made by causing a weight to fall through a regulated distance on a piece of the material supported as a beam.

*Tests of Strength.—*Ordinary tests of strength are made by submitting the piece to direct pull, direct compression, bending or torsion. Testing machines are frequently arranged so that they may apply any of these four modes of stress; tests by direct tension are the most common, and next to them come tests by bending. When the samples to be tested for tensile strength arc mere wires, the stress may be applied directly by weights; for pieces of larger section some mechanical multi­plication of force becomes necessary. Owing to the plas­ticity of the materials to be tested, the applied loads must be able to follow considerable change of form in the test-piece: thus in testing the tensile strength of wrought iron or steel provision must be made for taking up the large extension of length which occurs before fracture. In most modern forms of large testing machines the loads are applied by means of hydraulic pressure acting on a piston or plunger to which one end of the specimen is secured, and the stress is measured by connecting the other end to a lever or system of levers provided with adjust­able weights. In small machines, and also in some large ones, the stress is applied by screw gearing instead of by hydraulic pressure. Springs are sometimes used instead of weights to measure the stress, and another plan is to make one end of the specimen act on a diaphragm forming part of a hydrostatic pressure gauge.

*Single-lever Testing Machine.—*Figs. 7 and 8 show an excellent form of single-lever testing machine designed by J. H. Wick­steed *(Proc. Inst. Meeh. Eng.,* August 1882) in which the stress is applied by an hydraulic plunger and is measured by a lever or steelyard and a movable weight. The illustration shows a 30-ton machine, but machines of similar design are in common use which exert a force of 100 tons or more. AA is the lever, on which there is a graduated scale. The stress on the test-piece T is measured by a weight W of 1 ton (with an attached vernier scale), which is moved along the lever by a screw-shaft S; this screw-shaft is driven by a belt from a parallel shaft R, which takes its motion, through bevel-wheels and a Hooke’s joint in the axis of the fulcrum, from the hand-wheel H. (The Hooke’s joint in the shaft R is shown in a separate sketch above the lever in fig. 8.) The holder for the upper end of the sample hangs from a knife-edge 3 in. from the fulcrum of the lever. The lower holder is jointed to a cross-head C, which is connected by two vertical screws to a lower cross-head B, upon which the hydraulic plunger shown in section in fig. 7 exerts its thrust. G is a counterpoise which pushes up the plunger when the water is allowed to escape. Hydraulic pressure may be applied to the plunger by pumps or by an accumulator. In the present instance it is applied by means of an auxiliary plunger Q, which is pressed by screw gearing into an auxiliary cylinder. Q is driven by a belt on the pulley D. This puts stress on the specimen, and the weight W is then run out along the lever so that the lever is just kept floating between the stops E, E. Before the test-piece is put in the distance between the holders is regulated by means of the screws connecting the upper and lower cross-heads C and B, these screws being turned by a handle applied at F. The knife edges are made long enough to prevent the load on them from ever exceeding 5 tons to the linear inch. To adapt a machine of this class for tests in compression, a small platform is suspended like a stirrup by four rods from the weigh-beam, and hangs below the cross-head, which is pulled

I

I

down when the hydraulic cylinder is put in action. The arrange­ment is that of two stirrups linked with one another, so that when the two pull against each other a block of material placed between them becomes compressed. For tests in bending one of the stirrups, namely, the platform which hangs from the weigh-beam, is made some 4 or 5 ft. long, and carries two knife- edge supports at its ends on which the ends of the piece that is to be bent rest, while the cross-head presses down upon the middle of the piece. In both cases the force which is exerted is measured by means of the weigh-beam and travelling weight, just as in the tension tests. To apply the force continuously, without shock, and either quickly or slowly at will, a very con­venient plan is to use an hydraulic intensifier, consisting of a large hydraulic piston operating a much smaller one. By gradually admitting water to the large piston from any con­venient source under moderate pressure, such as the town water mains, a progressively increased pressure is produced in the fluid on which the small piston acts, and this fluid is admitted to the straining cylinder of the machine. One of the advantages of the vertical type of machine, with its single horizontal lever, is the facility with which the correctness of its readings may be verified. The two things to be tested are (1) the distance between the knife-edges, one of which forms the fulcrum of the