

heat to an order diversions are still necessary, 10 percent is not uncommon. This puts a double load on metallurgical departments which must continue to sell continuous cast billets and products and dispose of the off specification heats."

Rebars and light structurals

Most continuous casting plants in routine production in the U.S. and Canada make steel products to strength and surface specifications that are less demanding. Connors Steel Div. of H. K. Porter, and Roanoke Electric, two of the first into continuous casting, both operate straight mold machines making either structurals or rebars. Florida Steel, Soule Steel and Armco at Sand Springs, have gone into production in the last several years with curved mold machines making similar products. (For a complete listing of these under 200,000 ton/yr plants.)

Quality steels still require rigorous testing

Roblin Steel went on stream in 1964 with a straight mold machine making quality rod and bar stock. Cold heading steel made by Roblin must meet demanding specifications, both for internal cleanliness and defect-free surfaces. Roblin's practice has evolved into the customary close inspection familiar to quality alloy steelmakers for many years: 100% surface inspection with defect removal by chipping or grinding with top, middle and bottom acid etch tests for internal soundness and cleanliness checks. Roblin, from the start of its steelmaking, has had a corner crack problem. This is being "solved" by continuous corner removal during casting operation.

As to internal cleanliness and soundness, Roblin has evolved an elaborate argon gas shrouding practice to maintain existing levels of deoxidation as liquid steel is teemed from the ladle to mold. Roblin has applied for patents on the practice and given it the name "Impact."

All continuous casting operators making top quality products are concerned with keeping nonmetallic inclusions under control. Gas shrouding, of which the Roblin closed system is the most elaborate, is in common use. Various kinds of shielding powders are also used, especially in slab casting. Here, also the use of snorkel tubes for submerged pouring keeps liquid steel away from the atmosphere. Though these systems are more or less effective, the ultimate system of completely sealed transfer of liquid steel to the casting mold has yet to be developed.

In the U.S. the most recent addition to continuous cast quality steelmakers is Wisconsin Steel Div. Mel Nickel, manager of steel production, has had the job of setting up quality steel practices for continuous casting high quality forging and constructional alloy steels made in BOF furnaces (some 75 specifications are cast). Wisconsin has a raw steel capacity of 1.2 million tons annually, and has an 8 strand casting machine of some 0.4 million tons capacity as well as a Dortmund-Horder vacuum degasser with capacity equal to that of casting machine.

With a straight mold, vertical cut-off machine Wisconsin has no question of effect of bending on internal soundness (Wisconsin's "straight" casting practice was selected to insure trouble-free high sulfur steel product casting).

Wisconsin's inspection methods include spot billet surface and internal inspection at the discharge end of the casting machine. Results of this spot inspection give a statistical pattern of casting machine (and strand) performance for control purposes. 100% inspection is performed on all heats at the usual conditioning beds ahead of Wisconsin's bar and billet mills. These control procedures have enabled Wisconsin Steel to develop a continuous casting practice for "routine" production of quality steels. The important conclusion to be drawn is that Wisconsin's experience demonstrates that this is possible. It must also be observed that developing metallurgical controls is a never ending process both to accomplish the necessary upgrading of steel quality and to reduce operating costs. In this sense, Wisconsin Steel along with all other continuous casters is still pioneering both in developing the ideal casting machine design and the ideal steel-making practices to use with that ideal design.

Stelco (Steel Co. of Canada Ltd.) has also been continuous casting for about a year and a half. Stelco's machine is a six strand curved mold billet (4 x 4 in.) caster, using open hearth steel. Stelco has cast a fairly wide range of carbon steels for hot rolled bar and rod, including cold heading and manganese spring steels. Results to date demonstrate that multi-strand small size casters can be