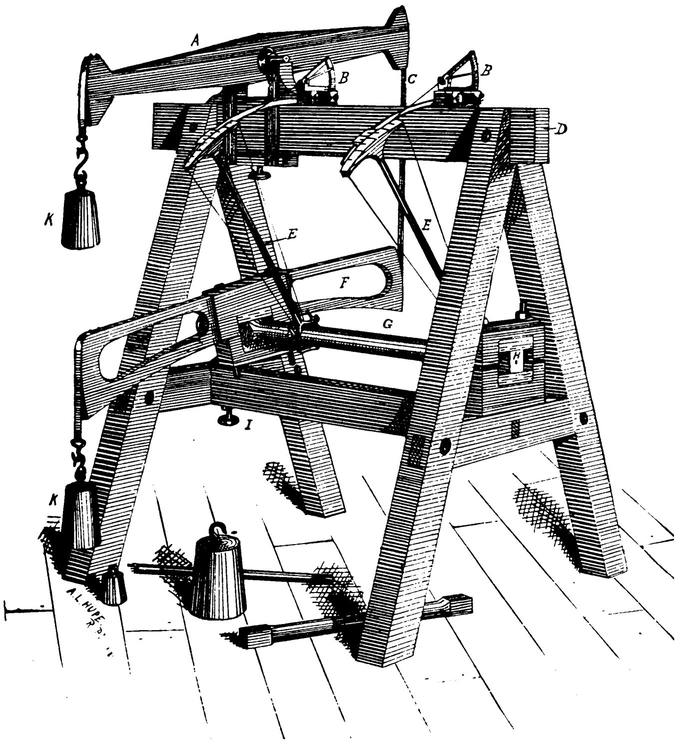
GRAY'S TORSIONAL TESTING-MACHINE.

THE accompanying figure illustrates an apparatus recently designed by Professor Thomas Gray of the Rose Polytechnic Institute, Terre Haute, Ind., for the purpose of testing the torsional rigidity of different kinds of materials.

The figure has been prepared from a photograph of a rough and



GRAY'S TORSIONAL TESTING-MACHINE.

inexpensive form of the machine, which was somewhat hurriedly made in the workshops of the institute by students, for use in the engineering laboratory course of the current year.

The apparatus, as here shown, consists of a wooden trestle, on the top bar, *D*, of which there is mounted a cross-beam *A*, about four feet in length, which rests, through knife-edges at its centre, on a support which can be clamped at any point of the bar *D*. The ends of this beam are cut to circles having the knife-edges as centre; and to one end a thin steel trap, *C*, is fixed, the lower end of which is attached to a cross-beam, *F*, of the same length as *A*. The beam *F* is clamped to one end of the specimen, *G*, which is being tested by means of strong clamps, which take different forms, and are made of different materials, according to the form and nature of the specimen. The other end is held in a similar clamp at *H*, and this clamp is firmly fixed to the trestle.

The end of the specimen to which the beam *F* is attached is kept in position by means of an attachment similar to the tail-stock of a lathe, the clamping-screw for which is shown at *I*.

This centre-bearing also prevents any cross-bending force being applied to the specimen by the weight of *F*. The torque, or twisting-couple, is applied to the specimen by hanging weights, *K*, *K*, on the free ends of the beams *A* and *F*. These weights should be of equal amount, as they then produce a pure twisting-couple without applying any force to the centre-bearing.

The amount of distortion produced by any torque applied to the specimen is measured by means of two indices *E*, *E*, which are clamped to the specimen at a measured distance apart. The outer ends of these indices carry a graduated arc, on which the angular displacement can be read by means of a fixed mark or vernier. For specimens of such large diameter that the limit of elasticity is exceeded before a sufficiently large deflection can be given to the indices *E*, *E* to render this method sensitive enough, the deflection is indicated by a multiplying index, *B*. An important feature of this apparatus is the elimination of any uncertainty as to effect of the clamps by measuring the relative twist at two sections a short distance from the ends.

This same method was adopted some years ago by Professor Gray, in a series of experiments on the elastic constants of rocks, but the apparatus was not then made in a permanent form. A considerable extension of the experiments is now contemplated in connection with investigations in seismology, under the direction of Professor Mendenhall, in which it is intended to determine the elastic constants of a number of rocks, for the purpose of ascertaining the theoretical velocity of a seismic wave.

