

Fig. 4.—Wake Robin (*Arum maculatum*).

A 15,000 Horse Power Vertical Turbine

IN the various articles that have been published describing the great electrification plans of the Puget Sound lines of the St. Paul Railway, reference has been made to the great system of power houses that will supply the current necessary for the operation of these lines, and the illustration on the first page of this issue of the SUPPLEMENT shows one of the great turbine water wheels that will be used for generating the electricity at one of the principal stations of the Montana Power Company, which has undertaken to supply the road with power.

The transmission lines of the Montana Power Company form a network that covers the greater part of Montana and a portion of Idaho, supplying electric power not only for the 440 miles of railway that is being electrified, and a large portion of which is now in operation, but also furnishing power for many mining enterprises. For this work the power company has twelve power stations, either already developed or projected, and by a complete system of interconnections a constant supply of power is insured, for if for any reason one station temporarily fails, other stations are immediately ready to take up the load.

These stations, which will have an ultimate capacity of 243,890 kilowatts, supply alternating current at 100,000 volts, which at the points where it is used is stepped down to the required point. In the case of the railway the current is utilized at 2,300 volts by motor-generators, which furnish a direct current of 3,000 volts to the trolley wires of the road.

One of the smaller power stations is operated by steam turbines, but all of the rest depend on water power, and to supply this a number of reservoirs have been established in different places. The largest reservoir, at Hebgen, has a storage capacity of 300,000 acre-feet, located at the headwaters of the Madison River, and this can supply in turn the several installations on the Madison and Missouri rivers, so that the same storage water is used a number of times, giving an available storage capacity considerably greater than the above figure would indicate. Besides this great reservoir there are several auxiliary reservoirs at various points that bring up the total available capacity to 418,000 acre-feet.

The largest of this great system of power plants is at Great Falls, Montana, where the large turbine illustrated is located, and it is one of six similar motors at this station, each rated at 15,000 shaft horse-power, that will give a combined output of 90,000 horse-power. In addition to these large main turbines there are being stalled two similar units of 850 horse-power each for driving the exciters for the large generators.

The big turbine shown has a single runner working in a cast iron scroll case, and operating under a head of 150 feet, and its size may be judged by the fact that the intake is eight feet in diameter. It will be noted that the shaft of this turbine is located vertically, and the moving parts of both the turbine and the electric generator are suspended from a thrust bearing located on top of the generator.

Electricity has demonstrated many advantages over steam in numerous cases, not only for railway operation but for power purposes generally, and it is particularly

valuable throughout a large portion of our western country, where no suitable coal for steam power is produced, and where the supplies of coal are liable to interruption by the heavy snows of winter; and it is particularly fortunate that in these regions the water power resources are so widely distributed and abundant. In time it is probable that electricity generated by water will be the sole power employed throughout the great northwestern country.

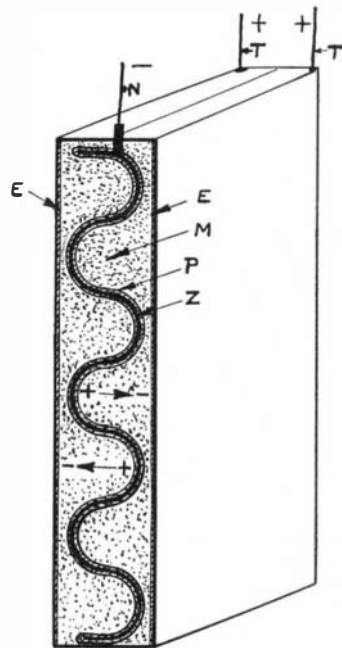
An Improved Dry Cell Battery

By H. R. Palmer

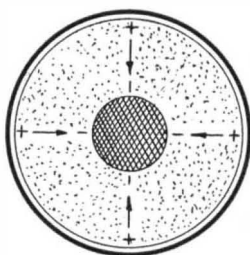
THE modern dry cell is a development of the old Gasner Leclanché type, rendered more efficient by reduction of internal resistance and increase of the depolarizing effect, together with the incorporation and retention of a greater percentage of electrolytic solution. The careful selection of pure ingredients has also been an important factor.

