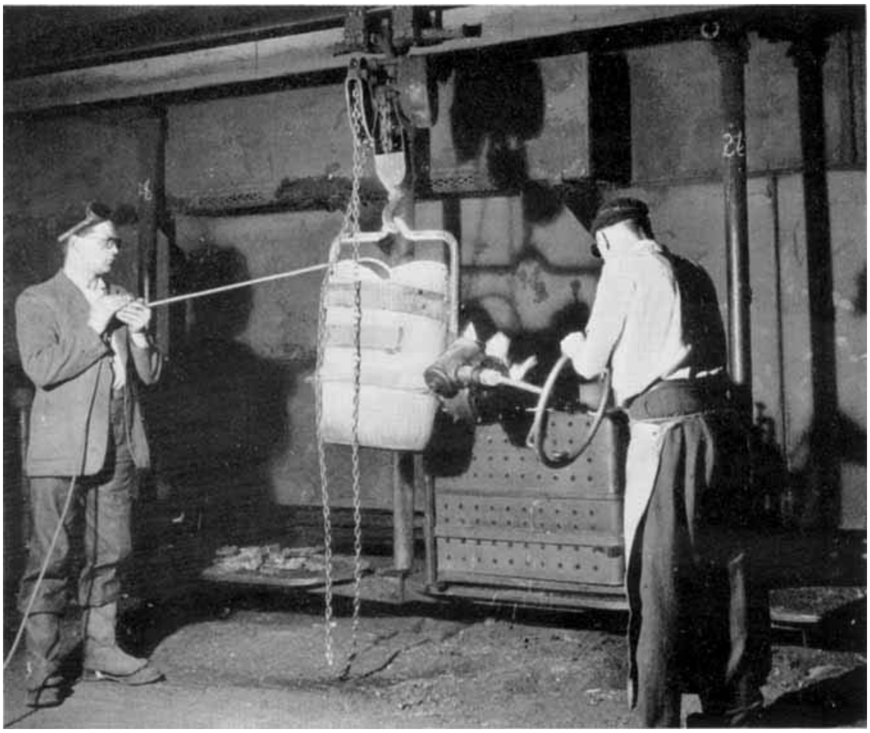
Temperature Control in the Ford Foundry

THERMOCOUPLE PRACTICE IN THE PRODUCTION OF GREY IRON AND ALLOY STEEL CASTINGS

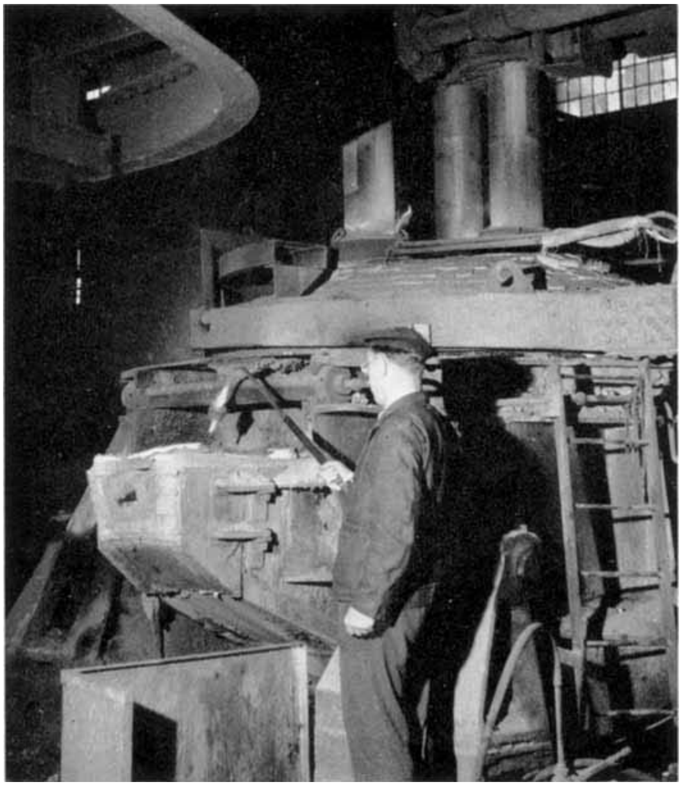
By H. Connor, B.Sc.

The Ford Motor Company Ltd., in developing improved manufacturing techniques for the large-scale production of engines and vehicles, has always paid great attention to foundry methods. The new £7¼ million Thames Foundry is the largest and most modern in Europe and, with the older Dagenham Foundry, supplies Ford's requirements for grey iron and alloy steel castings used in their production of motor-cars, lorries and tractors.

