not quite easy of reference). Five of these treat of general subjects, and the rest of particular machines or details.

The work opens with a well-written summary (16 pp.) of what is known of the flow of water under pressure, including a statement of the formulæ from Torricelli down to our own day, with a short account of some o the more recent experiments. Then follow some "General Observations," in which it is explained that the fears entertained on the first introduction of high-pressure water-power that accidents would be frequent from the bursting of pipes, especially in frosty weather, have proved groundless. The "relief-valves" necessary to avoid the shock from suddenly stopping or changing the motion of a non-elastic fluid like water are described and drawn. In another chapter the author describes the mode of "packing" so as to produce joints tight under high water-pressure, explains the use of "cupped leathers" to form a self-tightening joint, and shows the necessity of clear water, since dirty or gritty water causes rapid wear of the leathers.

The advantages of "power co-operation" all over large towns are considered in a short chapter (6 pp.), and illustrated by its successful application at Kingston-upon-Hull. Much more space might have been given to this now very important branch of the subject. A short chapter (6 pp.) details the cost of water-power in various places: it seems to vary from $\frac{1}{10}$ of a penny, to nearly 2*d.* per 100 foot-tons.

There are three chapters (covering only 7 pp. in all) on water-wheels, turbines, and centrifugal pumps. These chapters are too short to be of any practical use. The remaining 27 chapters are almost entirely devoted to the description of the appliances necessary for the use of high-pressure water-power, and to the very varied machines which may be thereby worked: many of these—especially the larger and more recent machines—are very fully illustrated. All this part of the work is of great interest. The pressure required for various purposes is stated to be 700 lbs. per square inch for ordinary hydraulic machines, 1500 to 2000 lbs. for shop-tools, and up to 20,000 lbs. for compressing iron and steel; and the advantages in the use of high-pressure are explained. The conditions to which this hydraulic power is suitable are shown to be those in which great power is to be exerted at scattered points for a short time only, and at irregular intervals. The machines and appliances described and illustrated are very numerous and diversified—far too many to enumerate here. Among the more interesting may be mentioned cranes, riveters, dock-gear, swing-bridge-gear, steering- and ship-gear, gun-lifts, and hoists of all sorts.

The practical part of this work is excellent: it is, in fact, a short monograph on the use of high-pressure water-power. But the theoretical part sadly needs revision. The term "power" is loosely used, sometimes meaning "force" (say in pounds), sometimes "work" (say in foot-pounds), sometimes "horse-power" (of 33,000 foot-pounds per minute). It is not surprising, therefore, to find the following mistakes: (1) a factor, 60 (*i.e.* 60 seconds in a minute), omitted in computing "horse-power" on p. 24; (2) a factor, 33,000, omitted in computing "horse-power" on p. 27, also the units (feet and pounds) not mentioned in same place; (3) a result on p. 35, which seems to be inch-pounds ÷ 33,000 (*i.e.* ÷ by foot-pounds per minute) marked as H.P.; (4) the following on p. 98, "the power (or foot-pounds) transmitted through a high-pressure water-main is determined by multiplying the fnumber of pounds of water flowing per second by the pressure." From a numerical example lower down it may be seen that the "power" referred to in this sentence is to be estimated (not in foot-pounds, but) in foot-pounds per second, and that by "pressure" is meant head of pressure, in feet.

ALLAN CUNNINGHAM, Major, R.E.

OUR BOOK SHELF

The Statesman's Year-Book for 1887. Edited by J. Scott Keltie. (London: Macmillan and Co., 1887.)

THIS work is so well known and so generally appreciated that it is necessary merely to note the appearance of the volume for 1887. The editor has made every effort to bring the statistics up to the latest date, and those who have been in the habit of referring to the book will find that its value has been considerably increased by important additions and modifications. An adequate account of the smaller British colonies has been introduced, and much new information is given with regard to the various systems of land-tenure in India. The leading facts brought out by the new censuses in Germany and France are embodied, and Mr. Keltie has been careful to show the precise results of the recent colonial enterprises of these two countries.

Joint Scientific Papers of James Prescott Joule, F.R.S. Published by the Physical Society of London. (London: Taylor and Francis, 1887.)

AMONG the contents of this volume are some elaborate papers on "Atomic Volume and Specific Gravity," prepared by Mr. Joule in association with Sir Lyon Playfair. Mr. Joule took the principal part in the experiments on the expansion of salts, the maximum density of water, &c.; but the important theoretical results arrived at with regard to atomic volume he attributes almost entirely to his colleague. Another valuable series of papers were the joint work of Mr. Joule and Sir William Thomson. The subjects are: "The Thermal Effects experienced by Air in rushing through Small Apertures," and "The Thermal Effects of Fluids in Motion." In the year 1843, Mr. Joule read a paper on "The Caloric Effects of Magneto-Electricity and the Mechanical Value of Heat," to the Chemical Section of the British Association assembled at Cork. The subject did not excite much general attention, so that, when he brought it forward again at the meeting in 1847, the Chairman suggested that he should not read his paper, but confine himself to a short verbal description of his experiments. "This," says Mr. Joule, "I endeavoured to do, and, discussion not being invited, the communication would have passed without comment if a young man had not risen in the Section, and, by his intelligent observations, created a lively interest in the new theory. The young man was William Thomson, who had, two years previously, passed the University of Cambridge with the highest honours, and is now probably the foremost scientific authority of the age." The work they afterwards did together, the results of which are here recorded, was chiefly experimental, performed in Manchester and the neighbourhood.