be readily detected by clear platina wires connected with a very sensible galvanometer. Two have been employed, one of 4000 coils, the other of 20,000. The following results have been arrived at by examination of what happens in different sections or the same section of the plant. Since my investigations, some of these results have been confirmed by M. Becquerel in an independent way.

Electric currents exist in *all* parts of vegetables, except in those which are furnished with insulating substances, or which contain scarcely any internal humidity.

These currents exist night and day, in the sunshine as well as in the shade; they are not destroyed by an exposure to the vapours of æther continued for twenty-four hours, nor by the partial or total separation of the portion examined from the remainder of the plant, so long as that portion is not dry.

In the roots, the stems, the branches, the petioles and the peduncles, a central descending current and a peripherical ascending one are to be found, which may be called *axial* currents.

On connecting, by means of the galvanometer, the layers of the stem where the liber and the alburnum touch (and where several botanists admit a descending flow of elaborated sap), either with the more central parts, such as pith and perfect wood, or with the younger bark, a lateral current appears from these layers to the neighbouring organs.

The strength of these currents, as well as of those which are exhibited in the other parts of the plant, depends on the energy of vegetation and the abundance of sap pervading the part under examination.

A current is also found when any portion of the plant is placed in the circuit of the galvanometer, the other extremity of the wire being inserted in the soil at a distance which may be very considerable if the tract is wet. The plant is negative in relation to the soil.

All these phænomena (the connexion of which with those described by MM. Matteucci and Dubois-Reymond is obvious) may probably be explained by the fact, that when two portions of a liquid, acid, alkaline or neutral, the concentration of which is different, are separated by a porous organic membrane, a current of electricity proceeds from the denser to the rarer.

The electric state of the soil, and perhaps the exhalation which takes place in the organs furnished with stomata, have an influence upon the electricity of the ambient atmospheric strata.

Description of a Sliding Rule for converting the observed Readings of the Horizontal and Vertical Force Magnetometers into Variations of Magnetic Dip and Total Force. By John Welsh, *Kew Observatory.*

The formulæ for converting the observed changes of the two components of magnetic force into their resultants, dip and total force, are

$$\text{arc}^{-1}\Delta\theta=\frac{\frac{1}{2}\sin 2\theta}{0{\cdot}0002909}\left(\frac{\Delta Y}{Y}-\frac{\Delta X}{X}\right) \text{ and } \frac{\Delta R}{R}=\sin^2\theta\,\frac{\Delta Y}{Y}+\cos^2\theta\,\frac{\Delta X}{X};$$

where θ=magnetic dip; R, the total magnetic force; X, the horizontal, and Y, the vertical components of force.

The formula for changes of dip therefore is of the form

$$\text{Angular change of dip}=a\,V-b\,H,$$

where V and H are the observed scale readings of the vertical and horizontal force instruments, and a and b certain factors depending upon the dip at the place, and the scale coefficients of the instruments employed.

In Plate I, fig. 2, let A be a fixed scale representing the variation of dip in angular measure; let e be the adopted length for one minute on the dip scale A; then make a scale B on one edge of the sliding piece, such that one of its divisions $=\frac{e}{a}$. Similarly, on the other edge make a scale C, one of whose divisions $=\frac{e}{b}$. These scales must be so placed that when the slide is closed the zero points of all shall be in a line. Draw also a fixed mark m, in such a position, that when the slide is closed it shall point to the upper extremity of the horizontal force scale C.

Let the numbers of the scale divisions increase in the same direction in all the scales.

The formula for changes of total force is of the form

$$\text{Variation in parts of total force} = cV + dH.$$

Let D be a fixed scale representing the variations of total force; f the length of unit of scale adopted. Make on the edge of the second sliding piece a scale E, such that one division $= \frac{f}{c}$. Make a fixed scale F on the other side of the sliding-piece, whose division $= \frac{f}{d}$. Place the scales so that when the slide is closed the zero-points shall be in a line. Draw also an index n on the sliding-piece, corresponding to zero on scale E, and let the numbers of the scales increase in the same direction as before.

To use the instrument:—1st. Move the first slide until the mark m is opposite to the scale reading of the horizontal force on C; find on B the scale reading of the vertical force, and opposite to it on A is the number representing the variation of dip from an assumed zero. 2nd. Move the second slide until the index n points to the horizontal force reading on F; then on D, opposite to the vertical force scale reading on E, is the variation of the total force in parts of the whole force.

ASTRONOMY, METEORS, WAVES.

Account of the Astronomical Instruments in the Great Exhibition. *By* Dr. BATEMAN.

Description of an Apparatus for making Astronomical Observations by means of Electro-Magnetism. *By* G. P. *and* R. F. BOND, *of the Cambridge United States Observatory.*

The apparatus exhibited to the Section is the same which has been in use at the Harvard Observatory, Cambridge, U.S., and is the property of the United States Coast Survey. It consists of an electric break-circuit clock, a galvanic battery of a single Grove's cup, and the spring governor, by which uniform motion is given to the paper. Two wires pass from the clock, one direct to the battery, and the other through the break-circuit key used by the observer, and through the recording magnet back to the battery. The length of the wire is of course immaterial. When the battery is in connection, the circuit is broken by the pallet leaving the tooth of the wheel, and is restored at the instant of the beat of the clock, which is in fact the sound produced by the completion of the contact restoring the circuit, the passage of the current being through the pallet and the escapement-wheel alone. With the exception of the connecting wires, and the insulation of some parts, the clock is like those in common use for astronomical purposes.

Several forms have been proposed by different persons for interrupting, mechanically, the galvanic circuit at intervals precisely equal. In the present instance the clock is of the form proposed by Mr. Bond. Prof. Wheatstone, Prof. Mitchell, Dr. Locke, Mr. Saxton and others, have contrived different modes of effecting this object; the former several years since, but for a purpose distinct from the present.

The cylinder makes a single rotation in a minute; the second marks, and the observations succeed each other in a continuous spiral. When a sheet is filled, and it is taken from the cylinder, the second marks, and observations appear in parallel columns, as in a table of double entry, the minutes and seconds being the two arguments at the head and side of the sheet.

The observer with the break-circuit key in his hand or at his side, at the instant of the transit of a star over the wire of a telescope, touches the key with his finger. The record is made at the same instant on the paper, which may be at any distance, many hundred miles, if required, from the observer. It is a well-established fact, that not only may observations be increased in number by this process, but that the limits of error of each individual result are also narrowed. As far as comparisons