A Platinum Resistance Thermometer for High Temperatures

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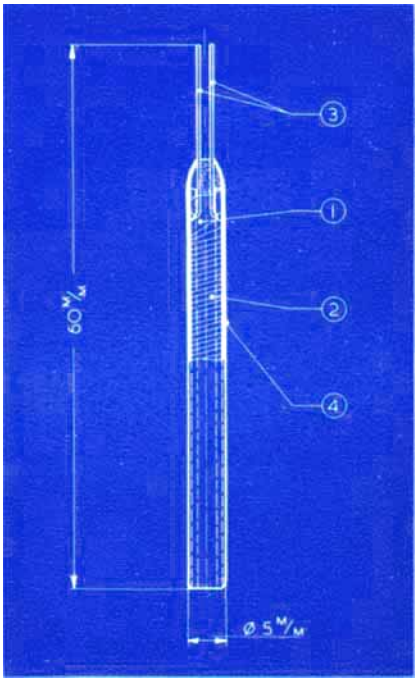
A new type of platinum resistance thermometer, constructed with ceramic insulating materials, is described. It may be maintained in continuous operation at temperatures up to 850°C for many hundreds of hours.

The use of resistance thermometers in industry has steadily increased during recent years. This is not merely due to the increased demand for measuring equipment in consequence of expanding production, but is largely the result of an extension in the measuring range of resistance thermometers to cover higher temperatures. This widening in range is of particular significance in the chemical industry since the development of a number of new processes and reactions has become possible only as a result of the use of high operating temperatures. These processes, however, demand exact temperature regulation and control; resistance thermometers for high temperatures are now indispensable tools for this purpose.

The large variation in the specific electrical resistance of metals with temperature has long been exploited for controlling temperature in industrial processes. However, the upper temperature limit previously lay between 500 and 600°C. This was due to the limited insulation at such temperatures of the types of glass employed in the manufacture of resistance thermometers. Depending upon the composition of the glass, slight ion transport commences in the presence of an electrical field as soon as a certain temperature is exceeded, i.e. the glass becomes an electrical conductor. Local currents then flow between the individual filament windings in the thermometer, causing an apparent reduction in its resistance. The thermometer thus gives a false reading.

It was possible to raise the upper temperature limit for resistance thermometers in continuous service only by altering the materials used in the construction of the former and for covering the measuring filament. This led to the development of the platinum resistance thermometer for high temperatures, as described in more detail below.

The construction of the platinum resistance thermometer, type W85, is shown diagram-



The construction of the platinum resistance thermometer, type W85 matically. It comprises the coil former (1) with its bifilar measuring winding (2) of fine platinum wire. The measuring winding is welded to the supply leads (3), constructed of a rhodium-platinum alloy. The supply leads and measuring winding are fixed to the former by means of a ceramic insulating layer which is fused over the wires at temperatures in excess of 1000°C. This construction is, in principle, the same as that employed in the older glass resistance thermometers. The chief innovation consists in the use of pure sinter clay as a former and a specially developed ceramic insulating compound (4) for covering the measuring winding instead of the glass hitherto employed. This insulating compound consists of a mixture of various oxides, the composition of which is such as to give a melting point below that of platinum. The compound possesses excellent insulating properties even at high temperatures.

A number of different models of the resistance thermometer, type W85, are available. The most common form has a resistance of 100.00 ± 0.10 ohms at 0°C. The resistance-temperature characteristic is practically linear up to about 850°C, thus permitting the accurate measurement of temperatures up to this value.

Temperatures from 0 to 850°C with corresponding resistance values are to be found in the table.

Even after operation for many hundreds of hours, the resistance values remain constant provided the measuring resistance is screened from metallic vapours. The penetration of such vapours into the ceramic insulating layer impairs the otherwise excellent insulating properties of this layer. Careful mounting in the protective sheath is therefore essential to the success of the instrument.

The half-value period* of this thermometer lies within the range 15 to 20 seconds. This is about the same as in the common forms of the glass thermometer. If required, it is possible to reduce this half-value period by decreasing the size of the former and by other changes in the construction. In normal industrial practice, however, the half-value period of the standard model is entirely adequate. The heating error has a value of 0.10 to 0.15°C in the standard model, 60×5 mm, with a bridge current of 10 mA when mounting is unfavourable, i.e. such as in still air.

Temperature-Resistance Values for the Platinum Resistance Thermometer, Type W85

Temp. °C	Resistance, ohms	Temp. °C	Resistance, ohms
0	100.00	450	264.16
50	119.40	500	280.89
100	138.50	550	297.30
150	157.32	600	313.38
200	175.86	650	329.14
250	194.12	700	344.59
300	212.08	750	359.74
350	229.75	800	374.61
400	247.11	850	389.23

The low temperature-shock sensitivity of the model W85 represents a further advantage of this type of thermometer as compared with glass thermometers. Since all constructional components, especially the former for the measuring coil and the ceramic insulating compound, are in a crystalline state, these thermometers are much less liable to fracture than models constructed wholly or partly of glass.

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* The "half-value period" is a measure of the time lag of the thermometer. It indicates in what time the temperature difference between the surrounding medium and the thermometer reaches half its original magnitude. In place of this value, the time constant is often quoted. The relationship between these two values is given by

Time constant $\approx$ 1.4× "half-value period".