Notes by Fritz Kokesh

Patterns and the Molding of Cast Iron Banks*

Seminar by Bill Robison

"Men well versed in the mechanic arts assert that the art of founding demands greater mechanical skill, caution, and good judgment than any other of the allied trades."
(Secrets of Green-Sand Casting)

Introduction

Production of a cast iron bank began with the creation of a wood pattern. If the design was approved by management the wood pattern was replicated in lead (or white metal) and then brass (or bronze) working patterns were made. These working patterns and their complementary match molds were used repeatedly to make sand molds for casting the bank in iron. Additional manufacturing steps included grinding, machining, and cleaning of the parts, and finally, assembly and finishing.

Wood and Lead Master Patterns

Bill Robison described the pattern making, mold making, and casting steps of the "green-sand casting" process that was used to produce antique cast iron banks.[1] A Chart that summarizes the process and a Glossary are included at the end of the article.

Production began with a wood pattern made by the Pattern Maker.[2] For example, the wood pattern for the "U.S. Tank Bank 1918," Moore–1437,[3] shown in Photo 1 was made by a combination of very precise tool work and skillful wood carving.[4] Some details were created by attaching metal parts to the wood pattern. For example, the rivet heads and lettering of the Tank Bank were stock metal pieces, and the clock face of the wood pattern for the "Street Clock," M–1548, Photo 2, was created with a brass engraved plate and hands. A finish, often clear or pigmented shellac, was applied to the pattern to protect the wood from moisture and to reduce adhesion of sand when the sand mold was made for replicating the wood pattern in lead.[5]

But, a wood pattern didn't always have all of the details of the final bank. For example, the wood pattern for the "Lion on Tub" did not have holes for fasteners or threads for screws; these were added to the lead or brass patterns or during machining of individual cast iron parts. And, the wood pattern might have features that would not be part of the final bank. The pattern for the "Tank Bank," for example, has two wedge-shaped pieces that protrude from the tank thread. These are "gates," the purpose of which will be explained later.

Of course carving a design that was attractive was a difficult job. But the Pattern Maker also had to create a pattern that would allow parts to be cast efficiently. In particular, it had to be possible for the pattern to be removed from the mold without disturbing the impression of the pattern in the sand. In the vernacular of the Pattern Maker, the pattern had to "draw." Another of the

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devilish details that the Pattern Maker had to factor in was the extent of contraction (also called shrinkage) that occurred when patterns were cast into lead, brass, and finally iron.

Next a single lead pattern was made by replicating the wood pattern. Bill did not discuss the details of how this was done, but the process was more or less like manufacture of iron parts and was carried out in the Pattern Shop. Because good patterns were the key to molding iron parts that required a minimum of hand work and with a minimum of scrap, the Pattern Maker perfected the lead pattern by repairing any defects and touching up details. In some cases lettering or other details were attached to the lead pattern as they were with the wood pattern. The unique wood and lead patterns, the "master patterns," were stored in the Pattern Shop.

Production Patterns and Match Molds

Now it was time to prepare the tooling needed for molding at a manufacturing pace. The lead master pattern was replicated in brass to prepare a number of "working patterns." The process again was more or less like that used in manufacture of iron parts, except working patterns were cast one at a time. As with the lead pattern, any casting defects were repaired.

To speed mold making, the parts of one or more working patterns were soldered onto brass rods or bars to create a "pattern tree." Attachments were made at the gate of each part.[6] See Figure 1 and Photo 3. The pattern tree simplified handling of working patterns and during mold making the impressions of the rods or bars created gates (channels in the face of the mold) to carry molten iron to each cavity. The number of patterns combined in this way varied. In general, a pattern tree would have as many pieces as would fit into standard sized 12" x 18" or 16" x 20" flasks; it might consist of one pattern for the "Prancing Horse" but five or six for the "Mulligan."

