The Molding Process

LESSON 3: Clamp End Parts and Their Functions – Part I

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In Lesson Three we will begin to discuss the parts and operation of the clamp end of the molding machine. The clamping unit is responsible for closing the mold and locking it up under high pressure. The mold is opened by the clamping unit so that the molded part can be removed. Part ejection is caused by the ejection mechanism that is located on the clamp end of the machine.

Most machines have clamps that open and close the mold in a horizontal direction. For some specialty processes, the clamp mechanism opens in a vertical direction. These machines are useful for processes such as insert molding, where the inserts can be loaded onto the lower mold half where they are held in place by gravity.

The hydraulic system in each molding machine is the source of the high clamping forces used to hold the mold shut during injection. The clamp system may be moved directly by hydraulic cylinders as in the "hydraulic clamp", or the hydraulic pressure may be channeled through a series of mechanical linkages as in the "toggle clamp". These systems will be covered in this lesson.

Objectives of Lesson 3

1. Learn the names of the major clamp end parts of the machine
2. Learn about the different types of clamping systems
3. Learn about the two types of machine ejection mechanisms

Objective One

Major Clamp End Components

Machine Base

The machine base is the frame on which the injection carriage and platens rest. It is important that the base be rigid and strong. The machine base's rigidity, and the use of leveling pads, ensures that the machine can be aligned correctly. The base often contains the oil reservoir. Figure 1 shows the base of a typical injection molding machine.

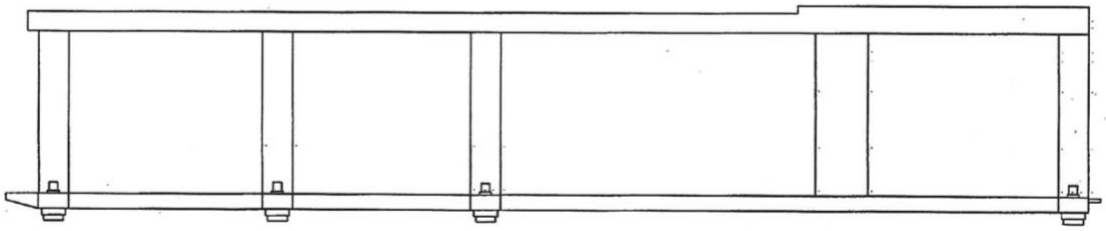

Figure 1 - Machine Base

Platens

Most molding machines have three platens. The platens are large steel plates that are attached to the machine base. The three platens are the front stationary platen, the moveable platen, and the rear stationary platen. Figure 2 shows the location of the platens and their relationship with the mold.

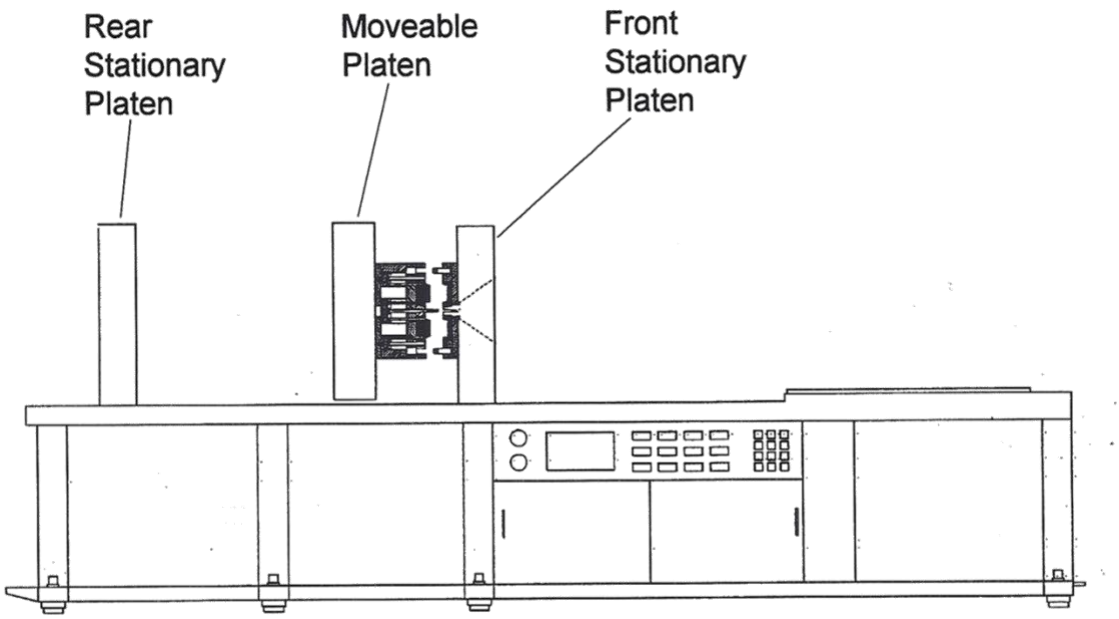

Figure 2 - Three Machine Platens

Tie Bars

Figure 3 shows the four tie bars that run through the corners of each platen. The tie bars are heavy steel bars that attach the rear stationary platen to the front stationary platen. The ends of the bars are attached to the two platens with large tie bar nuts. The tie bars align the platens and contain the forces between the platens when the mold is clamped up.

