become the best standard among European makers.

Among the hot-air engines, that of Rider is given a leading place, and is fully described. It is commended for its simplicity, its quietness in action, its regularity, and its careful design.

Stow's flexible shafting is noticed as one of the characteristic products of American ingenuity. It consists of two oppositely twisted helices of steel wire, the one enclosing the other, and both covered with a flexible sheath. The device is recommended for the transmission of motion around a corner. These American exhibits were all properly commended in the award of premiums by the jury.

Among other important exhibits from European countries were various forms of 'safety-boilers;' the singular modification of the injector of Giffard, which, by means of the energy of the exhaust-steam, performs the functions of the air-pump in the steam-engine; several forms of compound engine; Hall's pulsometer, which is a modification of the Savery steam-engine of nearly two hundred years ago, with automatically working valves, — an American invention; the gas-engine of Otto, which is said to have exceptional efficiency; the Sagebien vertical water-wheel, which is claimed to have extraordinary performance; the indicator of Deprez, which gives a diagram from the fastest engines; and many other important inventions.

One remarkable feature of the exhibition was the absence of valueless and eccentric devices. This point of difference, in contrasting the exhibition with those which preceded it, is attributed largely to the progress of technical education.

In studying progress, it is noted that the gain is considerable in every direction. In the production of steam, the more general use of 'heaters' of the feed-water is observable, the use of tubular and of the 'safety' forms of boiler is increasing, superheating is oftener practised, better material and workmanship are seen. In steam-engine practice, the use of higher steam, of greater expansion, the adoption of two types exclusively, — the compound of the Wolff type, and the American forms of single-cylinder engines, — greater speed of piston and of rotation, and the use of better material and superior workmanship, are the characteristics of recent practice. Rotary engines are given up. Air and gas engines are extensively used, but only for small powers. Among the hydraulic motors, the turbines are principally used, and have attained great perfection in practice as in theory. Aerostation has made no great progress, notwithstanding the interest which it continually awakens.

American exhibiters distinguished themselves by the boldness and the ingenuity of their designs, and by their entire independence of tradition. Their devices are adapted precisely and effectively to their work. "*Les Américains s'attachaient avec énergie à l'idée première, à l'idée juste; ils l'amélioraient, la perfectionnaient, et, même au prix de grandes complications de méchanisme, ils finissaient par la faire triompher, et par l'imposer de nouveau à l'Europe.*"

MINOR BOOK NOTICES.

Conversion-tables of metric and British or United States weights and measures, with an introduction. By ROBERT H. THURSTON, A.M., C.E. New York, *John Wiley & Sons*, 1883. 83 p. 8°.

IN the introduction, the requirements of any system of weights and measures are given. There is a brief history of the English and French systems, and the supposed advantages of the metric are stated. The difficulties and annoyances arising during the change from the English yard and pound to the metre and gram are suggested as sufficient reason for this book. In the second part, containing the tables of conversion, the units of length, mass, stress, work, and heat, temperature and barometric pressure are defined. A chapter is devoted to C. G. S. units. The tables are full, numerous, and seem to be well arranged, and will, without doubt, be found useful by those having occasion to make measurements. This book forms part of a treatise, in three volumes, on the Materials of engineering, by the same author.

How the great prevailing winds and ocean-currents are produced, and how they affect the temperature and dimensity of lands and seas. By C. A. M. TABER. Boston, *Williams*, 1882. 82 p. 12°.

This pamphlet, by Capt. Taber of Wakefield, Mass., gives a practical seaman's views on the origin of winds and ocean-currents, and suggests certain very hypothetical causes for glacial climate. The fundamental errors of the work lie in a misconception of the sun's action in producing, and the earth's effect in deflecting, the winds, and in a tendency to refer apparently simple effects to single instead of composite causes. The other side of some of the questions here raised is presented in Tchiatcheff's or Rolland's descriptions of the Sahara, and Woeikoff's and Hann's articles on the general atmospheric circulation.

The physiology of protoplasmic motion. By Th. W. ENGELMANN. Translated by C. S. DOLLEY. Rochester, N.Y., *Davis & Leyden, n.d.* 40 p. 8°.