In the more complete design of the testing-machine above described, both ends of the beam *A* are connected by straps or links to the beam *F*. The tail-stock centre-bearing is then omitted, and cross-bending stresses are avoided by mounting the clamp *H* on gimbals, which allow freedom to transverse motion. A graduated disk is then substituted for one of the indices *E*, *E*; and the other index is carried on a bar which extends from the clamp, in a direction parallel to the axis of the specimen, up to the front of the graduated disk. The relative distortion is thus read off direct when that method is sufficiently sensitive, or by means of a second index attached to the disk when higher sensibility is desirable. For some purposes the gimbals are mounted on a worm-wheel, which turns round an axis parallel to the direction of the specimen, which thus allows an unlimited amount of twist to be given to the specimen. This becomes necessary when torsional strength is the object of investigation.

With the apparatus here illustrated, specimens of any length up to three feet can be included between the clamps; while specimens of any length can be tested in sections of three feet or less, the ends being simply allowed to project beyond the clamps, and the tail-stock bearing modified to a V instead of a centre-bearing. As regards the power of this machine, it is capable of testing a three-inch steel shaft up to its limit of elasticity.

THE MACRÆON SECONDARY BATTERY.

THERE is no field in which experiment is being more actively prosecuted than in that of the storage of electrical energy. From the experience which has been gained in the last five or six years, the failings of secondary batteries have become pretty well under-

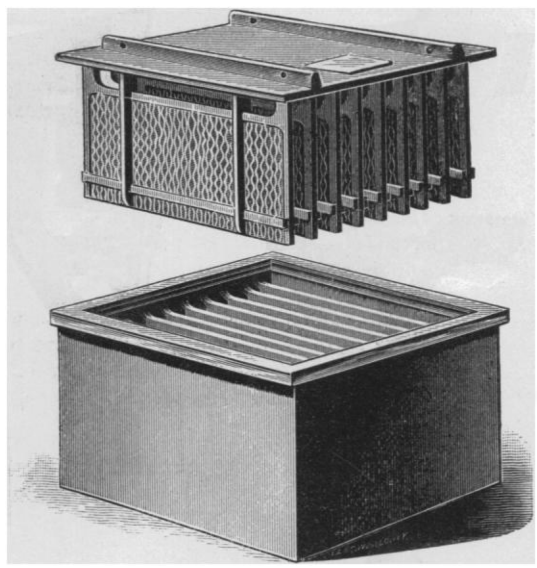


FIG. 1. — THE MACRÆON STORAGE-BATTERY.

stood, and many inventors are trying to remedy them. The two types of battery which have been at all generally used are the Faure and the Planté. In the former a support-plate is provided, and some salt of lead is mechanically applied to it, which forms the active material. In the latter the active material is obtained from the support-plate by reversing the current passing between two lead plates in dilute sulphuric acid. The Faure cells take but a very short time to manufacture: the Planté type takes several months. The advantages of the Faure type are the ease of manufacture, and the capacity, which is greater than that of the Planté type. The disadvantages are in the rapid depreciation and the limited discharge-rate.

In the Macræon battery the attempt is made to take advantage of the good points, avoiding the troubles. This is done in the following way. The negative plate is made according to the Faure process, as distinguished from the Planté. A framework of lead is filled in with active material obtained by fusion. The cross-bars making up the frame are thinner than the finished plate, so nothing but the active material is exposed to the liquid. The negative plates are permanently connected to the metallic box, which takes the place of the glass or rubber boxes now generally used.

The positive plates are made according to the Planté plan: the active material is obtained from the support itself by the chemical action of the current. But instead of the forming process taking months to accomplish, as in the original Planté process, it is accomplished in a few hours, the result of the special electrolyte used in the Macræon battery. The form of the positive plate is also an important question. In this cell it is made of corrugated strips of

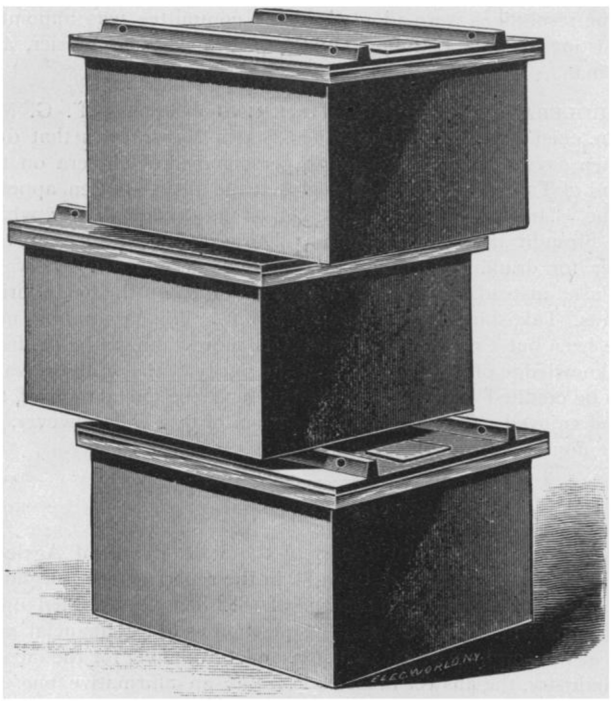


FIG. 2. — THE MACRÆON STORAGE-BATTERY.

