ings in the legislature of Connecticut on May 19, 1780, when the doughty Davenport of Stamford protested against adjournment:

> Either the day of judgment is at hand or it is not. If it is not there is no cause for adjournment. If it is, I wish to be found in the line of my duty. I wish candles to be brought.

As a loyal son of Harvard, the professor might have stretched space a little to tell of that good President Wigglesworth who on this same day read his Bible by a window. There had been thunder and rain in the morning. At 11 o'clock fowls went to roost. At 12:21 Mr. Wigglesworth, the darkness still increasing, could not read the running title of the large Bible. Candles were lit. At 1:12 the degree of light was the same as at 11 o'clock, which was determined by Mr. Wigglesworth's reading. So the day wore on. Observations of pressure and temperature were made every hour. A detailed account of the happenings on this day was kept by Nathan Read, a student at Harvard, and is now in the possession of the Essex Institute.

Tornadoes, cold waves, northers and blizzards are discussed; also hot waves, sunstroke weather and the Indian summer.

Concluding chapters deal with climate and health and climate and crops; and the final chapter is on the climates of Alaska. We are pleased to note the plural. It is well to have an authoritative word on this, because of the popular impression that rigorous weather is the rule. Indeed, one of the world flyers lately, when asked about the climate of Alaska, answered that there were only two seasons—this winter and the next. On the contrary, notwithstanding great contrasts, there are many localities where climate is not essentially different from that of our North Pacific states.

General Greely's "Handbook of Alaska" (third edition, 1925) will be found of great value to those interested in this matter.

Professor Ward has done a good service to all university instructors in climatology and economic geography by assembling in one convenient volume the essential facts of climatic conditions in the United States. His twenty-five years' experience as a teacher has enabled him to meet the needs of teachers and students primarily; but also he has given us a volume which agriculturists, medical men, business men and others may profit by reading.

The book deserves and probably will have a wide circulation.

ALEXANDER MCADIE

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SPECIAL ARTICLES

FLAMES OF ATOMIC HYDROGEN

A STUDY of the heat losses from tungsten filaments at very high temperatures in an atmosphere of hydrogen led the writer to conclude in 1911[1] that hydrogen is largely dissociated into atoms at temperatures of 2500°K or more. The total heat loss from the filament after subtracting that due to radiation increased in proportion to the 7^{th} power of the temperature at temperatures over 2700°K, whereas the normal heat loss by convection, as determined for example in nitrogen, should have increased with the 1.8^{th} power of the temperature. Further work showed[2] that by heating a platinum or tungsten filament above 1300°K in hydrogen at low pressures, atomic hydrogen was formed which had very remarkable properties. It would dissolve at ordinary temperatures in platinum and would be condensed on glass surfaces at room temperature and at this temperature combined instantly with oxygen, phosphorus and reduced oxides such as WO_3, CuO, Fe_2O_3, ZnO or PtO_2. More accurate measurements of the heat losses from tungsten filaments in hydrogen at various pressures[3] gave 90,000 small calories as the heat of combination of 2 grams of atomic hydrogen, and showed that the degree of dissociation at atmospheric pressure increased from about 2 per cent. at 2400°K to about 34 per cent. at the melting point of tungsten.

In attempting to obtain the Balmer spectrum of hydrogen without contamination by the secondary spectrum, R. W. Wood[4] built very long vacuum tubes in which he passed currents of amperes through moist hydrogen at a few millimeters pressure. He observed many remarkable phenomena. Short pieces of tungsten or platinum wire mounted in a side tube became heated to incandescence, although no electric current flowed through this tube and the glass walls near the wires were not heated strongly. These effects were nearly absent when the hydrogen was carefully dried. In correspondence with Professor Wood, the writer suggested that these effects were due to high concentrations of atomic hydrogen which could accumulate in the tube because of the effect of water vapor in poisoning the catalytic activity of dry glass surfaces that otherwise destroyed the atomic hydrogen. With moisture present the atomic hydrogen diffused through

[1] Langmuir, Trans. Amer. Electrochem. Soc. 20, 225 (1911) and Jour. Amer. Chem. Soc. 34, 860 (1912).

[2] Langmuir, Jour. Amer. Chem. Soc. 34, 1310 (1912); Freeman, Jour. Amer. Chem. Soc. 35, 927 (1913).

