

SECONDARY BATTERY.

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

Each cell of the battery consists of 16 lead plates, each 6×7 inches and $\frac{3}{32}$ inch thick, placed in a glass jar 6×9 inches, with a depth of 7½ inches. Each plate is provided with an arm 1½ inches wide and of sufficient 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 inches. 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 inch 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 paraffine—and rubber bands. The strips are placed on opposite sides of the series of plates at the top and bottom, and the rubber bands extend lengthwise of the strips.

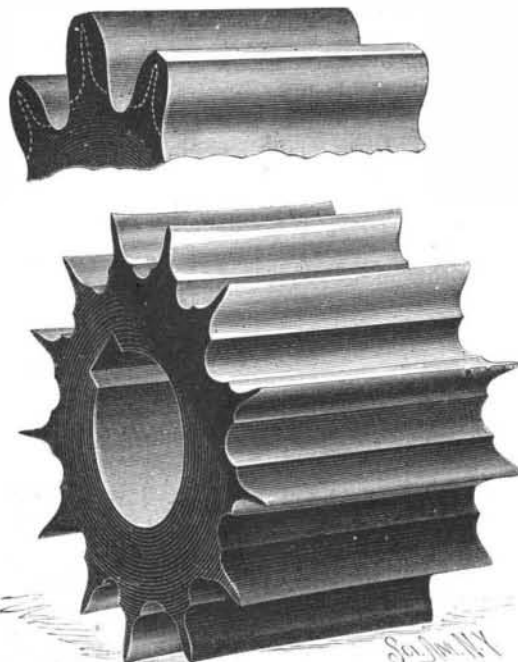
The arms of each series of plates are bent so as to bring them together about 3 or 4 inches above the upper edges of the plates. They are perforated to receive brass bolts, each of which is provided with two nuts, one for bending the arms, the other for clamping the conductor.

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, 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 ac-

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 75 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



CURIOSLY WORN GEAR WHEEL.

is then discharged through a resistance of 20 or 30 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.

Locomotive in Motion Struck by Lightning.

Quite a remarkable incident of an express train being struck by lightning while moving at the rate of thirty miles an hour recently occurred on the New York and New Haven Railway, at Stamford, Ct., during a heavy thunder storm. It was shortly before 4 P. M., as the train was whirling through the town that a tremendous



Fig. 2.—ROUGHENING THE PLATE.

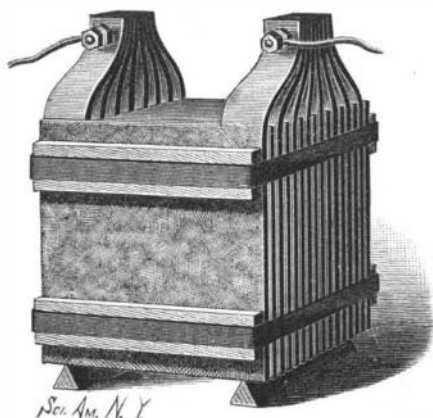


Fig. 3.—PLATES CONNECTED.

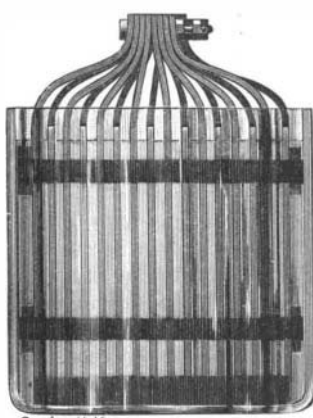


Fig. 4.—COMPLETE CELL.

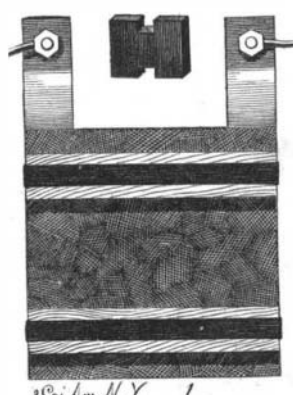


Fig. 1.—PLATES OF SECONDARY BATTERY.

CURIOSLY WORN GEAR WHEEL.

