Condition (1) is well fulfilled, as the E.M.F. is 1·9 volt; (2) is also good, for the cell is very constant (for the time the solution lasts). The hydrogen liberated in the outer jar, passing through the inner jar to the platinum element, decomposes the nitric acid, is itself oxidised and produces water and nitric peroxide gas, which forms no film upon the platinum element, and so does not interfere with the electric constancy of the action; (3) its internal resistance is low; (4) it is not without internal action when at rest, but such action is small as compared with that of the bichromate cell; (5) owing to the use of such acids, it can hardly be termed cleanly; (6) the strong fumes given off from the nitric acid in the form of nitric peroxide gas render this cell very objectionable under ordinary circumstances of medical work.

B.—(IV.) The Bunsen cell is very similar to the Grove, but the elements are zinc and carbon. This combination gives about the same E.M.F. as the other, but the Bunsen cell is notoriously difficult to keep in order.

(V.) Secondary cells, storage cells, or Accumulators do not properly belong to any class of electric *generators*, for energy must be put into them in the same form as it is afterwards obtained from them. That is to say, we charge them with electricity in order that we may obtain electricity from them.

The word *accumulator* is rather a misnomer and is also misleading. These cells do not accumulate electrical energy in the sense of being able to give out more than they receive. On the contrary, they are no exception to the rule laid down in Lesson I., regarding the loss of energy always involved by the use of apparatus or machinery, and therefore they give out less than the total energy put into them. They are *secondary* cells, because they do not generate electricity, but require to be charged with it from some *primary* source. They are *storage* cells, because when charged they will hold and retain ready for use at any time in the reasonably near future the charge given to them.

These cells consist of a vessel of glass or other suitable material, containing two or more plates or sheets of lead placed close together, but not in actual contact, dipping into dilute sulphuric acid. The lead plates are specially prepared, and are such that when a current of electricity of sufficient strength is passed the positive plate becomes peroxidised, while the negative plate is deoxidised, by the hydrogen which is liberated. The plates remain in this condition till the electric current is drawn off from them, but as soon as the two lead surfaces are reduced to a state of chemical inactivity the supply of current ceases.

The E.M.F. of these cells is two volts. They are mainly useful in medical work when a perfectly steady and constant current of considerable strength is required for a prolonged period. By their use currents generated by a dynamo may be rendered perfectly safe and convenient for medical use. Secondary cells are, however, costly to purchase, and costly to maintain, inasmuch as they must be frequently re-charged, and require very special care and attention in their management.

Batteries.

An electric battery may consist of one or more cells. When one cell alone is used, it may fairly be termed a battery, but the word battery is generally taken to mean several cells grouped together, and electrically connected in such manner as shall best suit the conditions of the work they are required to perform.

When the cells of a battery are connected together, with the negative pole of one cell in contact with the positive pole of the next, or *vice versa*, and so on to the end, they are said to be connected in *series*.

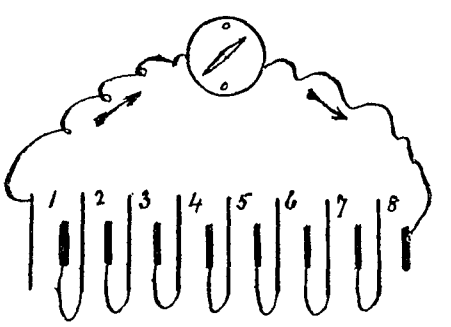

FIG. 11.—BATTERY (CELLS IN SERIES).

Fig. 11 is a diagram showing eight cells connected together in *series*, thus forming a battery having an E.M.F. equal to the sum of the E.M.F.'s of all the cells. For instance, if each of these cells has an E.M.F. of 1·5 volt, the total E.M.F. of the battery is 12 volts.

Note.—In these diagrams it is customary to represent the cell by lines, one thick and one thin line to each cell. The thick line should always be taken to represent the zinc in these lessons.

When the cells are connected, with the negative pole of one cell in contact with the negative pole of the next, and the positive of one cell to the positive of the next, and so on to the end, they are said to be connected *in parallel* or in *multiple arc*.

Fig. 12 is a diagram of six cells connected in parallel or multiple arc, thus forming a battery having an E.M.F. equal to that of *one cell only*, but capable of giving large current strength.

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