

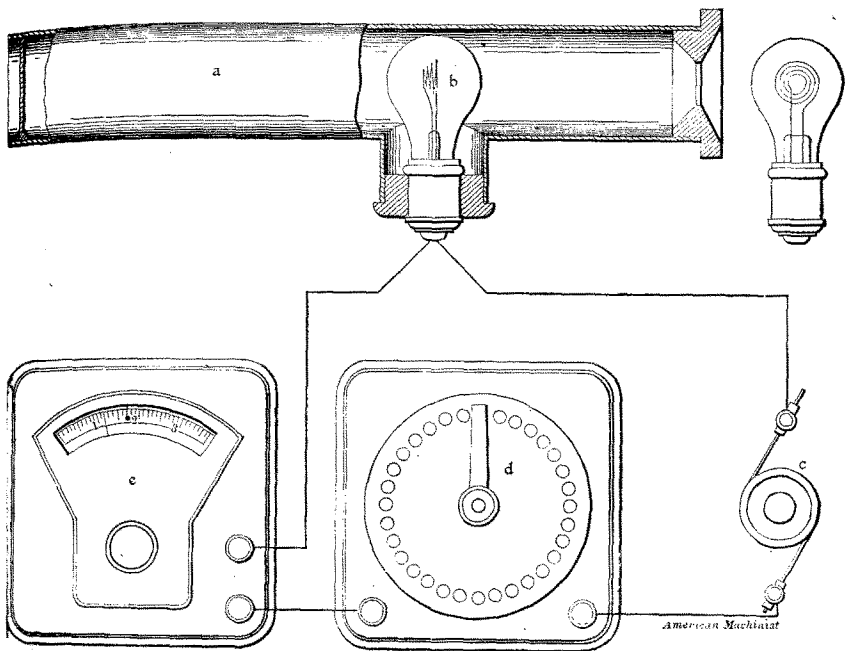
## The Morse Heat Gauge.

[Being the Report of the Committee on Science and the Arts on the invention of Everett F. Morse.

Sub-Committee: G. H. Clamer, Chairman, James Christie, John M. Hartman, W. D. Harris.]

[No. 2240.]

The Franklin Institute, acting through its Committee on Science and the Arts, investigating the merits of the heat



Diagrammatic representation of Heat Gauge.

gauge, invented by Everett F. Morse, of Trumansburg, N. Y., reports as follows:

Pyrometry is the term applied to measurement of high temperature such as cannot be determined by the ordinary thermometer. There have been many methods proposed for the measurement of such elevated temperatures, and a number of quite satisfactory instruments designed. The