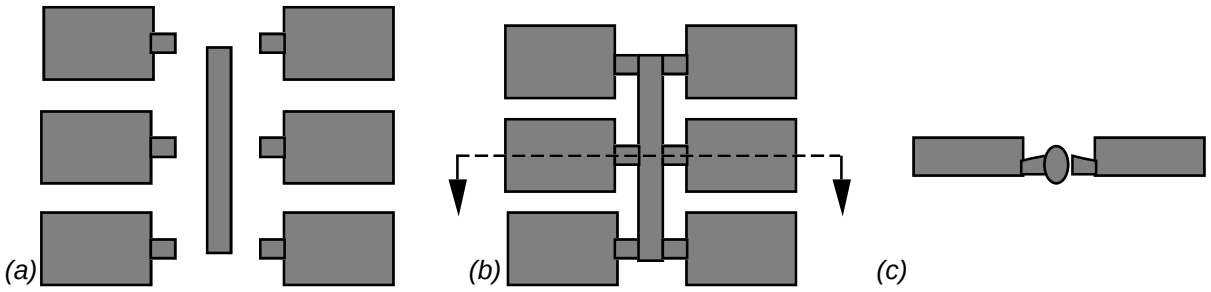

Figure 1. (a) Representation of six individual working pattern pieces and (b) a pattern tree created by soldering the pieces onto a bar. (c) Cross section of the pattern tree along line shown in (b).

Next a "match mold" was made from each pattern tree to serve as a labor saving device that was used over and over during mold making[7] (but never contacted molten metal). See Figure 2. The process for doing so was not described in the seminar, but the match mold was a hardened sand impression of the outer (sometimes inner) surface of the pattern tree.

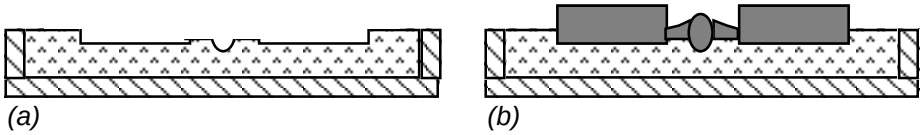

Figure 2. (a) Cross section of a match mold and (b) the match mold with its complementary pattern tree inserted. The match mold is hardened sand within a wood case.

Molds for Production

Making molds for production use was the job of the Molders. Bill has been told by Bob Saylor that at Kenton there were as many as sixty Molders and that each would prepare 150 flasks during a shift that began about 5 a.m. and lasted until 3 p.m. At this pace each molder completed a flask every 3 1/2 minutes! This required skill and a strong back:

> A working pattern tree was placed in its match mold. Half of a "flask," basically a box with no top or bottom, was placed onto the match mold. A light layer of "parting sand" was sprinkled onto the pattern to aid in removing it from the mold, the pattern was covered with "facing sand," and then "molding sand" was added above the rim and rammed. Excess sand was trimmed away, a "bottom board" was put atop the flask, and the entire assembly "rolled over" (turned upside down). See Figure 3.

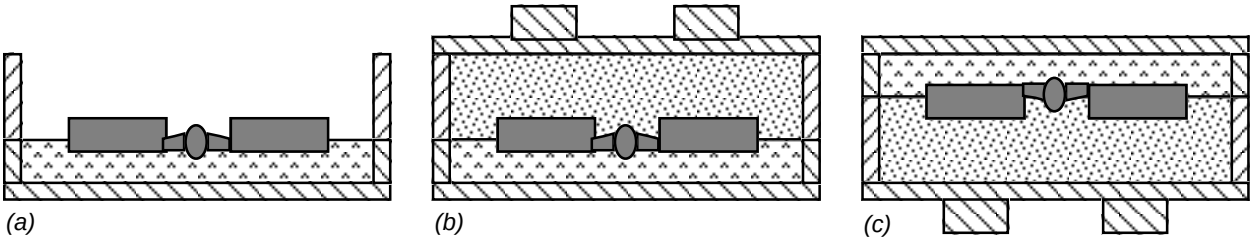

Figure 3. (a) The pattern tree in its match mold with half of the flask installed and (b) after sand was added and rammed, and a bottom board placed on top. (c) The flask after being rolled over.

> The match mold, which now was on top, was removed and set aside for making the next mold, but the working pattern tree was left in place. (At this point one half of the mold had been formed.) The second half of the flask was placed atop the first one. A thin layer of parting sand was spread on the pattern and molding sand so the two halves of the mold would not stick to one another. As before, molding sand was added, rammed, and trimmed flush with the rim. See Figure 4.