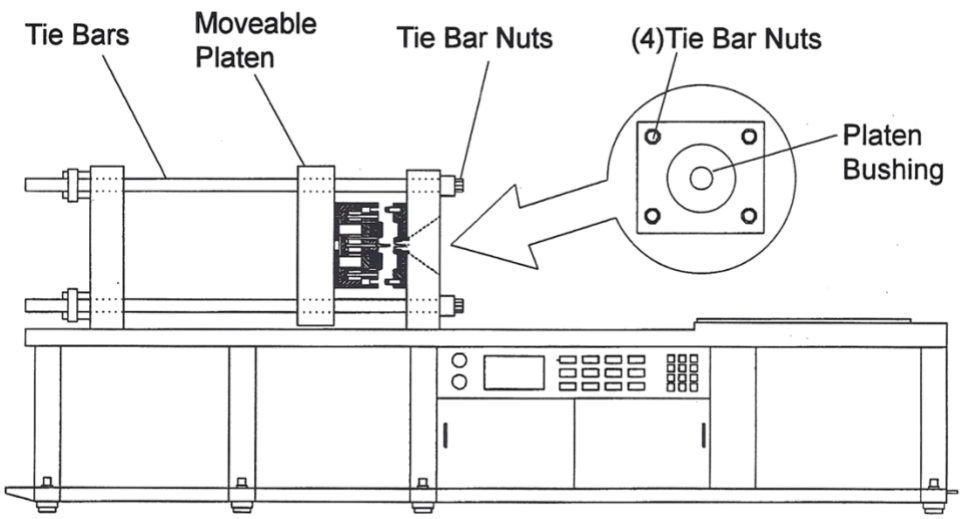

Figure 3 - Tie Bars

Front Stationary Platen

The front stationary platen is fixed to the machine base and does not move. The front stationary platen is really the center of the machine, with the clamp end on one side and the injection end on the other. On many machines the injection carriage is also attached to the stationary platen with its own two tie bars. This is the platen that holds the stationary half (cavity half) of the mold.

Moveable Platen

The core half of the mold is bolted to the moveable platen. This platen is moved back and forth on the tie bars causing the mold to open and close.

Rear Stationary Platen

The rear stationary platen supports the clamping mechanism at the rear of the machine and provides the backing for the clamping force on the mold halves. On a toggle clamp machine, the rear platen is stationary while the machine is running, but it can be moved when the mold height is changed. On toggle machines, the rear platen is often referred to as the tail stock.

Safety Gates and Machine Guards

Because of all the moving clamp end parts, and the danger at the point where the mold clamps together, most of the machine is covered with guards. Where no operator access is needed the guards are fixed (Figure 4). To gain access to the mold, a moveable safety gate is provided. In most of the machine drawings in this manual, the guards and safety gates have been removed to show the internal machine components. There are detailed descriptions of these and other safety features in another lesson.

Figure 4 - Clamp End Safety Gates

Exercise One

Platens

On several machines, indicate to your instructor or supervisor where each of the three platens are, and name them correctly. Place a check mark in the box when you have successfully named each of them.

Machine Number	Front Stationary Platen	Moveable Platen	Rear Stationary Platen

Instructor Date

Objective Two

Clamping Systems

Toggle Clamps

Toggle clamps are common on small and medium sized molding machines. Figure 5 shows a double toggle clamp. It is made up of many links that connect the moveable platen to the tail stock platen. When the hydraulic closing cylinder is moved forward, the crosshead link causes the toggle linkages to straighten out and lock. This action pushes the moveable platen forward, closing and locking the mold.

