67) \div (3 \times 8)$$
$$P = 55.8 \text{ lbs.}$$

The examples just given arise out of the general question of equilibrium and the moments of a force. Experiments were previously made to prove the laws of equilibrium, and the reader may feel confident that the methods adopted in the examples are correct because they are based on these laws. It is, however, an easy matter to verify, by trial, answers to most questions that may be asked, and readers are strongly recommended to find an answer experimentally and then test the answer by the law.

A very simple arrangement can be fitted up for experiments on beams, rods, levers, etc. Fig. 135 will give the general idea. Careful measurements of distances and exact notes of the weights and readings of the spring balances are, of course, absolutely necessary in all these experiments.

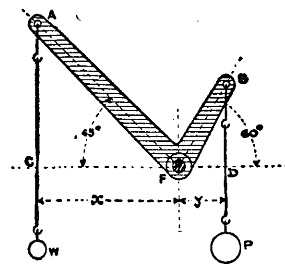

FIG. 134.

Fig. 136 illustrates the arrangements for experiments on levers. A stud F is fixed in the upright board and a rod AB bored at the center to fit the stud F loosely. If AB is made long enough it can be used for a variety of purposes.

Ex. A weight of 12 lbs. is placed 13 in. from the center F in Fig. 136. How far from F must a weight of 28 lbs. be placed so that the rod AB is balanced?

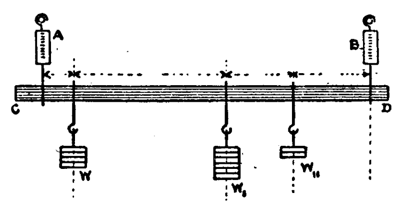

FIG. 135.

First place the weight W of 12 lbs. at 13 in. from F. Now slide a weight of 28 lbs., P, until AB remains horizontal. Measure its distance from F and the problem is solved. Compare the result by calculating the position of P by the principle of movements.

As the lever is in a balanced condition it is in equilibrium.

$$W \times x = P \times y$$
$$(12 \times 13) = (28 \times y)$$
$$(12 \times 13) \div 28 = 5.57 \text{ in.}$$

The weight P is therefore hung 5.57 in. from F.

During the experiment the reader will observe that the lever AB will balance in any position, so naturally the moments round the center F will always equalize each other.

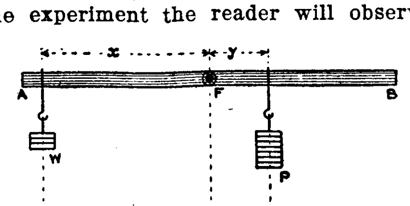

FIG. 136.

Baling Press.—Spencer & Cook Ltd., Stalybridge, Eng. An improved press for baling cotton, wool, waste, felt, rags, paper and like materials. Ease of operations, high density, economy of power and durability are among the claims made for it.