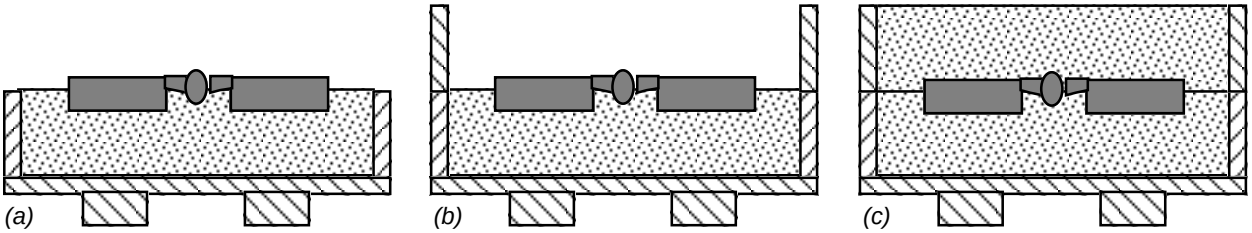

Figure 4. (a) The flask after the match mold was removed the second half of the flask was installed (b), and (c) sand was added and rammed.

> The top half of the flask (called the "cope") was lifted off the bottom half (the "drag") and the working pattern tree removed from the drag. If the mold was disturbed in the process it was touched up using small hand tools called "slicking tools." At this point the cope contained an impression of the outside of the working patterns and the drag an impression of the inside.[8] Starting at the top surface of the cope, a thin-walled boring tool was used to cut a tubular hole called a "sprue" into the cope. Then by hand, the hole was made funnel-shaped to facilitate pouring of the iron into the mold.[9] Thin vent lines also were cut in the top surface of the drag from each cavity to the edge of the mold;[10] these allowed steam and air to escape the mold when the iron entered. See Figure 5.

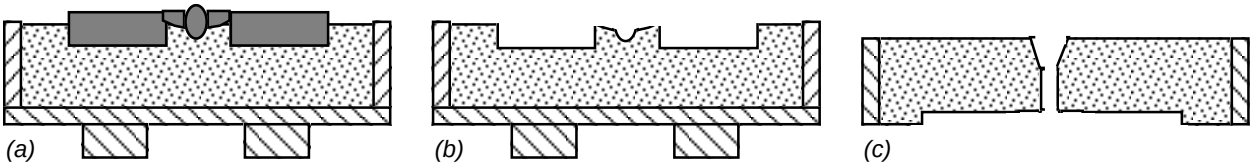

Figure 5. (a) The drag after the cope was lifted off and (b) the pattern tree removed. (c) The cope showing the sprue that was cut to allow molten iron to be poured into the mold.

The flask was reassembled and moved to the foundry floor. At this point the "snap flask" used during mold making was replaced by a "temporary binder" for casting. See Figure 6.

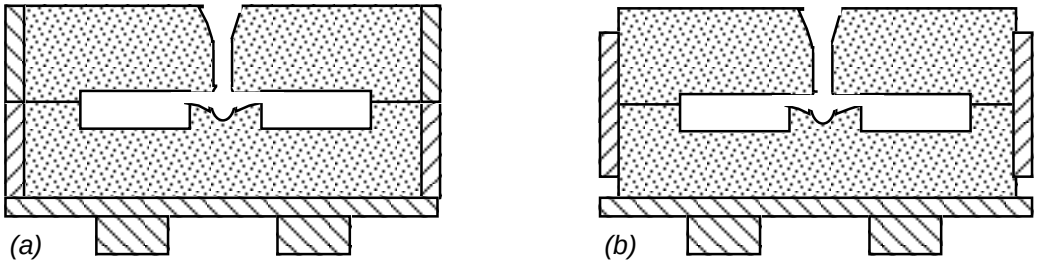

Figure 6. (a) The finished mold as it was moved to the foundry floor and (b) with the snap flask replaced with a temporary binder.

