UNIT 8 DESIGN OF METAL CASTING TOOLS

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8.1 INTRODUCTION

Large number of tools and other equipment are used in casting industry, particularly in sand molding, for carrying out different foundry operations. All of them can be classified into following categories:

Hand Tools
- It is used for doing operations by hand.

Mechanical Tools
- It is used in mechanized foundries. These tools include different types of molding machines, power riddles, sand mixers, conveyors etc.

Containers
- It is used for carrying sand molds and molten metal from one place to another.

Objectives
After studying this unit, you should be able to
- understand hand tools,
- understand mechanical tools, and
- understand moulding containers.

8.2 PRINCIPAL TYPES OF CASTING TOOLS AND ITS APPLICATION

8.2.1 Hand Tools

The common hand tools which are used in foundry are as follows:

Rammer
- It is used to strike the sand mass in the molding box to pack it uniformly around the pattern. Peen rammer, hand rammer and floor rammer are commonly used in foundry industry.

Peen Rammer
- It is wedge shaped in construction and formed at the bottom of a metallic rod. A peen rammer is shown in Figure 8.1. It is very useful in packing the sand in pockets and corners.
**Design of Metal Shaping Tools**

*Hand Rammer*

It is smaller than peen rammer. It is generally made of wood or metal. Hand rammer carries wedge shaped construction called peen at one end and a solid cylindrical shape called butt at the other. A hand rammer is shown in Figure 8.2. It is generally used in bench molding.

*Floor Rammer*

It consists of a long steel bar carrying a peen at one end and a flat shape at the other. Figure 8.3 shows floor rammer. It is larger and heavier than above rammer. It is used for ramming the sand in very large molds.

*Shovel*

It consists of an iron pan fitted with a wooden handle. A shovel is shown in Figure 8.4. It is used in hand mixing and conditioning of the foundry sand and transferring it to the flask.
Hand Riddle

It consists of a wooden frame fitted with a screen of standard wire mesh at its bottom. A hand riddle has been shown in Figure 8.5. It is used to hand-riddle the sand so that the foreign material, if any, is removed from it.

Strike Off Bar

It is a flat bar, made of wood or iron. A strike off bar is shown in Figure 8.6. It is used to remove the excess sand from the top of a box after ramming. Its one edge is made beveled and the surface is perfectly smooth and plane.

Vent Wire

It is thin steel rod or wire carrying a pointed edge at one end and wooden handle or a bent loop at the other. A vent wire is shown in Figure 8.7. The vent wire is used to make small holes after ramming and strike off, so that the gases can escape easily during casting. These small holes are called vents.

Lifter or Cleaner

It is a finishing tool that is generally used for repairing and finishing the sand mold after withdrawal of the pattern. A lifter has been shown in Figure 8.8. It is also used for removing loose sand from the mold cavity.
Design of Metal Shaping Tools

It is also used for repairing and finishing the mold surface and the edges after the pattern has been removed from mold. The shape of slick is either like a heart and a leaf or a spoon and a heart. The slick (a spoon and a heart) is shown in Figure 8.9.

![Figure 8.9: Slick](image)

**Trowel**

It is used for finishing the flat surfaces and the joints in the mold. A few trowels are shown in Figure 8.10. Trowel is generally made of iron and is provided with wooden handle.

![Figure 8.10: Trowel](image)

**Mallet**

It is made of wood and is used for driving the draw spike into the pattern and then to rap it. A mallet is shown in Figure 8.11.

![Figure 8.11: Mallet](image)

**Swab**

It is a hemp fiber brush. A swab is shown in Figure 8.12. It is used for moistening the edges of a sand mold which is in the contact with the pattern surface. It is also used for coating the liquid black on the mold faces.

![Figure 8.12: Swab](image)

**Sprue Pin**

It is a tapered rod of wood or iron, which is first fixed in the sand and is then withdrawn to produce a hole. This hole is called a runner through which the molten metal is poured into the mold.

**Gagger**
A gagger is a bent piece of wire and rod. It is generally used for reinforcing the downward projections of the sand mass in the cope.

Clamps
These are made of steel and are used for clamping the molding boxes firmly together during pouring.

Bellow
It is used to blow away the loose or unwanted sand from the surface and cavity of the mold. A bellow is shown in Figure 8.13.

![Figure 8.13 : Bellow](image)

**Draw Spike**
It is a tapered steel rod having a ring at its one end and a sharp point at the other end. A draw spike is shown in Figure 8.14. It is used to rap and draw patterns from the mold.