We illustrate a curious instance of wear in machinery. It is the armature shaft pinion of an electric motor that for four months propelled a street car. The wheel in question, carried by the armature shaft, rotated at a speed of about 900 revolutions per minute. It is interesting from several points of view. It shows forcibly the resisting power of steel. With the teeth worn away until little thicker than a sheet of paper, it was still strong enough to actuate the driving wheels of a heavy car, because, worn as it is, not the least sign of fracture or breakage is perceptible. Again, the curiously perfect shape of the teeth will be noticed, each one preserving the proper shape almost as accurately as if cut on a milling machine. It also illustrates one of the troubles of street car electrical propulsion. The reduction of the high velocity of the armature to a working speed by any of the known forms of gearing has been one of the most difficult problems to solve in this connection. Combination pinions of alternate disks of rawhide or of fiber with steel intermediate disks have been tried, as well as solid metal and various forms of friction and chain gearing. It is too soon perhaps to say that the problem has been solved. The grit caused by the location of the motors under a car and near a dusty roadbed makes the work very severe, and the example shows how soon even steel succumbs to the wear.

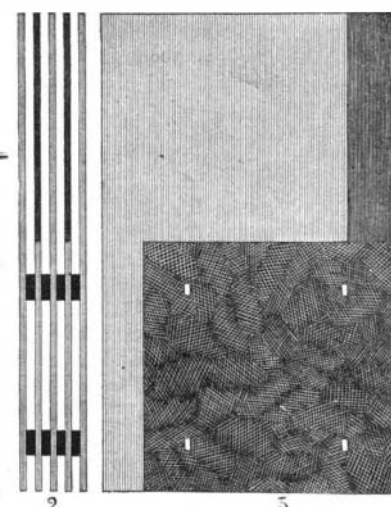
A Mountain Electric Railway.

One of the most interesting achievements in modern engineering is the electric mountain railway recently opened to the public at the Burgenstock, near Lucerne. The rails describe one grand curve formed upon an angle of 112 degrees, and the system is such that the journey is made as steadily and smoothly as upon any of the straight funicular lines. The Burgenstock is almost perpendicular—from the shore of Lake Lucerne the Burgenstock is 1,330 feet, and it is 2,800 feet above the level of the sea. The total length of the line is 938 meters, and it commences with a gradient of 32 per cent, which is increased to 58 per cent after the first 400 meters, this being maintained for the rest of the journey. A single pair of rails is used throughout, and the motive power, electricity, is generated by two dynamos, each of twenty-five horse power, which are worked by a water wheel of nominally 125 horse power, erected upon the River Aar at its mouth at Buochs, three miles away, the electric current being conducted by means of insulated copper wires. The loss in transmission is estimated at 25 per cent.

Woolen Looms and Cards.

According to "Babcock's Textile Directory of the United States and Canada," there were in the United States in 1888, approximately, 82,697 woolen looms. Of these there were located in the States of which Philadelphia can be claimed the business center, 30,238, as follows: In Delaware, 40; in Maryland, 136; in New Jersey, 2,044; and in Pennsylvania, 28,018. In the New England States, for which Boston may be considered the wool mart, there were 37,797, viz.: In Maine, 3,781; in Vermont, 863; in New Hampshire, 2,098; in Connecticut, 3,781; in Rhode Island, 7,829; and in Massachusetts, 21,216. In New York State there were located 4,946 looms.

Other sources of demand for wool are found in the



cumulator. Each cell of this battery has 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 matter 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 to use lamps of a lower voltage than 60. It will, therefore, require a battery having an E. M. F. of 60 volts to operate even a single lamp. This being the case, at least 30 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 32 cells

bolt of lightning struck the center of the locomotive. The report says: Engineer John Schofield and his fireman felt a severe shock which dazed and half stunned them. Upon being taken from the cab, both were seized with violent attacks of retching. The electric bolt disabled the engine and caused it to come to a stop. The substitution of another engine caused a delay to the train of forty-five minutes. The engineer and fireman soon recovered from the unpleasant consequences of the shock they received. Railroad men who were discussing the incident recently said it was the first time they ever heard of an engine in rapid motion being struck by lightning.

hat and hosiery mills of the country. "Dockham's Textile Directory" says there are 228 sets of wool cards, 77 of which are in Pennsylvania, 88 in the New England States, and 63 in New York; and from the latest directory of the hosiery mills of the country there are 654 of these, 194 of which are in Delaware, Maryland, New Jersey, and Pennsylvania, and 149 in the New England States.

THE saw is largely used now instead of the ax in bringing down the giant redwoods in California. The tree is sawed partly through, and then is forced over by wedges.