The interrupted movement may be brought about by having a strip, *e*, bearing at regular intervals round wire nails, attached to the lower portion of the carriage.

One of these nails is held for a certain time by the hook *h* (fig. 5), which is attached to the strip *f* (figs. 5, 2, 1), which moves about the pivot *g* (fig. 1). Finally, when *h* is elevated, *h'*, which is attached to a similar and parallel rod and moves with *f* about *g*, catches the next succeeding nail, and holds it a regular period, before allowing it to reach *h*. A short horizontal line is thus drawn by the style at *w* (fig. 2).

The elevating and depressing of the escapement at *h h'* is brought about by attaching the works of one of the cheap nickel-plated clocks, which will run when held in any position, to a board, *k* (figs. 2 and 3). In place of the "long hand" there is attached a crank which will play through the slot *i* (fig. 5). As the post turns the crank toward XII o'clock *h* will be elevated, and at VI o'clock, thirty minutes later, *h'* will be depressed to its greatest, one nail thus sliding by every half hour. The escapement hooks may be easily cut out of two pieces of tin.

If the arm does not swing parallel with the smoked surface, change the screws at *x* (fig. 3).

One recommendation the apparatus has is its inexpensiveness, costing, with the clock, if one is his own carpenter, not more than three dollars. Another is the ease with which the records for several half hours may be compared, and the little labor necessary to prepare permanent records, by simply placing the glass on a piece of "blue print" paper and exposing to sunlight.

A registering auxanometer.

CHARLES R. BARNES.

(WITH PLATE VIII.)

In January last my class in physiology had occasion to study the rate of growth of seedlings under various conditions. I needed an instrument to keep a continuous record of their growth, and Germany was too far away to send for one. With the help of the students in the mechanic shop I arranged and constructed the instrument here described. It is comparatively simple and inexpensive, and requires no

work which can not be done by a turner and a machinist, at slight cost.

R, plate VIII, is a cylinder of pattern pine, twelve inches long and three in diameter; centered in its ends are two pieces of brass rod about three-eighths of an inch in diameter, the lower and longer of which, *h*, is coned on its free end and carries about its middle a drum, *f*. This is a silk-spool bored out a little. The lower axle of the cylinder rests upon a piece of glass hollowed to receive its point, and the upper passes through a small plate of brass, *z*, (figs. *A* and *D*), bored to fit it smoothly and screwed to a light frame of wood, $\frac{3}{16} \times 2$. The upper or cross-piece is seen at *D*, with ends dovetailed to fit the side pieces. This top piece can be lifted out so as to allow the removal of the cylinder.

Around the drum, *f*, passes a cord, over the pulley, *r*, to the weight, *m*. The pulley is made of a section of a spool with a groove filed around it, revolving on a glass rod. By the fall of the weight, *m*, the cylinder would rotate continuously were it not for twelve equidistant pins, *o o*, which engage with the armature, *p*, of an electro-magnet, *e*. The pins are wire-nails, driven in and cut off, and in a second instrument were placed radially around the lower end of the cylinder so as to use a straight armature.

The electro-magnet is one of the simplest form and can be had of dealers in electrical apparatus. I first adapted a relay instrument to this use, but afterwards wound a magnet with number twenty-four silk-covered wire and made it a permanent part of the apparatus. The magnet is connected, as shown in the figure, with a battery, *W*, through the clock, 2, so arranged by tying the striking wheel as to strike but once each hour. One wire from the battery (the LeClanché cell used for door-bells) is soldered to the hammer arm, *v*. Its continuation is soldered to a piece of watch-spring, *d*, so fixed that the hammer, *v*, as it draws back to strike will come in contact with it.

The tripod lamp-stand, *g*, carries an arm, *u*, shaped like a tuning-fork, between whose arms the wheel, *a b*, (seen in section at *B*), revolves on a wire axle pointed to fit into holes in the arms. This axle can be taken from the works of an old clock. The wheel *B* is of wood and can be made by the turner who makes the cylinder. It is double, having a large part, *b*, and small part, *a*. This wheel must be so balanced that it will stop at any point indifferently. If not turned accurately counterpoises of flat bits of metal can be attached

on the light side by gummed paper. From the weight, *y*, the thread *c* passes over *b*, in the groove cut for it, and carries *t*, the recording needle. This, as shown in *E*, is a common needle heated and bent, and inserted in a block of lead which is grooved for the supporting threads. The point of the needle should be blunted, and the sides filed flat to prevent turning. Of course *t* and *y* must balance each other.

From the plant *n* around whose tip it is looped, the thread *k* takes a complete turn around *a* and is just kept taut by the weight *s*.

The apparatus, spread out in the plate, can be compactly arranged on a base-board 14 × 18 inches, which is supported by four leveling screws, *l l*. These are ordinary long wood screws with the points rounded. If desired a strip of metal can be soldered in the slits, so that they can be turned with the fingers.

When ready to operate, the cylinder *R* must be smoothly covered with a sheet of glazed paper, the edges gummed and overlapping in such direction as not to catch the needle point. Smoke the paper evenly over a *turpentine* flame. Camphor smoke adheres too firmly. Having arranged the threads *c* and *k*, twist *c* so as to make the point of the needle bear against the smoked paper. The growth of the plant *n* will, as the slack of *k* is taken up by the weight of *s*, cause the wheel to revolve and will raise *t* as many times as far as the plant grows, as the diameter of *b* divided by the diameter of *a*. While *R* remains still, the lifting of *t* will make a vertical mark. But at each hour the hammer of the clock touching *d* makes *e* a magnet, which draws up the armature, *p*, releasing the pin *o* and allowing the cylinder to revolve. The armature is released the next instant and returns in time to stop the next pin. By this partial revolution the needle makes a horizontal line. The record of a sunflower from 3 P. M. to near 11 is shown in *S*.

When the needle has risen to the top of the cylinder the paper may be slit along the line of union, removed and immersed in a solution of white shellac in alcohol. When dry the soot can not be rubbed off and the record may be studied and compared with others.

The total cost of the apparatus, including the clock, will be from $10 to $15, according to the amount of work put upon it. The results are entirely satisfactory.