![Figure 8.14 : Drag Spike](image)

**Draw Screws and Rapping Plate**
Draw screws are straight mild steel rods carrying a ring at one end and a machine screw at the other. It is always used along with rapping plate. A rapping plate consists of several holes to accommodate draw screws. Draw screws and a rapping plate are shown in Figure 8.15. These are used for rapping and removing the pattern from sand.

![Figure 8.15 : Draw Screws and Rapping Plate](image)

### 8.2.2 Mechanical Tools
Mechanical tools are used in mechanized foundries. Mechanical tools include various types of molding machines, sand slingers, core making and baking equipment, mechanical conveyors, sand mixers, sand aerators etc.

**Molding Machine**
Design of Metal Shaping Tools

It is a device by which sand mold is prepared with the help of various parts and mechanisms, transmits and directs various forces in required directions. The main functions of molding machines are as follows:

(a) Ramming of molding sand.
(b) Inverting the mold.
(c) Rapping the pattern.
(d) Removal of pattern from the mold.

The molding machines are classified in the following types of machines:

**Jolt Machine**

It consists of an air-operated piston and cylinder. The air enters through the bottom of the cylinder and acts on the bottom face of the piston so that piston moves up. The other end of piston is attached to the table of the machine. The machine carries the pattern and the molding flask. When the piston moves up to a certain height, which automatically raises the table, the air below the piston is suddenly released resulting in even packing of sand around the pattern in the flask. This operation is called jolting. This operation is repeated for a number of times and quite rapidly.

**Squeezing Machine**

This machine may be operated by hand or power. The pattern is placed over the machine table, followed by the molding flask. The machine platen is lifted by a hand-operated mechanism while works by the action of air pressure on a cylinder-piston system in power machine. The squeezing machine differs from the jolt machine in a way that the table is dropped gradually from a certain height in squeezing machine. A column is provided with overhead plate on the top of the machine. The sand in the flask is squeezed between the plate and the rising table. This enables uniform pressing of sand in the flask.

**Jolt-squeeze Machine**

The principles of jolt machines and squeezing machines are combined in this machine. A complete mold is prepared on this machine. The cope, the match plate and the drag are assembled on the machine table in reverse order. The drag is filled with sand and then rammed by the jolting action of the table. The assembly is turned upside down and placed with the bottom board placed on the table. Now, the cope is filled up with sand and then rammed by squeezing it between the overhead plate and the machine table. The plate is then swung aside and sand is leveled off. The cope is then removed and the drag is vibrated by air vibrator. This is followed by removal of match plate and closing of the two halves of the mold. The jolting and squeezing action is achieved by providing two separate cylinder-pistons at the bottom of the machine table. The two actions are well synchronized to give desired effects of jolting and squeezing one after the other.

**Sand Slinger**

This machine is used for filling and uniform ramming of the sand in the molds. This machine is particularly advantageous for large molds. Sand slinger consists of a heavy base, a bin or hopper to carry sand, a bucket elevator and a swinging arm which carries a belt conveyor and the sand impeller head. A bucket elevator consists of several numbers of buckets. Well-conditioned sand is filled in a bin. This sand is then fed to the bucket elevator. These buckets pour the sand onto the belt conveyor which carries it to the impeller head. This head can be positioned anywhere on the mold by swinging the arm. The head revolves at very high speed and throws a stream
of sand into the flask at a great speed. This is called slinging. The force of sand ejection and striking into the flask is enough to pack the sand in the flask uniformly. A sand slinger is shown in Figure 8.16.

![Figure 8.16: Sand Slinger](image)

**Stripping Plate Machine**

It consists of a stationary platen carrying a hole. The size and the shape of this hole is accurate to fit around the pattern. The pattern is secured in a pattern plate and then to the supporting ram. The pattern is drawn through the stripping plate either by raising the stripping plate and mold and keeping the pattern stationary or by keeping the stripping plate and mold stationary and moving the pattern supporting ram downward along with the pattern. The working principle of stripping plate machine is shown in Figure 8.17. Figure 8.17(a) shows that the complete unit is in assembled position. The removal of pattern by moving the stripping plate and mold upward is depicted in Figure 8.17(b). The pattern removal by moving the ram downwards is shown in Figure 8.17(c).