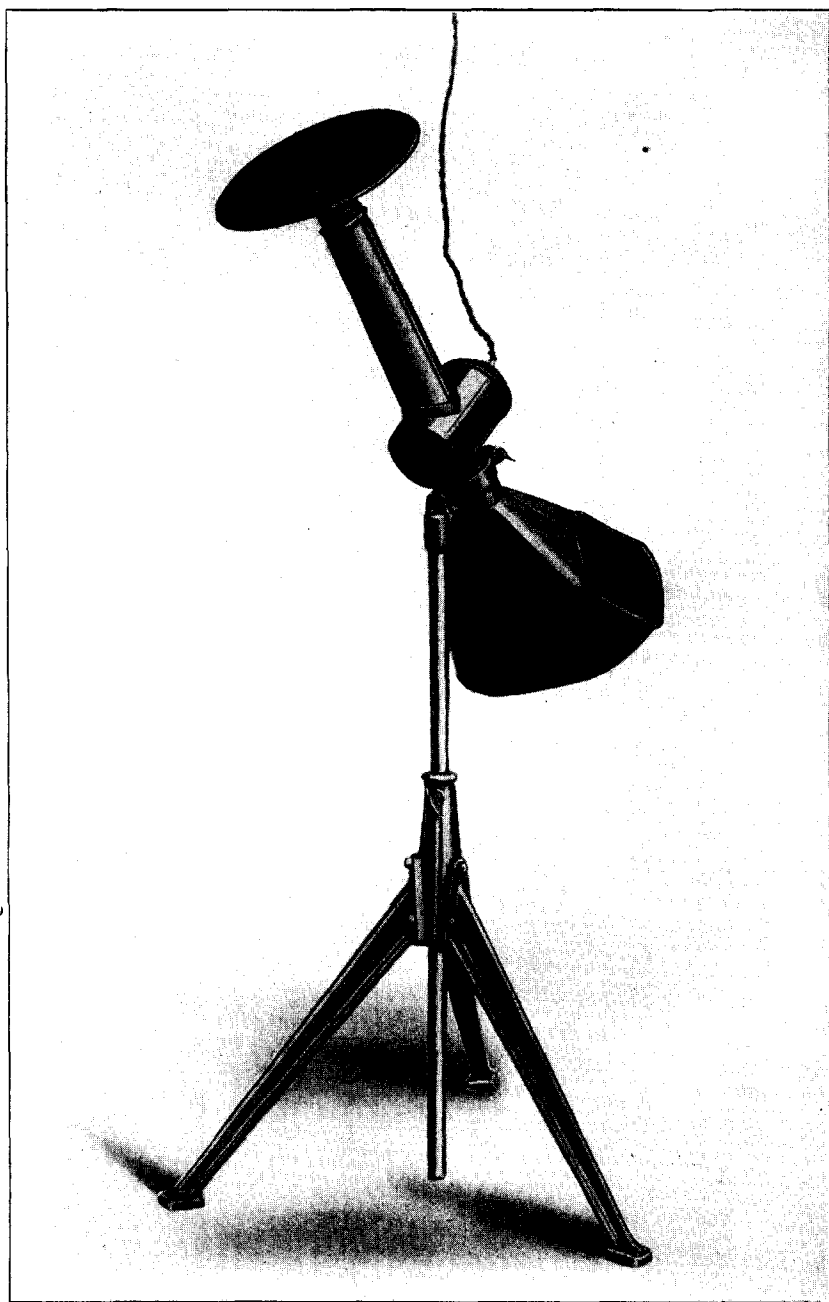
importance of pyrometric determinations is daily increasing, and the field of usefulness of a good heat gauge is an extensive one indeed.

Pyrometers have been made which depend on the method of mixtures, otherwise known as calorimeters, the principle of which is too well known to need description. Some have depended on the expansion of metallic strips or rods, and Messrs. Valy and Schorley employed a fluid alloy of sodium and potassium with mercury in a hard-glass tube by which means a temperature up to  $600^{\circ}$  C. could be read, as on an ordinary thermometer.

Carl Barus has given a classification of the principles on which pyrometers have been constructed. This appeared in the "Bulletin of the United States Geological Survey No. 54," 1889 :

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| 1. Dilatation of solids—                             | 7. Ebullition.                   |
| (a) A single solid.                                  | 8. Specific heat.                |
| (b) Two solids acting differentially.                | 9. Heat conduction.              |
| 2. Dilatation of liquids—                            | 10. Heat radiation.              |
| 3. Dilatation of gases—                              | 11. Viscosity—                   |
| (a) Expansion measured in volume, manometrically.    | (a) Of solids.                   |
| (b) Expansion measured in pressures, manometrically. | (b) Of liquids.                  |
| (c) Expansion measured in volume by displacement.    | (c) Of gases.                    |
| 4. Vapor tension.                                    | 12. Spectrophotometry and color. |
| 5. Dissociation.                                     | 13. Rotary polarization.         |
| 6. Fusion.   | 14. Acoustics (wave length).     |
|  | 15. Thermo-electrics.            |
|  | 16. Electrical resistance.       |
|  | 17. Magnetic moment.             |
|  | 18. Miscellaneous.               |

The above classification shows that almost every form of thermal phenomenon has been utilized for pyrometers. Probably the most important in practical application, because of its simplicity, is the method of fusion, viz., by means of various metals which, when brought into a heated atmosphere, or in the vicinity of a heated body, will melt, the melting point being known; thus a temperature which will melt one alloy and not another can be said to lie between the two. This, of course, gives but approximate results inside of a wide range, and hence is limited in its usefulness.



Heat Gauge as used with a blacksmith's fire.

The most important application of this method has been in the determination of temperature of hot blasts in connection with blast-furnace practice.

Quite a satisfactory pyrometer is built on the principle that if a current of water of known temperature be allowed to run through a coiled tube, the temperature of the out-flowing water will be proportionate to the temperature through which it has passed.