lead, fastened at the top to the crossbar of a lead frame, while at the bottom they have a freedom of movement which prevents "buckling" when the strips expand on discharge. These positive plates are fixed to the metallic top of the box. When the cover is in place, the top of the cell is positive, and the bottom is negative, with an insulation between them. The closing of the cell avoids the occurrence of acid fumes, and the evaporation of the acid.

The following tables give some data as to the performance of the cells: —

Stationary or "Central Station" Type.

Size.	Normal Charging Current.	Normal Discharge Current.	External Dimensions.			Weight Complete in Pounds.	Normal Capacity in Ampère Hours.
			Length.	*Width.*	*Height.*		
A	6	1-8	11	5¾	4½	35	50
B	12	1-17	11	5¾	6½	52	100
C	20	1-32	10½	10	6½	80	200

Portable Type for Railroad Purposes.

Size.	Normal Charging Current.	Normal Discharge Current.	External Dimensions.			Weight Complete in Pounds.	Normal Capacity in Ampère Hours.
			Length.	*Width.*	*Height.*		
D	20	1-25	11	5¾	6½	48	200
E	30	1-50	10½	10	6½	78	350
F	1-2	1-3	3	4	6½	-	8-9
G							
H							

ELECTRICAL NEWS.

The Velocity of Light.

ACCORDING to the electro-magnetic theory of light, which recent investigations, mathematical and physical, have rendered so probable, the velocity of light is equal to the quantity v, the ratio of the electro-static and electro-magnetic units of electro-motive force. Sir William Thomson has been engaged for some time on a series of measuring-instruments which will, by electro-static force, measure potentials from 40 to 50,000 volts. The method of calibration allows a determination of v to be made. The easiest way to get known potentials up to 200 or 300 volts is by sending a measured current through a known resistance, the difference of potential at the terminals of the latter being CR, the product of two easily measured quantities. This is the plan Sir William adopts for the calibration of instruments giving the lower readings, and the accuracy is within at least one-twentieth per cent. By the aid of condensers, these potentials are multiplied up to 2,000 or 3,000 with an accuracy of one-fifth per cent; and, by the aid of an intermediary electrometer, this is raised to 10,000 volts, with about the same limit of accuracy. This last measure, based on the original electro-magnetic determination with the resistance and current may now be compared with the electro-static measurement of the same potential made by an electro-static balance. Sir William has not been able to make sure of the accuracy of this last instrument to within more than one-half per cent, but within this limit the comparison of the two methods gives a ratio within one-half per cent of 300,000 kilometres per second. The velocity of light is known to be within one-fourth per cent of this value, — a most satisfactory agreement, speaking well for the accuracy of the new instruments.

The series of ammeters that Sir William lately developed will be of great practical benefit to electricians; their great range, accuracy, and permanence making them almost invaluable for certain classes of work. The series of volt-meters on which he is working will be of equal value, and we look forward to the time when they will have passed through the experimental stage.

ABSOLUTE RESISTANCE OF MERCURY. — In a recent number of *Wiedemann's Annalen*, F. Kohlrausch publishes a redetermination, which he has carried out with elaborate precautions, of the absolute resistance of mercury. The method employed was Weber's method of the damping of a magnet in a coil, with some slight modification of Dorn. The result arrived at is, that the resistance of a cubic centimetre of mercury at 0°C. is 94,060 centimetre seconds. In order to compare this with the B.A. unit, Mr. Glazebrook has compared one of the author's mercury standards with the B.A. unit in the Cavendish Laboratory, and finds, that, according to Kohlrausch's determination, one B.A. is equal to 0.9866 of an ohm. This would give a length of between 106.2 and 106.3 for the column of mercury of one square centimetre in section, having a resistance of one ohm.

ELECTRIC LOCOMOTIVES FOR MINES. — In this country the only applications of electricity to traction in mining, with which we are acquainted, is in Lykens, Penn. In this, current is conveyed to