HIGH TEMPERATURE MEASUREMENTS

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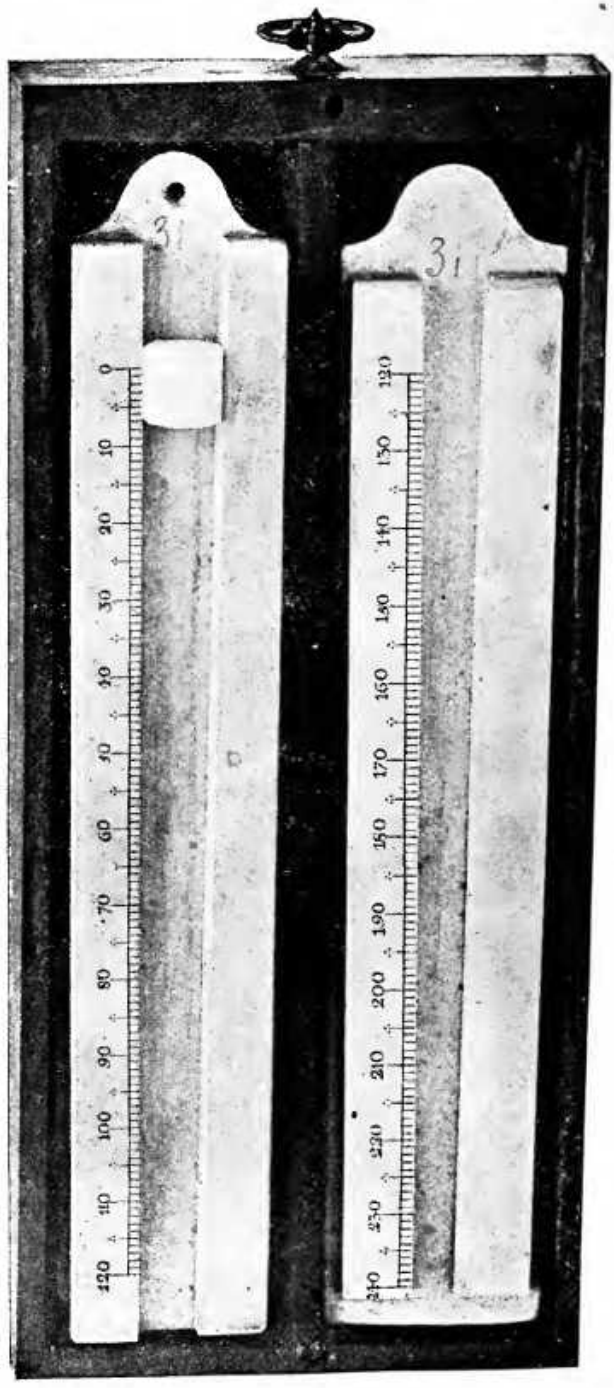

WEDGWOOD PYROMETER.

[*Frontispiece.*]

HIGH-TEMPERATURE MEASUREMENTS.

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AUTHOR'S PREFACE TO AMERICAN EDITION.

THE measurement of high temperatures was considered for a long time to be a very difficult operation and of a very uncertain precision. There were cited with admiration a half-dozen determinations seeming to merit some confidence. During the last few years the question has made considerable progress, and we possess to-day several sufficiently precise pyrometers whose usage is rapidly spreading among scientific and industrial laboratories. Before describing them, perhaps it will not be useless to indicate the services that they may render to science and to industry, by giving a brief summary of similar services that they have already rendered.

Among the researches in pure science which result from the new methods of the measurement of high temperatures, of primary importance are the masterly investigations of Osmond on the allotropic transformations of iron. After having precisely determined the nature of the phenomenon of recalescence, noted for the first time by Gore and Bartlett, Osmond discovered in iron two similar transformations: one, taking place in the neighborhood of 750°, corresponds to the loss of magnetic properties, and the other, at about 900°, is accompanied by a considerable evolution of heat. A third transformation of iron near 1300° has been discovered since by Ball. Soon after, Curie studied by the same methods the variation with the temperature of the magnetic properties of a great number

of substances, iron among them, which possess very definite perturbations corresponding to the different transformation-points.