![Figure 8.17: Working Principle of Stripping Plate Machine](image)

**Pin Lift or Push Off Type Machine**

In this machine, the supporting ram is stationary and contains four pins for passing through the machine platen and the pattern plate. These pins are operated mechanically by a mechanism used in the machine. The principle of working of this machine is shown in Figure 8.18. The molding flask is lifted by the use of four pins.
Roll Over Machine

It consists of a rigid frame carrying two vertical supports on its either sides including the bearing supports of trunnions. The roll over frame of the machine is mounted on the trunnions. The pattern plate is mounted on roll over frame of the machine. The pattern is mounted on the pattern plate. The principle of working of a roll over machine is shown in Figure 8.19. The roll over frame is clamped in a position with the pattern facing upward for completing the mold. The flask is placed over the pattern plate and is clamped. Sand is filled in it and is rammed by hand. The excess sand is removed and molding board is placed over the flask and clamped. Then roll over frame is unclamped and rolled over through 180° to suspend the flask below the frame. The pattern is then lifted up to push against the suspending flask. The flask is unclamped from the pattern plate to rest over the platen, which is brought down while leaving the pattern attached to the plate. The frame is again rolled over to original position in order to ram another flask. Suitable mechanisms are included to enable rolling over and platen motion.

8.2.3 Containers

The containers are classified as follows:

Molding Box

Molding boxes used in sand industry are of two types such as closed molding box and open molding box.
The boxes used in sand molding are generally made of wood, steel or cast iron. They consist of two parts. The lower part is called **drag** while the upper part is called **cope**.

Generally, a wooden flask is used in green sand molding. Dry sand mold often requires metallic boxes because they are heated for drying. A closed metallic flask may have a rectangular or round shape as shown in Figure 8.20. Large and heavy boxes are made of cast iron or steel and carry handle and grips in order to enable handling by cranes. A snap flask is made of wood and is hinged at one corner as shown in Figure 8.21. The snap flask is widely used in green sand small non-ferrous castings.

![Figure 8.20: Rectangular Box](image1)

![Figure 8.21: Snap Flask](image2)

**Ladle**

A ladle is used to receive the molten metal from the melting furnace and pour the same into the mold. Its size is designated by the metal holding capacity. Figure 8.22 shows a typical ladle used in the industry. Ladles facilitate a better pouring control and ensure more safety for workers. Ladle consists of an outer casting made of steel plate bent and welded in proper shape. A refractory lining is provided inside the casting. The casing is shaped so that it has controlled and well directed flow of a molten metal.

![Figure 8.22: Hand Ladle](image3)
Crucible

It is made of a refractory material. It is used as a metal melting pot. The raw material or charge is broken into the small pieces and placed in crucible. Crucibles are then placed in a pit furnace which is coke fired. After melting of the metal, crucibles are taken out and received in handles. Pouring is done directly by using crucible instead of transferring molten metal to ladle.

SAQ 1

(a) What are the principle casting tools?
(b) What are the various types of hand tools used in foundry? Explain.
(c) Explain important types of mechanical tools used in foundry.
(d) Explain various types of container used in foundry.
(e) What is the advantage of sand slinger over other machines?

8.3 SUMMARY

A large number of tools are used in foundry industries in order to carry out different operations. The principle casting tools are hand tools, containers and mechanical tools. Hand tools consist of rammer, shovel, riddle, vent wire, lifter, slick, trowel, mallet, swab, clamps gagger, bellow, etc. Mechanical tools are generally used in automated foundries. Mechanical tools include various types of molding machines, sand slingers, core making and baking equipment, mechanical conveyors, sand mixers, sand aerators etc. Containers are used for carrying sand molds and molten metal from one place to another. These include molding box, ladle, crucible etc.

8.4 KEY WORDS

Rammer: A rammer is used to pack the molding sand uniformly around the pattern.
Slick: A slick is used for finishing the mild surface after removal of the pattern.
Bellow: A bellow is used to blow away the loose sand from the surface and mold cavity.

FURTHER READINGS


DESIGN OF METAL SHAPING TOOLS

This block consists of 4 units. Mainly we will be explaining the concepts of design of die making tools, design of sheet metal, blanking and piercing tools, designing of forming tools and design of metal casting tool.

In Unit 5, there will be an elaborate discussion on various principles of die design and compound die design.

Unit 6 comprises description of press working tools. It also deals with the types and application of blanking and piercing dies.

Unit 7 explains the purpose of forming tools and various types of forming tools.

Finally, in Unit 8, we will discuss the principal types of casting tools and its applications. It also explains about the concepts of hand tools, mechanical tools and containers used in the casting operations.