About the Sand

The success of mold making depended on the quality of the sand and its consistency. The molding sand that formed the bulk of the mold was a natural mixture of silica and clay. Its consistency, which was critical for mold making, was adjusted by adding water; the water combined with the clay, which made it sticky and let it hold the sand grains together. Bill has been taught by his friend John Mahon, a pattern maker and foundry worker with years of experience, that the consistency of the molding sand is right when a handful of sand squeezed into a cylinder can be broken in half without any grains dropping away. Facing sand that was put closest to the pattern was finer so the cast part would be smoother. Unlike the molding and facing sand, parting sand was nearly pure silica and was used in a dry form to reduce adhesion between the pattern and mold or the two halves of the mold.

Ramming was important in order to transfer the detail from the pattern to the mold and also to create a mold that would maintain its form when the pattern was removed and when iron was poured into the mold.

Casting

The Cupola Foreman was responsible for preparing the iron for pouring. He had to see that it had the proper fluidity and was at the right temperature. There was a trade-off to be made between how well the molten iron flowed in the molds and how hard it became (and therefore how difficult it was to grind or drill) after the iron cooled. Addition of certain phosphorous compounds would make the molten iron flow better but also made it harder. The source of the iron also was important; Bill understands that the J.&E. Stevens foundry used a mixture from

three sources, including Allegheny and Susquehanna pig irons, because they believed this gave the best final properties. When the molds and iron were ready, the Cupola Crew filled the "bull ladle" that ran on an overhead track and was controlled using large handles and poured molten iron into each flask.

Shake Out

The next morning the Shake Out Crew began breaking open the molds (destroying them in the process), to remove the solidified iron castings. Each casting consisted of parts corresponding to each working pattern, plus the gates and sprue. Parts were broken off from the casting and each kind of part was placed in a separate barrel. The scrap from the gates and sprue went into a scrap barrel to the re-melted. This work was made more difficult by the fact that the castings still were quite warm.

Additional Manufacturing Steps

In the Grind Shop remnants of gate were ground off each part and "flash" was removed if necessary. Parts next went to the Machine Shop for drilling and tapping; jigs were used so each piece could be positioned precisely and quickly. Parts then were cleaned by tumbling them with agate balls or iron stars. Finally, parts were assembled and finished.[11]

Changes to Patterns

Although the processes that have been described might seem cut-and-dried, changes were occurring constantly. As Bill stressed, the production of cast iron banks was a business in which costs had to be very carefully controlled. It was important that each manufacturing step be conducted efficiently and with a minimum of hand work or scrap parts. Weight reduction also was important if only to reduce shipping costs. Therefore, factory management was always looking for improvements, and some of these required that patterns be modified or replaced. In addition, working patterns wore out as a result of the abrasive action of the molding sand and had to be replaced. As a result, over time the banks produced changed in small and sometimes more evident ways.

Bill's Collection of Patterns

Bill feels very fortunate to have a large number of wood patterns from the A.C. Williams Company along with lead master and brass working patterns from Williams and other foundries. His collection includes wood patterns for two Williams banks that were never produced: a "Clown on Tub" and "Possum on Stump." In the latter case he also has two iron castings made directly from the wood pattern. Bill feels that these banks were not produced because the clown's hand was considered too fragile, and the possum is easily mistaken for a rat. See Photos 5 and 6.

All patterns are scarce, but wood and lead patterns are especially rare since only one of each was made. Most of the wood patterns that have survived are from Williams. Apparently, obsolete

wood patterns were discarded and lead and brass patterns were melted; even some that had been stored away probably ended up in WWII scrap drives. And often, when working patterns did get in collectors' hands, the pattern trees were broken up and the parts assembled into banks. In fact, Bill has only once seen a match mold with its working pattern tree, although several match molds have survived and occasionally are seen on eBay.

That said, Bill offered a caution: not all lead or brass banks that one sees were assembled from patterns; some are reproductions that can be recognized because they are the wrong size or have too little detail. For example, the "Oregon (large)" often is seen re-cast in lead. The genuine lead pattern in Bill's collection is shown in Photo 6. Note the fine detail, for example in the anchor chain and the rivets on the hull.