Later, Le Chatelier studied the influence of temperature on the dilatation and electrical resistance of metals. The allotropic transformations are recognized by sharp points in the curves of electrical resistance and by sudden depressions in the dilatation curves.

But these researches have not been limited to the metals and their alloys. Investigating the dilatation of the different varieties of silica, Le Chatelier was led to the discovery of a transformation of quartz at 580°, above which the dilatation of this substance becomes negative, and to the discovery, still more important, of a new variety of silica distinct from tridymite, but possessing the same density and into which silex and even quartz are transformed by sufficient heating.

In the same manner have been studied the dissociation of the carbonate of lime, the bromide of barium, of minium, etc. Similarly the curves of fusibility of salt mixtures have been determined, their forms indicating the existence of definite compounds or of solid solutions. Also it has been possible to distinguish, among the natural products classed under the general head clay, a series of distinct chemical substances.

Finally, it has been possible to pursue the study of the laws of radiation at high temperatures with a greater precision, and to establish the theory of incandescent enclosures.

If we take up next the researches in industrial science, we find the number to be so considerable that it is out of the question to attempt to give in this short preface the complete list. It will suffice to mention the most important among them, such as the following investigations:

The fusibility of metallic alloys has been the object of a very complete memoir by H. Gautier, and of important researches by Sir Roberts Austin and by Heycock and Neville.

The tempering of steel has been examined in all its details by Osmond, Charpy, H. Howe, Sauveur, Brinnel.

Cementation by Arnold.

Crystallization in the annealing of metals, in particular of iron and brass, observed by Sauveur, Stead, Charpy.

And lastly the considerable number of researches made at the laboratory of the Ecole des Mines on the dilatation of ceramic pastes and of glass, by Damour, Chatenet, Grenet, Coupeau, Chautepié.

But the use of precise methods for the measurement of high temperatures is not limited to laboratory researches. It has rapidly penetrated into industrial practice. A series of investigations by Le Chatelier first made known the exact temperatures entering into the various metallurgical operations; and to-day, in the greater number of steel-works, the tempering and the annealing of the great forged pieces, cannons, plates, are no longer made without the aid of pyrometers, doing away with the workman's judgment, formerly alone consulted.

In glass manufacture Damour has introduced the employment of pyrometers for controlling the large furnaces and recipients, and for the regulating of the temperature of the annealing-chambers.

Parvillé has done the same for the porcelain industry, where the use of fusible cones allowed the determination of the stopping-point of the heating but gave no continuous indications necessary to regulate the time of heating, and on this last depends in a large measure the quality of the products obtained, and above all the cost of fuel.

In the manufacture of chemical products the precise

measurements of temperature render to-day very great services; for instance, in the Deacon process for the making of chlorine, whose yield varies very greatly for slight changes of temperature. Ludwig Mond in England and the St. Gobian Company in France have the merit of having first utilized these new scientific methods.

Euchène of the Paris Gas Company controlled all the details of the manufacture of gas by numerous measurements of temperature.

But the most remarkable of these industrial applications have been made in England under the lead of Sir Roberts Austin by applying photographic recording to the indications of the thermoelectric pyrometer. Such installations at the Clarence Works of Sir Lothian Bell and at the blast-furnaces of Dowlais give a continuous record of the temperature of the draft and of the escaping gases.

These very considerable results have been obtained within less than ten years, although the new methods of temperature measurement were known as yet to only a few savants and engineers. It is plausible to suppose that their influence on the progress of science and industry will be still greater during the coming years.

In finishing this preface, allow me to thank Mr. G. K. Burgess for having taken the trouble to translate into English our little volume. His science and his competence are for us a certain guarantee of cordial reception by American and English readers.

H. Le Chatelier.

Paris, January 10, 1901.