ENGINEERING EVOLUTION IN MATCH PLATE AND FLASKLESS MOLDING

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ARTICLE TAKEAWAYS:
- Rollover system improvements for better reliability
- Controlled Index of the bottom board for higher quality
- Mold closing process advancements

BACKGROUND HISTORY

I once saw a flow chart of the foundry casting process—a precise roadmap of boxes, arrows, decision points, and alternate pathways, all leading to a final box that simply read: "Then a miracle happens," and somehow, a casting emerges.

While that may oversimplify things, it highlights an important truth: countless variables influence the casting process. Since mankind first learned to control fire, we have been melting metal and refining the art of molding, continuously improving methods that began with the simplest of molds. The first molds consisted of only a drag, as the cope had not even been invented yet, and the sprue and vents not even envisioned

At EMI, we are fortunate to have access to more than a century of foundry equipment designs and engineering drawings acquired through generations of companies. These archives provide a fascinating look at the evolution of foundry technology and the engineers whose innovations shaped the industry. These are amazing archives; the drawing on mylar, vellum, with ink and pencil, shading, orthographic and section views, the detail of these engineers on the level of Picaso in some instances.

Reviewing historic Osborn molding machine drawings and photographs transports us back to the early days of industrial manufacturing. Building on the vision of pioneers like Henry Ford, companies such as Osborn, Herman, and later SPO introduced groundbreaking molding systems that transformed production. Their innovations culminated in high-production mold lines capable of producing larger molds at unprecedented rates—systems that helped define modern foundry manufacturing. Can you imagine, they sold 8 mold lines to Caterpillar back in the late 70's, all running 250 mph; one of the largest molding machine systems built to date.

FLASKLESS MOLDING REINVENTED

The Osborn Roto-Lift series machines set the standard for match plate molding in the early 1900s. These machines assisted molders with filling and rolling over the drag, handling and stripping the pattern, and managing the cope. While they significantly improved productivity and reduced manual labor, their size, scale, and production capabilities were ultimately limited by the labor-intensive nature of the process.

In the mid-2000s, we had the opportunity to acquire a Canadian manufacturer of hybrid automated match plate molding machines that complemented our existing family of molding equipment. This acquisition enabled us to offer customers a fully automated match plate molding solution while also allowing us to offer integrating advanced mold-handling systems to further improve productivity and efficiency.

This Canadian product line was originally based on a gravity-fed molding machine developed by a U.S. manufacturer that had been a foundry industry staple since 1964. As foundries demanded greater performance, reliability, and flexibility, these machines transformed into true industry workhorses and established a new standard in gravity-fed match plate molding.

These machines provided foundries with effective automated molding solutions, but they also required rigorous maintenance, careful monitoring, and frequent alignment to consistently produce high-quality

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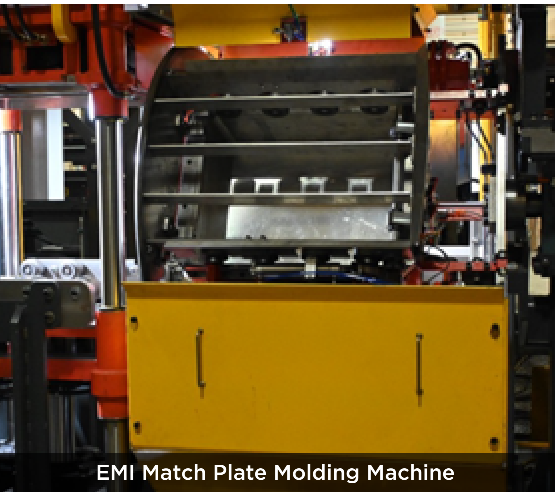
EMI Match Plate Molding Machine

Rollover Features of the EMI Match Plate Flaskless Molding Machine


Fixed roller bars, Cope lift cylinders & squeeze board assembly


Mold Pouring & Cooling Line

castings. This created an opportunity to better understand the equipment and develop innovations focused on reliability, ease of maintenance, and long-term performance.

Today, a wide range of match plate molding machines are available, including standard models in 14×19, 16×20, 20×24, 20×26, and 30×32 sizes along with custom configurations, including deeper flask depths and modified machine sizes such as a 20×28 model.

INNOVATION IMPLEMENTATION

As we studied these machines, we recognized an opportunity to apply concepts from automated tight-flask molding machines and large automated core machines to develop a match plate molding machine capable of producing premium-quality molds, but with improved, innovative heavy duty design concepts.
More than 15 years of research, development, and design refinement culminated in the latest generation 2024 match plate machine delivered to Fall River the end of 2024.

Throughout this process, we identified three key areas where significant improvements could be made to advance the technology.

ROLLOVER SYSTEM

The first was the rollover system, including the frame design and actuation method that would deliver optimal performance and long-term reliability. While the traditional flat-ring roller and urethane roller design had proven effective, wear caused by abrasive molding sand made the urethane rollers a frequent maintenance item and a common source of downtime.

We developed a hardened front roller ring supported by a series of commercial V-groove rollers. This design significantly improves wear life by providing a high-hardness contact surface while also allowing precise adjustment and alignment with the fixed roller bars in the squeeze station.