Conclusion

Bill's explanation of pattern and mold making is extremely valuable because it illustrates the enormous skill of the people who produced cast iron banks and provides a framework for a better understanding of cast iron banks. The audience also was extremely fortunate that Bill illustrated his talk with actual foundry patterns and allowed his audience to inspect and handle them to get a greater appreciation for their beauty and delicacy.

Descriptions of Photos*

Photo 1: A.C. Williams' wood pattern for the "U.S. Tank Bank 1918," M–1437.

Photo 2: A.C. Williams' wood pattern for the "Street Clock," M–1548.

Photo 3: A working pattern for the A.C. Williams "Prancing Horse (large)," M–520.

Photo 4: A.C. Williams' wood pattern for the proposed "Clown on Tub" bank.

Photo 5: A.C. Williams' wood pattern and two trial iron castings for the proposed "Possum on Stump" bank.

Photo 6: J.&E. Stevens' lead pattern for the "Oregon (large)," M–1452.

* Photos 2 to 6 are used with permission of Bill Robison.

Chart: Production Process for Cast Iron Banks[†]

Design: The bank's creator conceived of the idea for the bank, prepared drawings, and (if the design was complex) built working models.

Master Patterns: The pattern maker created a wood pattern. If management gave its go-ahead he replicated the wood pattern in lead (or white metal) and perfected the lead pattern. In some cases details or lettering were added to the lead pattern.

Brass Working Patterns: In preparation for mold making at a manufacturing pace, multiple brass (or bronze) working patterns were made by replicating the lead master pattern. Any casting defects were repaired and the finish was refined on each pattern. Working patterns might be machined to provide for turn-pin or threaded fasteners or have details or lettering attached.

Working Pattern Tree: The parts of the working patterns were soldered to brass rods or bars to create working pattern trees. These facilitated handling the working patterns when making production molds.

Match Mold: Match molds complementary to each pattern tree were made of hardened sand.

Production Molds: Molders used the working pattern tree and complementary match molds to make sand molds and prepared them for casting.

Cast Metal: The cupola foreman prepared the molten cast iron and the cupola crew poured it in each mold.

Mold Shake Out: The shake out crew opened the molds, broke the parts off the castings, and placed each kind of part into a separate barrel.

Grinding and Machining: The grinders removed remnants of gate from each cast part and removed flash as necessary. They ground a smooth finish onto parts that were going to be plated. In the machine shop parts were drilled and tapped.

Tumbling (Cleaning): Parts were tumbled with (for example) agate balls or iron stars to clean and lightly polish them in preparation for finishing.

Assembly: Banks were assembled from the cast parts and other parts such as stamped wheels. Assembly might include touching up parts and turn pins in order to achieve desired fit.

Finishing: Each bank would either be painted or plated. Painting involved dipping the bank and also might have included hand brushing to apply details like eyes and mouth. Labels or decals were added. If the bank was painted, finishing occurred last; if the bank was plated, then assembly was last.

[†] This Chart includes information presented in seminars by Bill Robison and by Don Heim, Mike Henry and Bob Brady. It also incorporates information from Bob McCumber, Frank Kidd, Charlie Reynolds and others, from a visit to the Williamsport Foundry in Williamsport, Penn., and from various publications on the subject. If the Chart is incomplete or portions are wrong, the author accepts responsibility and looks forward to learning from his mistakes.

Glossary of Foundry Terms

Bull Ladle: the large ladle that ran on overhead tracks and was used to move molten iron from the cupola to the flasks.

Cupola: the foundry furnace in which iron was melted. Also, **Cupola Crew:** the workers who tended the cupola and poured the iron.

Draw: the property of a pattern that allows it to be removed from a mold without disturbing the sand. Also, **Draft:** the slight angle or slant on surfaces of the pattern that allows it to be drawn from a mold without disturbing the sand.

Flash: A thin layer of metal in openings or around the edge of the casting that formed during casting as a result of molten metal flowing between the two halves of the mold.

Flask: the box that contained the sand during mold making and pouring of the iron. Also, **Snap Flask:** the type of flask used during mold making that was hinged at one corner so it could be removed, and **Temporary Binder:** a simpler type of flask that slipped over sand mold and used during casting.

