of *vis viva* which the sun pours out yearly upon every acre of the earth's surface, chiefly in the form of heat, is 800,000 horse power.* Of this mighty supply of energy, a flourishing crop utilizes only 3,200 horse power, so that the energy wasted per acre of land is 796,800 horse power. We talk loudly of the importance of utilizing the refuse of our manufactures; but what is the value of alkali waste, of furnace slags, of coal tar, or of all of them together, compared to the loss of 796,800 horse power per acre?

The application of electricity to sanitary improvements is another possibility, turning again mainly on a cheap supply of current. The electrical treatment and purification of sewage and industrial waste waters is a demonstrated reality which merely requires a reduction in the cost of the agent employed.

The sterilization, *i. e.*, the destruction of disease germs by electrical means, of the water supply of cities has been proposed and discussed. Theoretically, it is possible, but the practical difficulty of dealing with the vast volumes of water required for the daily consumption of London is prodigious. But, "a difficulty," said Lord Lyndhurst, "is a thing to be overcome." There is a still more important consideration; the living organisms in water are by no means all pathogenic—many are demonstratively harmless, and others are probably beneficial. Pasteur proposed to bring up young animals on sterilized food and drink with a view to determine whether their health and development would be affected for the better or for the worse. Decisive results are not yet forthcoming. Before the sterilization of our water sources can be prudently undertaken, this great question must be first decided by experimental biologists.

Another point at which the practical electrician should aim is nothing less than the control of the weather. We are told that these islands have no climate—merely samples—that an English summer consists of three fine days and a thunderstorm, and that the only fruit that ripens with us is a baked apple. There is more than a grain of truth in this sarcasm. The great evil of a thunderstorm in this country is not that the lightning may kill a man or a cow, or set barns or stacks on fire. The real calamity consists in the weather being upset. The storm is followed by a fall of temperature; and a fit of rain, clouds and wind, which rarely lasts less than a week, sadly interferes with the growth and ripening of grain and fruits. The question is, Cannot the accumulations of electric energy in the atmosphere be thwarted, dispersed, or turned to practical use? In like manner we may hope to abate the terrible fog nuisance, which is now in point of time no longer confined to the month of November, and by no means limits its attacks to London. It has been shown that during a genuine London fog the air is decidedly electro-positive. What the effect would be of neutralizing it would not be very difficult to show.

We hear of attempts at rain-making, said to have been more or less successful. Shall we ever be able, not to reduce our rainfall in quantity, but to concentrate it on a smaller number of days, so as to be freed from a perennial drizzle?

I shall, perhaps, be styled a dreamer, or something worse, if I remotely hint at still further amending the ways of nature. We all know, too well, that cloudiness and rainfall occur chiefly by day, and clear skies at night. This is precisely the opposite distribution to that which our crops require. We need clear heavens by day, that the supply of sunshine may not be interfered with, and we want clouds at night to prevent the earth losing by radiation the heat which it has gained in the day. As we have just seen, nature supplies energy amply sufficient. How is this enormous quantity of power to be made available? These are problems which may safely be left to the devices and the inspirations of our electrical engineers.

I have thus glanced at some of the intricate electrical problems to be solved—some of the enormous difficulties to be surmounted. Progress, a word now in the mouth of every one, may—as Dean Swift observed—be too fast for endurance. Sufficient for this generation are the wonders thereof!—*Fortnightly Review*.

HOW TO MAKE A STORAGE BATTERY.

By GEORGE M. HOPKINS.

PROBABLY no secondary battery can be more readily made or more easily managed than the one invented by Plante. It is, therefore, especially adapted to the

unskilled hands and of allowing a more rapid discharge without injury.

Each cell of the battery consists of 16 lead plates, each 6 × 7 in. and $\frac{1}{8}$ in. thick, placed in a glass jar 6 × 9 in., with a depth of 7½ in. Each plate is provided with an arm 1½ in. wide and of sufficient

FIG. 2.—ROUGHENING THE PLATE.

length to form the electrical connections. The plates are cut from sheet lead in the manner indicated at 3 in Fig. 1, *i. e.*, two plates are cut from a sheet of lead 8½ × 14 in. This method of cutting effects a saving of material. The plates, after being cut and flattened, are roughened. One way of doing this is shown in Fig. 2. The plate is laid on a heavy soft wood plank and a piece of a double cut file of medium fineness is driven into the surface of the lead by means of a mallet. To avoid breaking the file, its temper is drawn to a purple. After the plate is roughened on one side it is reversed and treated in the same way upon the opposite side. If a knurl is available, the roughening may be accomplished in less time, and with less effort, by rolling the knurl over the plate. Half of the plates are provided with four oblong perforations, into which are inserted H-shaped distance pieces of soft rubber, which project about ¼ in. on each side of the plate. The perforated and imperforate plates are arranged in alternation, with all of the arms of the perforated plates extending upward at one end of the element and all of the arms of the imperforate plates similarly arranged at the opposite end of the element. The plates are clamped together by means of wooden strips—previously boiled in a paraffine—and rubber bands. The strips are placed on opposite sides of the series of plates

FIG. 3.—PLATES CONNECTED.

at the top and bottom, and the rubber bands extend lengthwise of the strips.