Drawing from the extensive range of rollover systems used in automated tight-flask molding lines, we evaluated designs from Osborn, SPO, Herman, and IMPACT. While each offers a unique approach to high-speed mold handling, we ultimately leveraged concepts from Sutter core machine designs by incorporating a controlled sinusoidal rotary actuator in place of the traditional push-pull cylinder arrangement.

This rotary actuator features proportional control, cushioning, and hard stops to ensure precise 0° and 180° positioning—critical for aligning the drag with the squeeze station as well as the bottom board feeder. It also enables the rollover to stop at intermediate positions for specialized applications such as sand tuck, facing, or targeted parting line spray on specific areas of the pattern.

In addition, the system can position the rollover in an ergonomic orientation to improve accessibility during pattern changes.

CONTROLLED INDEX OF THE BOTTOM BOARD

The second major design improvement focused on achieving a positive, controlled transfer index of the bottom board into the drag fill station. The previous approach relied on board velocity overcoming variable sand levels and other conditions, which made consistent performance difficult to achieve. Proper molding quality depends on ensuring the bottom board is level and accurately centered in the bottom of the drag flask before engaging the roller bar clamps.

The prior design—an off-angle, cylinder-actuated crank arm—did not provide sufficient consistency, particularly on larger mold sizes. The board could dive or twist depending on sand conditions. Additionally, the single-cylinder, four-bar linkage used to actuate the bottom board roller bars made it difficult to consistently achieve precise positioning.

We developed a bottom board carry system that introduces the board into the sand in a perfectly level orientation using a fork-style plate. This plate is hydraulically driven and guided by a system of linear bearings and side roller supports. It delivers the bottom board into the drag not only level, but also accurately centered and securely positioned for engagement by the roller bars.

The roller bars are now symmetrically driven and independently cylinder-actuated, with easily shimmed hard stops. This configuration allows precise setup on both sides of the machine and eliminates the need for load equalization associated with single-cylinder linkage systems, which by design of only 1 position can easily lead to bottom board misalignment in the drag.

The bottom board storage was improved by redesigning the internal and external cassette systems to reduce unnecessary load on the bottom board lift mechanism. The inlet chute was reengineered to ensure accurate entry, drop, and placement of incoming boards within the machine. In addition, a laser depth detection system was incorporated to verify that a minimum number of boards are available for proper operation.

SQUEEZE STATION & MOLD CLOSING PROCESS

The third major improvement focused on optimizing the squeeze station and mold closing process. All machines now include hydraulic cope lift cylinders, and four cope mold shot pins to contain the cope mold as standard. The cope lift system is utilized not only for positioning the cope at a lower elevation for cycle start but now can keep the cope elevated at a raised position after squeezing and hold it elevated after squeeze to provide maximum clearance for ergonomic core setting.

We leveraged the new standard cope lift system and integrated it into the mold-closing process by using the cope cylinders for stripping the cope flask upward against a redesigned squeeze board anvil assembly. The previous two- or three-cylinder squeeze board system was replaced with a free-floating squeeze board. This welded assembly eliminates vertical guide rods that were previously prone to sand contamination, by replacing these guides with tee blocks and guide block interfaces.

As the hopper car returns the squeeze head into position, the squeeze board frame now engages four wear pads on the upper heavy-duty frame with minimal clearance that align with corresponding reaction pads. As mentioned, the four main squeeze station guide rods—shared by the drag platen and cope—now also function as strain rods, significantly reducing deflection during the squeeze cycle, and eliminating any transfer of forces into the hopper car itself.

We also wanted to improve the cycle needed to ensure proper closing of the drag mold to the cope, as well as assuring continuous contact throughout the stripping process, without introducing unnecessary squeeze cylinder forces on the exposed drag mold by relying on velocity matching between the platen cylinder and cope strip cylinders.

The original Canadian machines used a proportionally controlled pump system that required calibration and allowed programming of the desired final squeeze pressure. While this system was generally adequate, the calibration was only approximate, and overall machine pressure could vary depending on the target squeeze setting.

Eliminating the common overall hydraulic pump system pressure control, EMI moved the function of the proportional pressure regulation directly into the platen squeeze cylinder valve stack. This change allows the squeeze pressure to remain independently programmable to set and vary, while maintaining the balance of the hydraulic system to remain at a fixed operating pressure. This also eliminated the need for routine calibration cycle of the platen pressure circuit.

This resulted in the most precise platen pressure control, a positive closing circuit to maintain continuous mold engagement of the drag against the cope at a controlled pressure, incorporating a regenerative hydraulic circuit with LDT positioning feedback that reduced the required closing force. This new innovative squeeze station feature assures the full closure is confirmed and contact maintained as the cope is stripped upward against the squeeze head anvil. Once no further platen movement is detected, the system retracts and lowers the closed mold for pushout for the next cycle.

EMI flaskless match plate molding machines and mold handling systems are built upon proven machine designs that draw the best from our tight-flask molding and core machine design solutions. Innovation requires a deep understanding of each foundry's specific needs and is grounded in proven, field-tested equipment designs.

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