Liquid Steel Temperature Measurement in the U.S.S.R.

THERMOCOUPLE DESIGN AND PRACTICE

The use of the platinum:rhodium-platinum immersion thermocouple in a Soviet steel works and the consequent improvement in control of pouring temperatures and in the quality of the steel produced are described in a paper recently published by two engineers of the Kuznetsk Metallurgical Combine (KMK), S. G. Otlivanov and I. A. Sokolov (*Stal*, 1956, (5), 409).

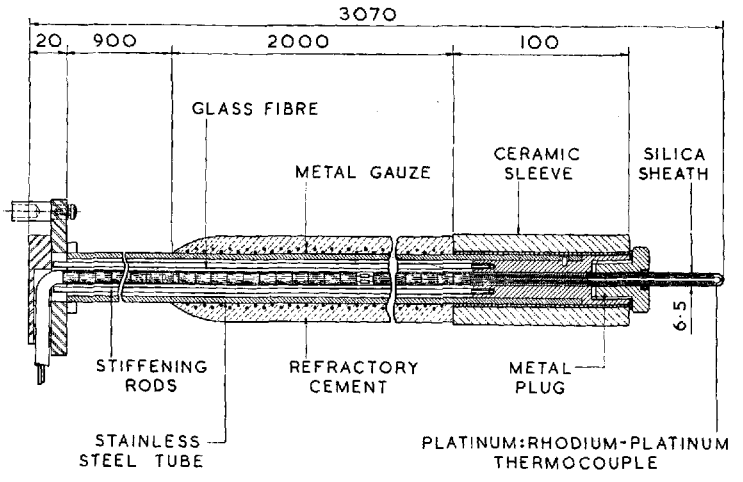
After extensive studies on the construction of the necessary equipment and of methods of temperature determination in open hearth furnaces, electric furnaces and ladles, the arrangement shown in the diagram below was adopted.

The thermocouple is enclosed in a seamless tube of stainless steel, 3000 mm long, 20 mm inside diameter and 2.5 mm in wall thickness. For a length of 2000 mm this tube is coated with refractory cement (largely replaced in British practice by the more easily renewable graphite sleeving), this cement being reinforced with a ten-mesh metal gauze of 1 mm wires. A silica sheath 75 mm long protects the hot junction, and is cemented into a metal plug. The couple wires and compensating leads are insulated with porcelain tubes and also with glass fibre.

Generally this design appears to be of orthodox construction, the use of a straight tube following American rather than British practice and being designed for insertion through a fairly large inspection hole in the door of the open hearth furnace.

Interesting features include the use of a pressed ceramic sleeve, and of two 2 mm diameter stiffening wires located inside the case and rigidly connected to the metal cap.

The equipment is of comparatively light weight—8 to 10 kg—and is easily portable, while its rigidity is said to contribute to greater accuracy in temperature measurement. Experiments with varying sizes of silica sheaths showed that with an external diameter



Design of the platinum:rhodium-platinum thermocouple head used for liquid steel temperature determinations at the Kuznetsk Metallurgical Combine

of 7 to 9 mm and a wall thickness of 1.0 to 1.2 mm the time taken to establish maximum temperature was about 12 seconds. Temperatures are recorded by means of an electronic potentiometer installed on the control panel of each furnace, and are recorded on graph paper operated automatically on immersion of the couple.

An average of 18 to 20 immersions is obtained before the ends of the couple are cut back; a length of 50 mm is then removed, and the couple recalibrated. In many cases measurements are carried out simultaneously with two couples in order to ensure steady readings and to check any discrepancies. The proportion of inaccurate readings with deviation of $\pm$10 to 15°C was found to be around 3 to 5 per cent.

The thermocouple assembly is pre-heated to 1000°C, introduced into the furnace through an inspection hole in the centre of the charging door and then immersed into the bath at an angle of 45° to a depth of 150 to 200 mm.

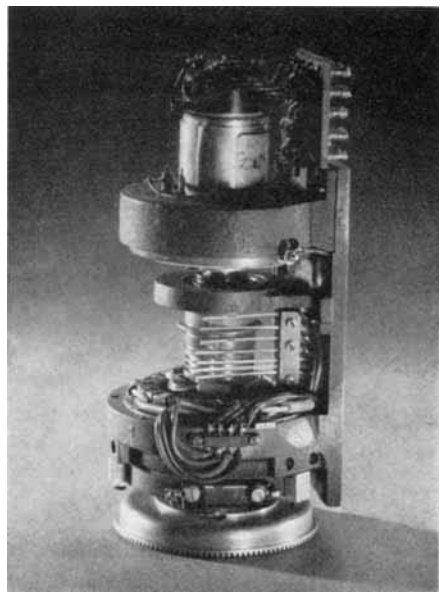
The temperature of the metal in each furnace is determined on melting, at the beginning of the boil, at 20 to 30 minutes before deoxidation, and again immediately before deoxidation. Throughout the plant some 5000 measurements of temperatures are made in a month, the cost per determination working out at only about 10 kopeks per ton of steel cast.

Experience with this technique has shown much less deviation from the optimum pouring temperature, with an appreciable improvement in the quality of the metal and increased stability of the open hearths.

Rhodium Plated Slip Rings in Flight Instruments

The design of flight instruments—to give the necessary information about an aircraft's attitude, heading and position and their rates of change—has become more difficult with the production of aircraft capable of high speeds and with more critical characteristics. A development recently announced by S. G. Brown Ltd., Watford, provides in one instrument an improved means of obtaining such data irrespective of the conditions of flight or of aerobatic manoeuvres. This equipment, based on a design conception of the Royal Aircraft Establishment and sponsored by the Ministry of Supply, is known as the Master Reference Gyro Type A.

These gyros incorporate a large number of light duty slip rings and brushes that must operate efficiently under conditions of very light brush pressure. Rhodium plated rings, used in conjunction with multi-wire brushes made in a copper-silver-gold alloy, have proved very satisfactory even with brush pressures as low as 2 grams.



The output unit of the Master Reference Gyro Type A, developed by S. G. Brown Ltd., showing some of the many rhodium plated slip rings embodied in the instrument