A CONVENIENT STORAGE BATTERY INSTALLATION.

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A GOOD storage battery is justly regarded as one of the most essential things in the equipment of a physical laboratory. Its value, however, both as a reliable and convenient source of electric currents and as an instrument for instruction, depends largely on the way in which it is set up; and while it would seem that there could be no trouble whatever in adapting so simple a thing to the use of students, I suspect that others, like myself, have found the problem not wholly free from difficulties; at least such was my own experience when I undertook, some four years ago, to so fit up a storage plant that it would meet the various needs, other than those of lighting and power, of our new laboratory. Nor was I able to get helpful suggestions from any of several sources to which one would naturally turn for such directions. But I did obtain much kind and valuable information from Professor Hering who had just completed an excellent storage installation in the physical laboratory of the Johns Hopkins University. I should probably have tried to duplicate his work in every particular but for the fact that the means at my disposal and some of the objects in view compelled modifications and simpler plans. The mounting finally used cost but little, is convenient in every particular and suited to teaching and general laboratory work. A test of four years has not suggested desirable changes, and besides it has so commended itself to others that it is now adopted in several institutions. I therefore, in response to many requests, offer a brief description of its essential features, trusting that in this way I may serve some one who has occasion to install a storage plant for similar purposes.

The battery I shall describe consists of thirty-six cells of the "chloride accumulator," type E, with glass jars, but evidently the same plans can be used for any number and any type of cells.

The frame on which these cells are placed is accessible from all sides, is eight feet four inches long, six feet high and one foot six

inches wide, and is divided into three shelves, each carrying one dozen cells. The cross-sections of the corner posts and of the railings along each shelf are two and three quarter by three and one half inches. The frame is still further strengthened by an upright at the middle of each side, and the whole is mounted on six heavy glass insulators, one under the foot of each post. The paint with which the entire woodwork is covered is the kind known as "tileite," selected because of its resistance to acids and alkalis. Each cell

is separately mounted in a wooden tray about three quarters of an inch deep that stands on three small glass insulators. The trays are painted with asphalt varnish and filled with ground mica of medium fineness, the flakes varying in area from one to three or four square millimeters. Still further insulation is secured by covering the cells with vaseline which prevents any liquid that might get on the sides from forming a continuous layer. The mica is intended to absorb stray drops of water or acid which will be taken up by the top layers, leaving the lower ones still dry and non-conducting. Good white sand would probably do nearly as well as the mica.

It has been suggested that carbonate of soda be added to the sand or mica since this would unite with the acid, should any get on it, and produce dry non-conducting sulphate of soda, but there is a chemical action between the carbonate of soda and the mica which, though it takes place slowly, soon produces a damp, unsatisfactory mass that can do no good and is likely to do much harm.

The liquid in each cell is covered with a layer, about a quarter of an inch thick, of paraffine oil. This prevents excessive evaporation during very dry weather, and absorption of moisture that might cause disastrous overflowing when the air is particularly damp. Besides, the disagreeable and corrosive acid spray, caused by the bursting of bubbles while the cells are being charged, is well nigh wholly avoided. Apart from the comfort this gives it makes it safe to have apparatus near the battery, avoids the necessity for extra ventilation, prevents fouling of the battery frame and preserves the insulation.

The above precautions against leakage may be excessive, but they are easily made, and I have had no trouble whatever from imperfect insulation during a constant use of the battery for four years, though it is placed in a small basement room that has often been very damp, nor has it been necessary to renew or clean any of the insulating materials.

Two large copper wires, of very low resistance, run from each cell to the switch board which is placed just beyond a partition near one end of the battery frame. These wires are soldered to the terminal lugs of the elements, and thus the trouble due to corroded and bad connections is avoided. Each wire is also soldered to a fuse block conveniently located above the switch board. According to my experience it is far better to use fuse links provided with flat copper terminals, since fuse wires, when clamped down with screws, frequently get loose and give bad connections. The links seem to be free from this objection.

The switch board which lies horizontally in a suitable frame, consists of a close-grained white marble slab, two inches thick, twelve inches wide and forty inches long. This slab is drilled through with holes the proper size to take the wires from the battery that come up from beneath, bend over and terminate in nearby larger holes about three quarters of an inch deep, that contain mercury.

I will say for the benefit of those who have occasion for the first time to drill marble, that it is an exceedingly easy thing to do. I use for this work a sensitive drill press and ordinary twist drills. It is only essential to use plenty of water as a lubricant, but of course it is also desirable to keep the drills reasonably sharp.

For the sake of compactness and convenient spacing these holes are arranged in two double rows as illustrated in Fig. 1, which shows a part of the slab as laid off or drilled, but without connections. The cups, a , b , c , and so on, are connected by wires through x , y , z , ..., say to the positive sides of the cells, while a' , b' , c' and so forth, are similarly connected through x' , y' , z' , ..., to the negative sides of the corresponding cells. In this way the slab, by its pairs of mercury cups, becomes a simple representative of the entire battery, one that any beginner can understand and by means of which he can readily test the voltage of all sorts of combinations.

To connect the cells in multiple or series straight heavy wires with their ends bent down are used. The mercury cups are so spaced that the wires connecting them in multiple, that is, of sufficient length to unite a and b say, are too short to connect the positive and negative sides of a cell, while those used for joining in series, and therefore reaching from a to b' , are too long to connect opposite sides of the same cell. In this way the chances of short-circuiting are materially reduced, a feature by no means undesirable in a laboratory battery.

The wires of the various laboratory circuits are soldered to a row of fuse blocks above the switchboard, and connection between them and the mercury cups is secured by means of flexible cords, also soldered to the fuse blocks that terminate with a short section of solid copper. I used, for these terminals, heavy wires about an inch long, drilled axially deep enough to admit the ends of the flexible cords, which, of course, were soldered in place. As a matter of convenience each circuit is correspondingly numbered above the switchboard and at the terminal end.

A rheostat, a circuit breaker and an ammeter in the charging circuit, and a voltmeter for testing the cells, all close beside the switchboard, complete the outfit.

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