This pamphlet, without date or any statement as to the original, is a good translation, with very poor reproductions of the illustrations, of Engelmann's chapter in Hermann's well-known Handbuch der physiologie. It is to be regretted that the author did not see fit to date his translation, nor give the source of the original. The latter omission we are fortunately able to supply.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Orthogonal transformations. — Mr. W. J. C. Sharp has investigated the invariants of a certain orthogonal transformation with special reference to the theory of the strains and stresses of an elastic solid. If a, b, c, f, g, h, are transformed according to the same law as $x^2, y^2, z^2, yz, zx, xy$ (x, y, z, being the rectangular Cartesian co-ordinates of a point, transformed without change of origin), they will have a system of invariants entirely unaffected by the transformation. The author gives the three invariants corresponding to these quantities, and makes a large number of exceedingly interesting applications to different geometrical and physical problems. As Mr. Sharp's paper consists almost entirely of algebraical work, it is impossible to give it more than this brief reference, and to commend it to the notice of those interested in the subjects which he touches upon. — (*Proc. Lond. math. soc.*, xiii.) T. C. [1137

Elliptic functions. — The Rev. M. M. U. Wilkinson has given a number of general formulae arising from the differentiation of the elliptic functions with respect to the modulus. — (*Proc. Lond. math. soc.*, xiii.) T. C. [1138

Unicursal twisted quartics. — Mr. R. A. Roberts considers in this paper some properties of the unicursal twisted quartic curve; namely, the intersection of a quadric and a cubic which contains two non-intersecting generators of the quadric. Almost exclusive use is made of the expressions for the co-ordinates of a point on the curve in terms of one independent parameter. A reduction is first given to the canonical form, and, after examining a particular property of the curve, the author obtains the condition that four points of the curve shall be complanar; then certain points on the curve are examined, and invariant conditions are obtained for degenerate forms of the curve. The next five sections treat of polygons circumscribed about the curve, and the five concluding sections treat of circular unicursal quartics. — (*Proc. Lond. math. soc.*, xiv.) T. C. [1139

PHYSICS.

Acoustics.

Maintained vibrations. — Lord Rayleigh discusses mathematically that type of maintained vibration which is most familiar in the form of Melde's experiment in which a fine string is kept in transverse vibration by connecting it at one end with one prong of a vibrating tuning-fork, the direction of the motion of the point of attachment being parallel to the length of the string. The string settles into a state of permanent vibration whose period is double that of the point of attachment. The equations indicate that an absolutely rigorous adjustment of pitch is necessary, a conclusion not borne out by experiment. This is accounted for by the slight variation of rate with variation of amplitude. The *son rauque* of Savart is probably caused in a similar way, as the periodic variations of tension accompanying longitudinal vibrations will produce associated transverse vibrations. For lecture illustration, a soft-iron pendulum vibrating on knife-edges may be placed vertically over a vertical bar electro-magnet, through which are sent intermittent currents whose frequency is twice that of the pendulum vibrations. Of the same nature are the crispations observed by Faraday on the surface of water which oscillates vertically. The author has shown that Faraday was correct in his opinion that there are two vibrations of the support for each vibration of the liquid. — (*Phil. mag.*, April.) C. R. C. [1140

Hydrogen-whistles. — Le Conte calls attention to an error in Galton's calculations, as he assumes that the number of vibrations of the whistle, when blown with different gases, is in proportion to the density, while it is actually in proportion to the square root of the density. Hence 86,533 instead of 312,000 vibrations would be given by Mr. Galton's proposed whistle. — (*Nature*, May 17.) C. R. C. [1141

Electricity.

Winding electro-magnets. — Professors Perry and Ayrton have experimented upon the following types of electro-magnets: —

1. Wires wound equally over the whole length.
2. Wires coned toward each end.
3. Wire wound equally over half the iron bar, leaving the other end bare.
4. Wire wound on one half, but coned towards the end.

It was found that the effect of coning the wire is to produce a strong field very near the pole, but that the force falls off very rapidly as the distance from the pole increases. At considerable distances from the end of the electro-magnet the uniformly coiled magnet, No. 1, produces the most powerful field. At very small distances from the end of the magnet, Nos. 3 and 4 give the strongest effects. They conclude therefrom, that with a definite length of wire, of core, and strength of current, the mode of coiling the wire determines the strength of the magnetic field at different distances from the end of the electro-magnet. — (*Phil. mag.*, June, 397.) J. T. [1142

CHEMISTRY.

(*Analytical.*)

Ammonic hyposulphite as a reagent in qualitative analysis. — A. Orlowsky suggests the use of ammonic hyposulphite instead of hydric sulphide in a qualitative separation of the metals. In a systematic course of analysis which Orlowsky proposes, lead, barium, strontium, and calcium are precipitated