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Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

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THE DISCOVERY OF ARGON.

Some six years ago the Right Hon. Lord Rayleigh undertook one of the most difficult of chemico-physical measurements, namely, the determination of the densities of certain "permanent" gases. He established satisfactorily the densities of oxygen and hydrogen, but on undertaking that of nitrogen he was confronted with an anomaly, both curious and serious, which for some time he regarded only with "disgust and impatience."

Nitrogen to be weighed may be obtained from two entirely different sources—from the atmosphere, where it exists free, or from chemical compounds, such as ammonium nitrate, or nitric acid, in which it exists in combination with other substances. The air, as everybody knows, consists chiefly of nitrogen, oxygen, carbon dioxide, and water vapor. In order to free nitrogen from the other constituents, air was bubbled, first through a solution of potash, which detains the carbon dioxide, then through concentrated sulphuric acid, which is a trap for water vapor, and lastly over red hot copper, which is a famous oxygen "grabber," after which the nitrogen emerged into the globe prepared for it, supposably pure. Red hot iron filings, or ferrous hydrate, may be substituted for hot copper; but whatever means were employed to separate the atmospheric nitrogen from its fellow constituents, Rayleigh found that the weight of nitrogen going into the globe, in each experiment, remained fairly and satisfactorily constant.

So far, so good; but when nitrogen from ammonium nitrate, nitric oxide, or any other compound, was conducted into the glass globe, it weighed eleven milligrammes less than when it contained atmospheric nitrogen. Eleven milligrammes is not a great weight, about that of a pin's head, but it was quite sufficient to disturb the equilibrium of both his lordship's balances and—mind. It was not, however, until a year ago, after two years' work, that the result stood sharply and unmistakably out that "chemical" and "atmospheric" nitrogen differed in weight.

Now, admitting this difference to be established, an obvious explanation would be the presence of some impurity in the gas from either source. An elaborate investigation proved, so far as chemical science can prove, that the nitrogen derived from chemical sources contained nothing which could account for the discrepancy, and Rayleigh was thus obliged to ask himself the further question, "What evidence have we that atmospheric nitrogen is one substance, pur et simple?" On referring back, great was his surprise to find that the question had been put, just as sharply and decisively, one hundred years ago, by that shrewd Scotchman, Henry Cavendish, who so advanced the science of his time; and furthermore, that no work had been done since. Cavendish not only asked the question, but endeavored to answer it by the following experiment:

A mixture of air and oxygen, together with a small piece of potash, was passed into a U tube inverted over mercury. Through the air so inclosed, a series of electric sparks passed continuously for days, and even weeks. Under these circumstances nitrogen unites with oxygen to form nitrous acid, which is converted by the potash into solid potassium nitrite. The mercury rises in the tube to take the place of the disappearing oxygen and nitrogen; but Cavendish found that, even after weeks of continuous sparking, a small bubble of gas remained unabsorbed. That bubble, if Cavendish had only known it, was argon. Needless to say Rayleigh repeated the experiment. He then transferred the gas so obtained to a vacuum tube, and observed the spectrum. It was different from anything else in the universe; and lo, argon was discovered!

Cavendish cannot be awarded the honor of the discovery, because with his crude apparatus he could not feel certain that his residual bubble was genuine.

He merely concludes that "if there is any part of the phlogisticated air (nitrogen) of our atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude that it is not more than $\frac{1}{120}$ of the whole."

In the method of Cavendish, as improved by Rayleigh, the mixed gases, air and oxygen, are fed into an immense glass flask half filled with caustic potash. Instead of the small electric spark he uses an electric arc (from a current potential of 2,400 volts), between thick platinum terminals, situated about half an inch above the alkali. The mixed gases are absorbed at the rate of seven quarts an hour. The argon gradually accumulates, and when it is desired to stop operations, oxygen only is fed into the flask. At the end, when the nitrogen is completely absorbed, the flame suddenly changes to a bright blue color. The excess of oxygen is then absorbed by potassium pyrogallate, so well known in photography, and the argon remains free from impurity.

Soon after isolating argon, Rayleigh took Professor Ramsay into his confidence, who soon devised a chemical method which is equal, if not superior, to the foregoing. This method depends on the peculiar fact that nitrogen, so inert with most substances, will unite quite readily with magnesium to form a solid nitride. The apparatus consists of a closed system, containing soda, sulphuric acid, phosphorous pentoxide, red-hot copper and red-hot magnesium, through which the air wanders in a closed circuit until deprived of carbon dioxide, water, oxygen and nitrogen. The residue is pure argon. So far as the yield is concerned, the second method is preferable to the first, giving as much argon in eight hours as can be obtained in fourteen hours by the oxygen method.

Ramsay's method has lately been much improved by M. Guntz, who passes atmospheric "nitrogen" over several iron boats containing electrolytic lithium, which absorbs nitrogen completely at a low temperature and collects the argon over mercury at the exit end of the apparatus.

Still another method is to pass atmospheric "nitrogen" into a large flask in which there is an electric arc formed between magnesium terminals. The magnesium burns the nitrogen into solid magnesium nitride, and the argon remains.

Now, what is argon? It is a colorless, odorless gas, existing in the atmosphere to such an extent that, in a room containing 6,000 cubic feet, we should have about 50 cubic feet of argon.

Since we have thus a practically unlimited supply, can we put it to any economic use? Not unless we can make it enter into combination with some other element; and happily enough, in spite of its name—"lazy"—the famous French chemist, M. Berthelot, by means of the silent electric discharge, has succeeded in making it enter into a combination in which mercury, argon and condensation products of benzine are concerned. In addition, argon has lately been found with helium in combination with meteoric iron.

Should Berthelot's compound turn out sufficiently stable to be isolated, there is a probability that it may serve as a gate through which our element may enter into innumerable other combinations possessing properties which may or may not be useful to the race.

The very discovery of argon, however, stands as a warning to those who would teach us that science is bankrupt. R. K. DUNCAN.

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 magnetized.

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

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

Lightning has an electro-motive force of 3,500,000 volts and a current of 14,000,000 amperes. The duration of the discharge of lightning is $\frac{1}{20000}$ of a second.

The resistance of copper rises about 0·21 per cent for each degree Fah., or about 0·38 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 Atlantic cables is eighteen words of five letters each per minute. With the "duplex" this rate of transmssion 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 Professor Alfred Daniell, we would probably never have known anything about electricity, for our attention would never have been directed to any electrical phenomena.

A perfect vacuum is a perfect insulator. It is possible to exhaust a tube so perfectly that no electric machine can send a spark through the vacuous space, even when the space is only one centimeter.

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; consequently, 100 yards will be required to measure 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 10 cells will supply more than 20 lamps.

Compression of air increases its dielectric strength. Cailletet found that 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