Gate: the point where a pattern was soldered to a runner and where molten metal entered a mold cavity. Also, the wedge-shaped protrusion on a pattern that was not part of the final molded part, and the channels in the face of the mold that carry iron from the sprue to each cavity.

Match Mold: a hardened mold with the impression of the outside (sometimes inside) of a pattern tree. The match mold and complementary pattern tree were used to form sand molds. Also, **Follow Board:** A more general name for match mold.

Mold: an impression of a pattern into which molten metal was poured in order to replicate the pattern. Also, **Molder:** a foundry worker who prepared molds.

Pattern: a model of the item that was to be cast; the pattern was used to make sand molds for casting. Also, **Pattern Maker:** the foundry worker who created the **Wood and Lead Master Patterns.** Also, **Working Pattern:** the brass or bronze patterns replicated from the lead master pattern and used for making molds for casting parts in iron.

Ramming: the process of tamping (consolidating) the sand in a flask tightly around the patterns.

Shake Out: the opening of a mold in which molten metal had been poured and allowed to cool. Also, **Shake Out Crew:** the foundry workers who did the shake out work.

Sprue: the channel through which the molten iron flowed into the mold, and then along the gates into each cavity of the mold. Also, **Sprue Pad:** a cavity inside the mold at the base of the sprue that connected to the gates.

Vent Lines: scratches made in the mold surface to allow air and steam to escape when molten metal was poured into the flask.

References

[1] For additional details see "Secrets of Green-Sand Casting," International Correspondence Schools, 1906. Reprinted by Lindsay Publications, Bradley, Illinois, 1983. The green-sand process still is used to make banks, as those of you who toured the foundry at Williamsport, Penn. will know. Charlie Reynolds also uses it to cast aluminum banks. But it is not the only method for casting iron. For example, Larry Egelhoff produced the Club's convention Safe and Marietta Silo banks using the "lost wax process."

[2] Bill noted that 'what to make' was a decision for management. In the case of a still bank the Pattern Maker might have been provided a drawing or only told the design concept. For a mechanical bank he probably was given a working model. There also was a seasonal factor: Bob Saylor has told Bill that at Kenton from January to July 4 work focused on cap guns and the rest of the year on items for Christmas.

[3] Andy and Susan Moore, "The Penny Bank Book: Collecting Still Banks," Schiffer Publishing Ltd., Exton, Pennsylvania.

[4] Note by Fritz Kokesh: When I was a boy my neighbor Neil Goldberg was a pattern maker for the Minneapolis Moline Company. When asked to explain his job he would say: "I make wood models with the precision of a machinist."

[5] Herbert J. McCaslin, "Wood Pattern Making," McGraw Hill Book Company, New York, 1923. Reprinted by Lindsay Publications, Inc., Bradley, Illinois, 1997, p. 46.

[6] The gate was wide where it contacted the rods or bars and narrowed at the cavity. The gate funneled molten metal into the mold cavity and created a weak point where molded parts could easily be broken from the sprue during Shake Out.

[7] When a pattern didn't lie flat a match mold was essential to keep it from moving during ramming.

[8] Usually the match mold was an impression of the outside of the patterns. If it was an impression of the inside, then the impressions in the cope and drag would be reversed.

[9] Alternatively, during mold making a "sprue pin" was used as a pattern to form the sprue.

[10] According to Charlie Reynolds, the bristle of a broom is ideal for this purpose.

[11] For more about how banks were painted, see: Notes by Fritz Kokesh: Bob Brady, Mike Henry, and Don Heim, “Recognizing Repairs and Repaints of Cast Iron Banks,” SBCCA Seminar June 12, 1997. Copies of these notes and seminar handouts are available from the SBCCA Historian.

Photo 1. A.C. Williams' wood pattern for the "U.S. Tank Bank 1918," M–1437.

Photo 3. A working pattern for the A.C. Williams "Prancing Horse (large)," M–520.

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Photo 6. J.&E. Stevens' lead pattern for the "Oregon (large)," M–1452.