[3] Langmuir and Mackay, Jour. Amer. Chem. Soc. 36, 1708 (1914), 37, 417 (1915) and 38, 1145 (1916).

[4] R. W. Wood, Phil. Mag. 44, 538 (1922).

the side tube and the atoms combined to form molecules on the surfaces of the metallic wires which acted as catalysts.

Shortly after this correspondence it occurred to the writer that it should be possible to obtain even higher concentrations of atomic hydrogen by passing powerful electric arcs between tungsten electrodes in hydrogen at atmospheric pressure. The high heat conductivity of the gas due to the energy liberated by the recombination of the rapidly diffusing atoms should prove of particular value in the construction of electric furnaces, and for melting metals in general. Experiments of this kind were soon made. Twenty ampere arcs from a constant current transformer were passed between two tungsten rods 6 mm. in diameter mounted transversely in an alundum tube (10 cm. diam.) through which a stream of hydrogen flowed and burned at the open end.

Arcs up to 2. cm. in length were obtained with voltages ranging from 300–800. The arc, of a beautiful red color, was of small diameter (about 3 mm.) and was bowed out into a fan shape by its own magnetic field.

Iron rods 2 or 3 mm. in diameter melted within a couple of seconds when they were held 3–5 cm. above the arc. By directing a jet of hydrogen from a small tube into the arc, the atomic hydrogen could be blown out of the arc and formed an intensely hot flame of atomic hydrogen burning to the molecular form and liberating 90,000 calories per gram molecule—about 50 per cent. more than that in an oxy-hydrogen flame. To maintain these conditions the electrodes had to be brought closer together (preferably 1–3 mm.).

In this flame, even at distances of 1 or 2 cm. from the arc, it was found that molybdenum melted with ease, and tungsten rods of 3 mm. diameter could be melted when held very close to the arc itself. Quartz, on the other hand, melted with more difficulty than molybdenum, indicating that the catalytic action of the metals played an important part in the rapidity with which they could be heated.

The use of hydrogen under these conditions for melting metals has proved to have many advantages. Iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon or manganese can be welded without fluxes without surface oxidation. The rapidity with which such metals as iron can be melted seems to exceed that in the oxy-acetylene flame, so that the process promises to be particularly valuable for welding.

The technical development of these welding processes using flames of atomic hydrogen has been the work of several men, among whom Robert Palmer and R. A. Weinman must be particularly mentioned. Papers describing the apparatus used and the results obtained will soon be published by Mr. Weinman and the writer in the *General Electric Review*.

Mr. P. Alexander, following out a line of development suggested by Professor Elihu Thomson, has independently arrived at an arc welding process utilizing hydrogen for the purpose of improving the ductility of the weld and the speed of operation. In this process the arc is passed between an iron electrode and the material to be welded. This process also depends at least in part on the use of the high heat conductivity of atomic hydrogen.

Some joint work of Mr. Alexander and the writer has shown that particular advantages are obtained in some cases by using mixtures of nitrogen and hydrogen, and that the quality of the weld is not impaired by nitrogen unless oxygen is also present. A paper by Mr. Alexander describing his process will appear simultaneously with those dealing with the atomic flame process.

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THE BINDING OF ACID AND ALKALI BY PROTEINS

WE have recently published[1] an extensive study of acid and alkali binding by proteins with especial reference to the mechanism involved in such binding and the relations which may exist between the chemical composition of the protein and the amount of acid or alkali which it binds at certain definite hydrogen-ion concentrations.

Inasmuch as the cited publication may not be generally available to persons interested in this subject, we have felt that it might be advantageous to briefly state certain of the conclusions which we arrived at in the course of our study.

The study included the isolation, purification and chemical analysis of a series of fourteen proteins. Twelve of these were isolated from the cereal grains and belong to the class of prolamines, the alcohol-soluble proteins of cereals. These proteins were isolated from the seeds of *Triticum vulgare, Triticum*

[1] Walter F. Hoffman and Ross Aiken Gortner, "Physico-chemical studies on proteins I. The prolamines—their chemical composition in relation to acid and alkali binding," Colloid Symposium Monograph, Vol. 2, pp. 209–368, 110 tables, 20 figs., 1925. The Chemical Catalog Company, New York City.