An important advance was made with pyrometric construction when Sir Wm. Siemens discovered that an instrument could be made to gauge temperatures quite accurately, by comparing the resistance of platinum wire at ordinary temperatures with the same at an elevated degree. The method used being to pass a current through a platinum wire around about a porcelain tube, balancing the resistance by means of another coil, so that equal currents would pass through both. The platinum wire when placed in the heated medium is increased in resistance—the smaller current traversing it. This current, compared with that passing through the standard coil, is reduced to temperatures recorded on a table. Other instruments have been produced which depend upon the electrical resistance of bodies at elevated temperatures, notably the one of Professor LeChâtelier, which consists of a thermo-couple composed of platinum and an alloy of platinum with 10 per cent. rhodium. Such a couple, under the effects of heat, is capable of generating a current which can be measured on a sensitive galvanometer. The galvanometer in practice is standardized for direct reading of temperature. This pyrometer is very extensively used at the present time, and your chairman has had some experience with this apparatus in the measurement of the temperature of molten metals. This instrument is very trustworthy for the measurement of furnace chambers, etc.; but, owing to the thick walls of clay, or infusible material, with which it is necessary to protect a thermo-couple, takes a long while to produce a variation. A further difficulty lies in the inability to produce a clay protection which is substantial enough to make the instrument successful in the hands of any but a careful operator, and is entirely too deli-



Heat Gauge as used with a heating furnace.



Heat Gauge as used with a lead bath.

cate a contrivance for every-day use in the foundry. It was on this account that its use was abandoned.

Other pyrometers have been produced, of which the Morse gauge is a type, known as "optical pyrometers." In this, the eye of the workman, supplemented by an instrument which enables him to record the intensity of the radiations, becomes a pyrometer, so that the old method of judging temperatures by the appearance of the same is rendered comparatively accurate, and familiar indications of bright redness, etc., are subjected to direct measurements.

The optical pyrometer of LeChatelier is a photometric instrument. In this apparatus the rays emitted from a standard are compared with the rays emitted from a heated body whose temperature is to be determined. A red glass is interposed in the eye-piece and only red rays enter the eye. The photometer depends upon the adjustment to the same brightness of two images, one of the standard and the other of the compared body. The adjustment is made by means of two diaphragms having V-shaped notches opposite one another. They are operated by means of a milled head, and the light admitted depends upon their respective distance from one another. The measurement of this distance compared with the distance apart when observing the standard light is reduced to temperature.

Other optical instruments have been put upon the market, but the one under consideration is perhaps the most ingenious invention, because of its simplicity.

The invention of Everett F. Morse is covered by two patents, granted April 1, 1902, the first covering the process, and the second the method of gauging the temperature by heated substances. First, No. 696,619, and the second, No. 696,878.

The methods of optical pyrometry employed previous to the invention of Mr. Morse are unreliable, chiefly because the optical standards for comparison have been placed to one side of the compared, and consequently such comparisons are greatly dependent upon the personal equation of the observer.

The gist of Mr. Morse's invention is best stated in the

first patent, viz.: The method of gauging the temperature of a material which becomes incandescent when heated, consists in comparing said material, heated to luminous state, with an optical standard so that at least a portion of one is in the path of the rays passing from the other to the eye observing the standard and material and noting when the one immerses in the other to such a degree as to indicate the correct temperature within the necessary limits.

The apparatus of Mr. Morse consists first of a standard and by preference he has chosen the simple incandescent lamp, the temperature or color of which can be regulated by resistance, and the amount of current passing through the circuit recorded on a mill-ampere meter. This makes a very convenient and reliable standard. The lamp is enclosed in a tube which may or may not be open at both ends as desired. The tube containing the standard is held in such a position that the rays passing through the object of comparison will be superposed by the rays from the glowing lamp, the color intensity of which is regulated by means of the resistance in the circuit, that it will be of the same intensity, and will apparently be obliterated from view. At this point an observation of the ammeter and a comparison with the table, the result of calibration by means of a LeChatelier pyrometer, gives the ampere reading direct in temperatures.

The Morse Gauge is an exceedingly simple and practical device founded on good scientific principles, and should have a wide field of usefulness, especially in the study of that important question, the heat treatment of steel. It has been used by a number of prominent manufacturers for some time, whose testimonials form a part of the Committee's records.

In view of the novelty of the invention and its practical advantages over other apparatus and methods, the Institute recommends the award of the John Scott Legacy Premium and Medal to Everett F. Morse.

Adopted at the stated meeting of the Committee on Science and the Arts, June 10, 1902.

Attest:                      WM. H. WAHL, *Secretary.*