surprise he found it would not work, although he knew it had been doing excellent service where last in use. On examination he found that the springs on the suction valves had been adjusted at about 30 lbs. per square inch to suit former service, where water was pumped direct from town mains. As soon as proper adjustment had been made the pump performed quite satisfactorily.

3rd: That all air must be excluded from pump cylinder or chamber, and that all flanges and stuffing boxes must be kept tight, not only to prevent the admission of air, but to prevent leakage of water while pump is in operation.

4th: The discharge valve and pipe must also be clear, and all check valves, stop valves, etc., in proper working order, so that the plunger, or piston of the pump, will not be subject to any greater pressure than that within the boiler.

It will be unnecessary for me to add that water sufficiently hot to form steam at atmospherical pressure cannot be pumped owing to the destruction of the vacuum by the vapor. Nor will it be necessary to enumerate the various disorders to which pumps are subjected, as all minor troubles can invariably be traced to some of the causes already discussed.

## THE MEASUREMENT OF RESISTANCE.

SINCE the resistance of no two metals is the same, it was necessary to select the resistance of some accurately defined substance as a standard of measurement. The unit adopted by the international electrical congress in 1893 and called the ohm, after the discoverer of what is called Ohm's law, is "the resistance offered to any unvarying electric current by a column of mercury at the temperature of melting ice, 14,4521 grammes in mass of a constant cross sectional area and of a length of 106.3 centimeters." From this is obtained the standard unit of resistance, but for practical purposes wires of known resistance or resistance coils are used.

The resistance coils require great accuracy in their measurement, in the insulation of the wire and in the mounting of the coils. The wires must be carefully selected and tested. The insulation must be such as will withstand the highest temperature to which it is subjected without change. Silk thread is extensively used for the insulation. The wire is usually wound on spools or in coils so as to occupy as little room as possible, and are mounted in a box, which protects them from injury and places them in a convenient form to be carried. The ends of the coils are connected to plates or binding posts in the cover. This, also, must be carefully constructed so that the resistance at the point of contact will be as low as possible. A single coil is sometimes placed in an ebony case, or any number, according as the work for which it is to be used seems to require. When a large number is placed in one box the ends of the wires are usually connected to metal blocks, placed at such a distance apart that a metal plug will make a good connection between any two.

The resistance coils being uniform in size, the entire resistance or any part may be used. This is one of several styles of resistance boxes which are manufactured by instrument makers, and is the one commonly used. In measuring the resistance of an electric circuit, we cannot take our standard of measurement as we would take a foot measure to obtain the length of a piece of timber, but we can use it in another way, which will be explained with the Wheatstone bridge. If that of which we wish to measure the resistance is carrying a current and we have a voltmeter and ammeter so we may obtain the difference of potential and amount of current, the resistance is easily obtained by means of Ohm's law, the resistance equaling the electromotive force divided by the current.

## ELECTRICAL ITEMS WORTH REMEMBERING.

DROPPING a steel magnet, or vibrating it in other ways, diminishes its magnetism.

It is said that steel containing 12 per cent. of manganese cannot be magnetised.

Flames and currents of very hot air are good conductors of electricity. An electrified body placed near a flame soon loses its charge.

In changing a secondary battery, the charging electromotive force should not exceed the electro-motive force of the battery more than 5 per cent.

The resistance of copper rises about 0.21 per cent. for each degree Cent.

A lightning rod is the seat of a continuous current, so long as the earth at its base and the air at its apex are of different potentials.

The rate of transmission on the Atlantic cables is eighteen words of five letters each per minute. With the "duplex" this rate of transmission is nearly doubled.

The effect of age and of strong currents on German silver is to render it brittle. A similar change takes place in an alloy of gold and silver.

To obtain the number of turns of wire in an electro-magnet, multiply the thickness of the coils by the length, and divide by the diameter of the wire squared.

A test for the porosity of porous cells consists in filling the cell with clean water and taking the per cent. of leakage. The correct amount of leakage is 15 per cent. in 24 hours.

If the air had been as good a conductor of electricity as copper, says Prof. Alfred Daniell, we would probably never have known anything about electricity, for our attention would never have been directed to any electrical phenomena.

For resistance coils, for moderately heavy currents, hoop iron, bent into zigzag shape, answers very well. One yard of hoop iron ½ inch wide and 1-32 inch thick measures about 1-100 of an ohm.

The voltage of a secondary battery must always be equal to or slightly in excess of the voltage of the lamp to be burned. For example, a 20 volt lamp will require 10 secondary cells, but ten cells will supply more than 20 lamps.

Compression of air increases its dielectric strength. Cailletet found dry air compressed to a pressure of 40 or 50 atmospheres resisted the passage through it of a spark from a powerful induction coil, while the discharge points were only 0.05 centimeter apart.

An accumulator with 17 plates, 10 by 12 inches, is reckoned, in horse-power hours, equal to about one horse-power hour. Taking this as a basis, it will require 6 cells for one horse-power for 6 hours, or 30 cells for 5 horse-power for the same length of time.

To obtain the length of wire on an electro-magnet, add the thickness of the coils to the diameter of the core outside of the insulation, multipy by 3.14, again by the length, and again by the thickness of the coils, and divide by the diameter of the wire squared.

Blotting paper, saturated with a solution of iodide of potassium to which a little starch paste has been added, forms a chemical test paper for testing weak currents. When the paper (slightly damp) is placed between the terminals of a battery, a blue stain appears at the anode, or wire connected with the carbon or positive pole of the battery.—Scientific American.