The arms of each series of plates are bent so as to bring them together about three or four inches above the upper edges of the plates. They are perforated to receive brass bolts, each of which is provided with two nuts, one for bending the arms, the other for clamping the conductor.

The element thus formed is placed in a glass cell, and the formation is proceeded with as follows: To hasten the process, the cell is filled with dilute nitric acid (nitric acid and water equal parts by measure), which is allowed to remain for twenty-four hours. This preliminary treatment modifies the surface of the lead, rendering it somewhat porous, and, in connection with the roughening, reduces the time of formation from four or five weeks down to one week. The nitric acid is removed, the plates and cell are thoroughly washed,

an electro-motive force of two volts, and the voltage of the series of cells would be the number of cells × 2. It is a simple manner to determine the amount of current required to charge a given series of cells. For example, a battery is required for supplying a series of incandescent lamps. It has been found uneconomical

FIG. 4.—COMPLETE CELL.

to use lamps of a lower voltage than sixty. It will, therefore, require a battery having an E. M. F. of sixty volts to operate even a single lamp. This being the case, at least thirty cells of battery must be provided, and, on account of a slight lowering of the E. M. F. in use, two extra cells should be added. It will, therefore, require thirty-two cells for a small installation, and the machine for charging such a battery should be able to furnish a current of ten amperes, with an E. M. F. of seventy-five volts.

To form the battery, it is placed in the circuit of the dynamo and kept there for thirty hours continuously, or for shorter periods aggregating thirty hours. It is then discharged through a resistance of twenty or thirty ohms, and again recharged, the connections with the dynamos being reversed, so as to send the current through the battery in the opposite direction. The battery is again discharged through the resistance, and again recharged in a reverse direction. These operations are repeated four or five times, when the formation is complete. It will require from five to seven hours to charge the battery after it is thoroughly formed. It must always be connected with the dynamo as connected last in charging.

Although amateurs may find pleasure in constructing and forming a secondary battery, there is no economy in securing a battery in this way. It is less expensive and less vexatious to purchase from reliable makers.

ACTION OF ELECTRIC CURRENTS UPON THE GROWTH OF SEEDS AND PLANTS.

By Dr. JAMES LEICESTER.

A.—Zinc plate buried in the soil and about 1 sq. ft. in size.

B.—Plate of copper having the same dimensions as the zinc plate, and connected at the top by a copper wire above the surface, C, with the copper plate, B.

D.—A box about 3 ft. long and about 2½ ft. wide filled with soil.

By means of the apparatus shown in Fig. 1. a weak

FIG. 1.

current can be passed through the soil. The strength of the current will vary with the amount of organic acids in the soil. A series of experiments were conducted with the object of finding out whether these weak currents would in any way affect the growth of seeds and plants. In order that there could be good comparative tests, a number of glass vessels were obtained, all of the same size, filled with similar soil, and exposed to the same conditions, such as temperatures and sunlight. In some of these were placed earth plates, as shown in A (Fig. II.), whereas the others only contained the soil.

FIG. II.

They were watered each day at the same time and with equal quantities of water. Various seeds were obtained, and the same number of seeds sown in both vessels at the same time and under the same conditions. In all cases the seeds grew very much quicker in the vessels containing the earth plates. In the case of hemp seed it was fully an inch above the surface before there was any sign of it in the ordinary vessels.

Larger plates have been made connected as before and buried in the ground a few feet apart. In these larger experiments the same results were obtained. Seeds were sown in drills as shown in Fig. III. Those in the zones, a, b, b', were the first to appear. Next came those in the zones c and c'. Those sown at d and d' came up nearly a week later than the others.

In order to vary this experiment the earth plates were next buried where d was, and fresh seeds sown. The greatest fertility was then noticed to be in the

FIG. 1.—PLATES OF SECONDARY BATTERY.

wants of the amateur who makes his own apparatus. It takes a longer time to form a Plante battery than is required for the formation of some of the batteries having plates to which the active material has been applied in the form of a paste, and its capacity is not quite equal to that of more recent batteries, but it has the advantage of not being so liable to injury in

and the cell is filled with a solution formed of sulphuric acid 1 part, water 9 parts.

The desired number of cells having been thus prepared, are connected in series, and the poles of each cell are marked so that they may be always connected up in the same way. The charging current, from whatever source, should deliver a current of ten amperes with an electro-motive force ten per cent. above that of the accumulator. Each cell of this battery has

* "The Perplexed Farmer," by George Villé. English edition, by W. Crookes.