The accurate control of liquid metal temperatures is of great importance in the continuous and large-scale production of a wide variety of castings in a number of alloys. In order to produce high quality castings which, for the heaviest cylinder blocks and gear-boxes, weigh several hundredweights



Measuring the temperature of grey iron while pouring a cylinder block casting in the Dagenham foundry of the Ford Motor Company Ltd. A platinum : 13 per cent rhodium-platinum quick-immersion thermocouple is used



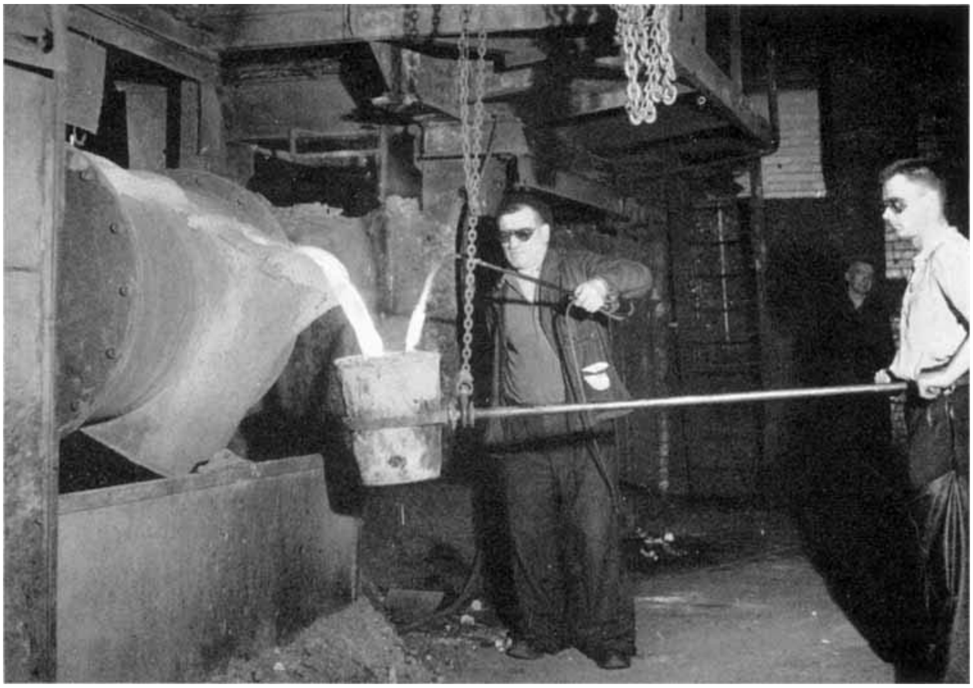
Measuring the temperature of molten iron in the spout of a 7-ton tilting electric arc furnace. Each time a ladle is filled a reading is taken to ensure uniform casting temperatures in the production of cylinder heads and blocks

and are of great complexity, the temperature of the molten metal must lie within a narrow range to give the best results. Certain alloys are sufficiently temperature sensitive to cause a substantial increase in casting rejects and scrap if the casting temperatures deviate from the optimum determined by experience. In addition, it is highly desirable to have an accurate knowledge and record of the temperatures of liquid steels held in electric arc furnaces and receivers before pouring into the ladles.

For some years the temperatures of molten metals used in the foundry were measured by means of the optical pyrometer. This method was subject to a number of errors due to the presence of slag, fumes and dust, and to the variable emissivity of oxide films. It also suffered from the variable human element and the inability to effect automatic and permanent records of the temperatures measured.

The quick-immersion thermocouple, employing a suitably sheathed platinum : 13 per cent rhodium-platinum couple and an automatic indicating-recording instrument, provides a rapid, accurate and completely reliable method for measuring liquid metal temperatures. The Ford foundry has employed this method with great success for over five years. It has provided much closer control over casting conditions than had previously been possible, and enables refractory and sand problems to be fully investigated. Above all, a high degree of confidence is now placed in the permanent records of the temperatures of individual melts. In the event of defects in the castings being found, these records rule out the possibility of the human error in temperature measurement being held responsible.

