## SEMI-STEEL CASTINGS.

In a paper read recently, by Mr. R. H. Probert, to the Ohio Society of Engineers it was stated that one of the principal points in making semi-steel is to have the metal hot. To get the best results and to insure a thorough mixing of the iron and steel when tapping, the metal is run into the tapping ladle, which is tilted enough to run the metal into a shank or bull ladle. The latter also is tilted to allow pouring the metal into the hand or crane ladles. When melting for castings weighing from 2,000 to 8,000 lbs. each, the crane ladle is of sufficient capacity to hold the entire amount of metal required, and into this ladle is placed 5 lbs. of 80 per cent. ferro-manganese to each ton of iron. This method of tapping permits the steel and iron to mix thoroughly in the ladles before pouring the metal into the molds.

In mixing metal for high-grade castings that are required to stand up under high pressure and high speeds, the pig iron is charged on the bed and the steel scrap on top of this charge of pig iron. Charges amounting to 2,500 lbs. each in a 40-in. cupola are as follows:

| | |
|---|---|
| Coke | 1,000 lbs. |
| Pig iron | 1,000 " |
| Gray iron scrap | 500 " |
| Steel scrap | 500 " |
| Pig iron | 500 " |
| Coke | 250 " |

The coke bed must be large enough so that the first iron will come hot. Having tapped the metal white hot, it must be poured into the molds as nearly as possible at that heat. The hotter the iron the greater should be the care taken in venting the molds, as the more resistance and refractory the mold, the more care and skill is required in feeding the hot metal into the mold.

The steel used is boiler-plate scrap from ¼ to 7/16 in. thick, either square or rectangular pieces, from 6 to 18 in. long. The steel scrap is not charged directly on top of the coke bed, but, as previously stated, about 150 lbs. of coke are charged on top of steel scrap before charging the next layer of pig iron.

Careful attention is given to the charging of the cupola throughout the various heats including the firing of the coke bed before the first charge of pig iron is placed in the cupola. By doing so, dull metal is avoided during the whole of the heats for the day's melt.

The range of analysis of the boiler-plate scrap, which consists of shell, firebox and flange steel, is as follows:

| | Per cent. | |
|---|---|---|
| Sulphur | 0.022 | 0.038 |
| Phosphorus | 0.015 | 0.020 |
| Carbon | 0.12 | 0.18 |
| Manganese | 0.34 | 0.45 |

In 25 minutes after the blast is turned on the metal is ready to be tapped and drawn off.

Recently several semi-steel flywheels about 9 ft. 6 in. in diameter, each weighing 7,500 lbs., were successfully cast without difficulty or loss. They were for special service, to run at a peripheral speed of 12,000 ft. per min. The castings proved to be clean, solid, without flaws, the metal was tough, but not hard, and the turnings curled from the tool like pine shavings. The steel scrap amounted to 25 per cent. of the charge. The transverse tests on a ¾-in. square bar with 12-in. supports averaged 1,625 lbs.

The analysis averaged:

| | Per cent. |
|---|---|
| Silicon | 1.41 |
| Manganese | 0.36 |
| Phosphorus | 0.462 |
| Sulphur | 0.122 |
| Combined carbon | 0.95 |
| Graphitic carbon | 2.46 |

The analysis of the pig iron charged with the gray iron and steel scrap averaged:

| | Per cent. |
|---|---|
| Silicon | 1.65 to 2.75 |
| Sulphur | 0.035 to 0.054 |
| Phosphorus | 0.322 to 0.754 |
| Manganese | 0.55 to 0.85 |

Small and medium-sized castings that are cored and of peculiar shape, weighing from 400 to 500 lbs. each, that are required to stand up under constant high duty, are made as previously stated, showing the same analysis in the pig iron and in the finished castings.

Gas-engine cylinders each weighing about 1,650 lbs. for 50-h.p. engines, were successfully made from semi-steel. The metals charged were No. 2 foundry pig iron, gray iron scrap and the steel scrap amounted to 30 per cent. of the charge. The transverse tests on ¾-in. square bars, with points of support 12 in. apart, averaged 1,755 lbs. The deflection amounted to 0.22 in. The cylinders were solid, clean and tough. They were easily machined and the bore showed excellent, smooth finish. The fractures on the test bars were fine and close grained and took a very fine finish when machined, draw-filed and polished.

The cylinders were poured on end, the molds were skin-dried and were provided with ample pouring basins, down gates or leaders and large risers. The shrinkage was about 3/32 in. to the foot, but on castings poured in a horizontal position the shrinkage is about 7/64 in. per foot.

In making the molds the best results are obtained by working the sand as dry as possible, not sponging the patterns around their ends and sides, as the water will dampen the edges of the molds and will result in making the castings hard on their outside edges—too hard to machine profitably.

Provide the molds with a pouring basin and well, and do not depend on one large down gate or leader. When making medium and small work, use a strainer gate, which is a pouring basin on the top surface of the cope, with sufficient down runners of small diameter to a gate below in the surface of the drag. These runners will prevent the lighter metal and other impurities from running down into the body of the mold, resulting in clean, solid castings. Large molds should be skin-dried, and all molds for semi-steel castings provided with ample pouring basins, down runners, gates, risers, etc.

The flasks should be strongly made, as the mold strain is entirely within itself and on heavy castings the flasks must be well braced and banded around cope and drag to counteract the great strains on the mold.

Semi-steel can be used in such castings as cylinders, pistons and plungers for steam, gas, ammonia and hydraulic work, engine and machine beds, flange couplings, bearing boxes, large flanges, brackets, pedestals, pinions and gear segments, forming dies for sheet metal, electric motor castings, etc.

It takes no more coke or labor to melt semi-steel than it does to melt gray iron—1 lb. coke to 7 and 7½ lbs. of iron.