PRESSURE CASTING OF STEEL SLABS

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Casting steel under controlled pressure has come into wide use in the United States, first for casting railroad wheels, then slabs of stainless steel in graphite molds. In the pressure casting process the ladle, without a stopper, is placed in a hermetically sealed casting chamber. A filler pipe made of refractory material is inserted in the ladle, reaching almost to the bottom. The mold (cast iron or graphite of any design) is placed on top of the casting chamber, compressed air or inert gas is introduced into the casting chamber, and the pressure forces the liquid metal through the filler pipe and into the mold above (see Fig. 1). When the mold is filled the filler pipe is shut off at the mold, the pressure in the casting chamber is reduced, the filled mold is removed, and a new mold is put in its place.

The advantages of pressure casting are the high and easily controlled rate of filling the mold, the smooth surface of the graphite molds, and the transfer of the metal from the ladle to the mold through the filler pipe, which prevents interactions between the metal and the atmosphere, i.e., oxidation and contamination with nitrogen (the mold is filled with argon before filling). All these factors make it possible to obtain castings with high-quality surfaces, eliminating the necessity of scalping ingots before rolling. This leads to savings of about 2% of the metal and practically eliminates labor costs associated with trimming.

In addition, the casting of slabs instead of ingots eliminates the necessity of passing ingots through the blooming mill and sharply reduces trimming of the head (from 15-18% for ingots cast by the conventional method to 3-5% when slabs are pressure cast). According to American calculations, the savings resulting from the use of this system amount to $75-80 per ton of cast slab.

At the present time experimental and experimental-commercial machines for casting slabs and also ingots are in use in seven American plants. These machines are being used to cast slabs weighing up to 20 tons, mainly of stainless steel. The slabs are cast on edge with a slope of about 25° to aid removal of the gas as the mold is filled. The length of the slabs is 1.5-8.5 m, the width 240-1524 mm, the thickness 75-228 mm. The casting rate varies from 10 to 14 tons a minute, i.e., slabs weighing 20 tons are cast in 90 sec. The output of the machine with a 32-ton ladle reaches 180,000 tons a year, each machine having three to five graphite molds.

There are two types of machines — with a stationary casting chamber and movable molds, and with stationary molds and a movable casting chamber. The first type was built by the Amsted Company for the Stainless Steel Corporation. The casting chamber is situated in a pit and the molds move on a trolley from the casting chamber to the area where the slabs are removed, the graphite molds are cooled with water, and the protective coating applied to the mold faces before casting is removed. With this type of machine the necessity of a crane and the space it takes up is eliminated.

The second type of machine has been built by the Washington Steel Corporation. In this case the molds are stationary and 4.2 m apart. The casting chamber moves on a self-propelled trolley in a tunnel beneath the molds. This design makes it possible to fill the molds in any order. No platform is needed for the machine. The selection of one type of machine or the other depends on the particular plant conditions.

The foreign literature gives only general data on these machines. No specific design data on the various units have been published, and

Fig. 1. Diagram of pressure casting.
therefore building such machines in the Soviet Union will necessitate the development of the following units: filler pipe, shut-off device, graphite molds, a pressure control system.

The principal requirement for the filler pipe is resistance to the slag and to erosion from the stream of metal, which moves at high speed (over 3.5 m/sec), and, most important, heat resistance and impermeability to gases. Submersion of the pipe in the metal results in thermal shock (500°C), which cracks ceramic pipes; the air passes through the cracks and comes into contact with the metal.

The firm of Babcock and Wilcox is already producing filler pipes of high-alumina refractories 3.1 m long with an inside diameter of 150 mm. The manufacturing technique remains a trade secret.

Important factors in the resistance of filler pipes are slow heating to 1050°C (not over 95 deg/h) and thin walls (50 mm) to reduce internal stresses during heating. For this latter reason the American firm has begun to produce two-layer pipe (in thickness) to increase the resistance to liquid slag and metal without increasing the wall thickness, which would be considerably easier. The durability of the pipe has increased so that 150-200 tons can be cast, i.e., a single pipe can handle six to seven 30-35-ton ladles before failure.

The main requirement for the shut-off device is dependable closing of the filling channel. Many types have been developed—a moving plate, a device of the stopper type, and slide valves. The latter type is the most widely used, the metal passing through a metal slide valve with a refractory lining. For dependable closing, the valve drive mechanism develops a force substantially exceeding that required to move the valve. The use of a hydraulic drive unit with the oil pressure around 150 atm ensures a mechanism of small size. A characteristic feature of such valves is the fact that the valve and the drive mechanism are rigidly connected, i.e., no force is transmitted to the mold and no leverage is exerted on the mold.

The low mechanical strength of graphite, which in the best foreign samples does not exceed 600 kg/cm² in compression or 280 kg/cm² in bending, creates a danger of splitting at the corners of the graphite blocks. Therefore it is necessary to enclose the graphite in metal rings, which complicates the construction of the molds. The rise in the mold is located above the filling channel. If it is located above the highest point of the slab (the end opposite the filler pipe) the crystallization and cooling of the slab, with the consequent shrinkage, freezes the casting to the