The quick-immersion thermocouples employed in the foundry are all of the same pattern. A pair of platinum : 13 per cent rhodium-platinum thermocouple wires pass



Taking an immersion reading to determine the liquid alloy steel temperature in the ladle prior to casting crankshafts. The melting process is accurately controlled by taking temperature measurements at five minute intervals

through insulators in a mild steel tube about four feet long, having a right-angle bend about 18 inches long. Surplus wire is held on reels in a head box fitted at one end. At the other end the two wires forming the junction are protected by a thin silica sheath, which is closed at one end and fitted into a graphite plug. The graphite plug is pressed into a graphite sleeve which protects the bottom 18 inches of the couple. To extend the life of the silica sheath and the thermocouple junction for use in the measurement of grey iron temperatures (1375 to 1430°C) an expendable graphite sheath is used to protect the silica sheath. This graphite sheath is replaced every 50 readings, the silica sheath every 150 readings. After 200 to 300 dips the thermocouple junction is renewed by cutting off about one inch of the wires, drawing down fresh wire from the reel, and making a new twisted junction. About 12 feet of wire are stored on the reels in the thermocouple-head boxes. No graphite sheath is used for the measurement of alloy steel temperatures (1510 to 1540°C) where a speedy reading is essential, and the silica sheath is replaced after every five to six readings.

Honeywell-Brown "Electronik" 24-hour recording instruments are used and give a visual indication of the temperature measured as well as providing a permanent record of each cylinder block or other casting produced, and this provides valuable data for investigating the cause of any faults detected at a later date.

Casting temperatures vary with the alloy employed and the size and shape of the individual casting concerned. Grey iron cylinder blocks for tractors, for example, are cast at a temperature lying in the range 1375 to 1420°C. Alloy steel crankshafts are cast at 1530 to 1540°C.

An interesting application of the quick-immersion thermocouple is in the control of the melting process of the alloy steel for cast crankshafts. An air-blown cupola melts low-carbon iron (2.3 per cent carbon) into a 15-ton electric furnace. Also charged into this furnace is a burden of cold low-carbon steel (approximately 0.4 per cent carbon), this making about 50 per cent by weight of the total charge. The electric furnace discharges into a receiver, the temperature here being measured and recorded every five minutes.

The temperature range here is the controlling factor in the balancing of the two charge constituents and in any adjustment of composition found necessary.

The Honeywell-Brown "Electronik" indicating-recording instrument employed with the thermocouple used in this procedure is fitted with a time-controlled bell to give an audible warning when the highest temperature is reached during each dip. This prevents undue immersion of the couple in the metal and consequently reduces the attack on the silica sheath. In addition, a permanent record of the temperature is thus obtained for reference in the future.

It can be seen that the platinum : rhodium-platinum quick-immersion thermocouple is a reliable tool in the quality control of castings in grey iron and alloy steels. It enables the Ford Motor Company Ltd. to produce many thousands of cylinder blocks, cylinder heads, gear-boxes, crankshafts, malleable iron chassis brackets and other castings with a high degree of confidence that the casting conditions are maintained completely uniform throughout each production run.

The author wishes to express his thanks to the Ford Motor Company Ltd. for permission to publish this article, and to the management of the foundry for their ready co-operation in its preparation.

Ruthenium Catalyst for Paraffin Wax Synthesis

LIQUID PHASE HYDROGENATION OF CARBON MONOXIDE

The possibility of using ruthenium catalysts in the preparation of high-melting hydrocarbons through the reaction of carbon monoxide with hydrogen—the Fischer-Tropsch synthesis—has been known for many years. In a recent paper (*Liebig's Ann. Chem.*, 1958, **618**, 67–71) H. Kölbel and K. K. Bhattacharyya describe the preparation of similar compounds by the liquid-phase hydrogenation of carbon monoxide with water, again using a ruthenium catalyst.

The reaction is carried out in a two-litre steel autoclave containing the catalyst, 5g of finely-divided metallic ruthenium, suspended in 750ml of water, through which a stream of carbon monoxide is passed. The product, which consists almost entirely of high molecular weight paraffins, is immiscible with water, and can easily be separated from the aqueous suspension. The best results are obtained with a reaction temperature of 195°C and a carbon monoxide pressure of 100 atm, when over 70 per cent of the carbon monoxide is converted. The paraffin wax so formed has a molecular weight of up to 7000 and a melting point of up to 130°C. The course of the reaction can be represented as a combination of the water-gas reaction with the Fischer-Tropsch synthesis – the carbon monoxide and water first react giving hydrogen and carbon dioxide, the hydrogen so formed then reacts with further carbon monoxide to form hydrocarbons and carbon dioxide.

The advantages of carrying out the hydrogenation in the liquid-phase are numerous. The water, which is present in large excess, acts not only as reactant but also as a means of uniformly suspending the catalyst and as a medium for dispersing the excess heat produced by the reaction. The technical development of the process would be favoured by such advantages and also by the simplicity of the apparatus and the high yields obtained.