Realizing that an inherent change in the construction of dry cells was necessary in order to attain any further marked improvement, the writer devised an entirely new method of construction, abandoning the familiar round type of zinc container and adopting a flat type similar to the lead plate construction of the storage cell.

The positive element consists of a zinc sheet *Z*, encased in a porous envelope *P*, completely surrounding the same, and imbedded in the electrolytic and depolarizing material, technically known as the mix *M*. Next to the mix lies the negative elements or electrodes *EE*, which, taken as a unit, form the container of the cell. Thus the current generated on the zinc element has two paths through the mix (as shown by arrows) to the electrodes, which act merely as non-corrosive collectors, and emerges at the terminals *TT* which, connected to-



A new form of dry cell battery.



Section of an ordinary round cell.

gether, form the positive pole of the cell, the zinc terminal *N* being the negative pole.

It will be seen that this is a reversal of the common round cell, in which the carbon rod electrode is the center and the zinc the outside container.

The greatest difficulty to be overcome in the production of the flat cell type was the formation of the flat type electrodes *EE*. Carbon plates were found to be prohibitive, owing to high first cost and the fragile nature of the material. The comparatively high resistance of carbon also caused an uneven distribution of current, the portions nearer the poles *TT* supplying much more current than the diagonally opposite corners. The electrodes as now constructed in this cell are of such a low resistance (considerably under 1/1000 of an ohm) as to give a uniform current distribution. They are flexible, unbreakable and non-corrosive and very thin, about 1/32 inch.

Since the distance separating the zinc element from its container remains constant, the output of the cell varies directly as its area and weight, whereas, in the

Fig. 5.—Lady Slipper (*Cypripedium calceolus*).

round cell, the increased size of can in diameter increases the resistance and amount of material in a much greater ratio than the output. For instance, the 8-inch round cell weighs 250% more than the 6-inch, but is only about 50% stronger electrically. This new flat cell 7 inches by 9 inches by 1 inch weighs 300% more than the 4 1/4 inches by 5 inches by 1 inch, and is exactly 300% stronger. Another great advantage of this cell lies in the greater depolarizing power of the mix, owing to the greater contact area of the zinc element with the depolarizer. This is a corrugated sheet and presents 40% more area than the equivalent round cell. The current density of the dry cell should not exceed 0.013 ampere per square inch of zinc depolarizing surface to obtain economical service. The life of a dry cell does not vary in a direct ratio with this current density, but approaches more nearly the law of inverse squares, i. e. the life of a given cell supplying 0.013 ampere current density would be nearly four times longer than the same cell supplying 0.026 ampere current density. Following the above law an increase of 40% area means an increase of life of about 96% which accords approximately with the results found under test.

These cells at present are manufactured in unit batteries of 2, 3, 4, 5, 6, 7, 8 cells connected in series and sealed under pressure in waterproof non-corrosive containers and occupy much less space than an equivalent number of round cells, and have only two connecting posts, regardless of the number of cells in a battery. They occupy much less space, weigh less and will not deteriorate under moisture. In fact, will operate equally well in the air or submerged in water.

Owing to the lower internal resistance, the short circuit test shows about 75 amperes. The voltage is the same as the round cell as the electro-chemical reactions are identical.

The round cell container being zinc, which is the fuel supplying the electrical energy, becomes thinner with use and will eventually be eaten through in spots. The cell is then rendered useless and the remaining zinc and other materials become waste product. Whereas in the new flat type, the zinc sheet can be entirely consumed and will deliver current up to the last, the cell on dissection showing no zinc whatever within the porous envelope. The cell, owing to its greater depolarizing area, maintains a higher voltage under load than the round cell, thus rendering better service as well as longer life.

Golfer's Foot

For practically every occupation and recreation that has attracted any general public attention, the doctors have produced a corresponding disease. Many will remember the dread "kyphosis biclarum" of the wheeling days, and more recently the "automobile knee;" and now we have the "golfer's foot." This is described as an acute condition due to distortion of the foot as a result of broken arch in the anterior metatarsal curved area, and results from an improper position of the feet while playing, which throws undue stresses on certain portions of the foot. Besides its discomfort, this trouble is said to be very frequently responsible for the annoying and, hitherto, unexplainable periods of "off play."