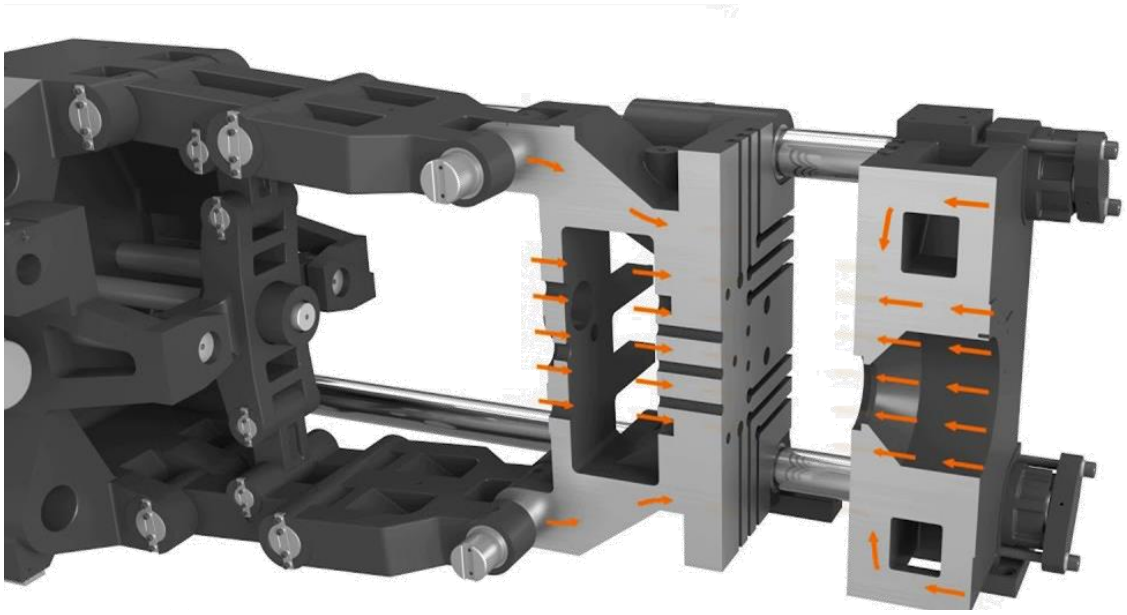

Figure 5 - Double Toggle Clamp

Hydraulic Clamp

A simplified hydraulic clamp mechanism is shown in Figure 6. This type of clamp relies completely on the movement and pressure generated by hydraulic cylinders. A large diameter "main ram" is used to generate the high clamp pressures required to hold the mold closed during injection. Because it is so large, this cylinder requires a large quantity of oil to move it any significant distance. This makes it slow moving. To generate high speed clamp movements, one or more booster rams (or jack rams) are built into the clamp system. They are small diameter cylinders that are used to open and close the clamp rapidly.

On the closing stroke, just before the mold halves come together, the valve to the main ram is activated, causing the mold to lock up under high pressure.

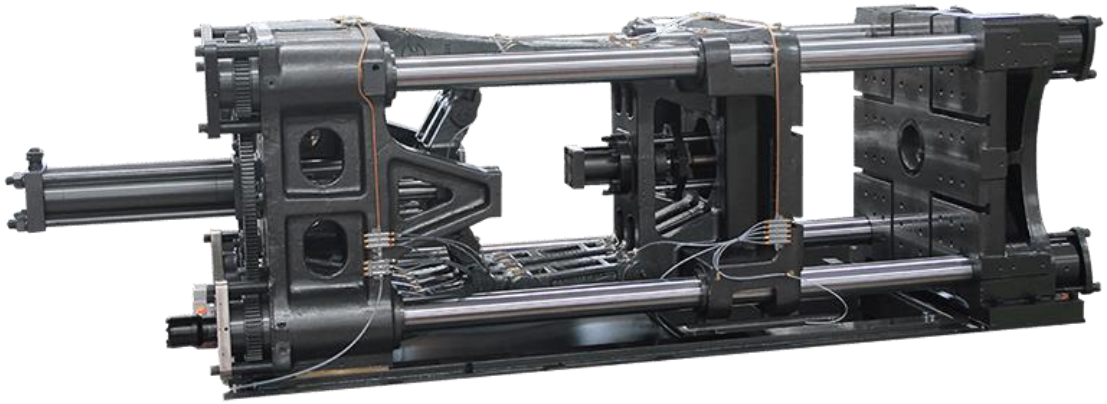

Figure 6 - Hydraulic Clamp

Hydromechanical Clamp

Some of the largest molding machines are designed with a hydromechanical clamp. This type of system is basically a hydraulic clamp with a lock and block feature built into it, as shown in Figure 7. Fast moving cylinders move the clamp quickly over most of its stroke. Then, a mechanical block is locked into place. Finally, the separate main clamping cylinder is used to finish the remaining stroke movement, and clamp the mold closed under high pressure.

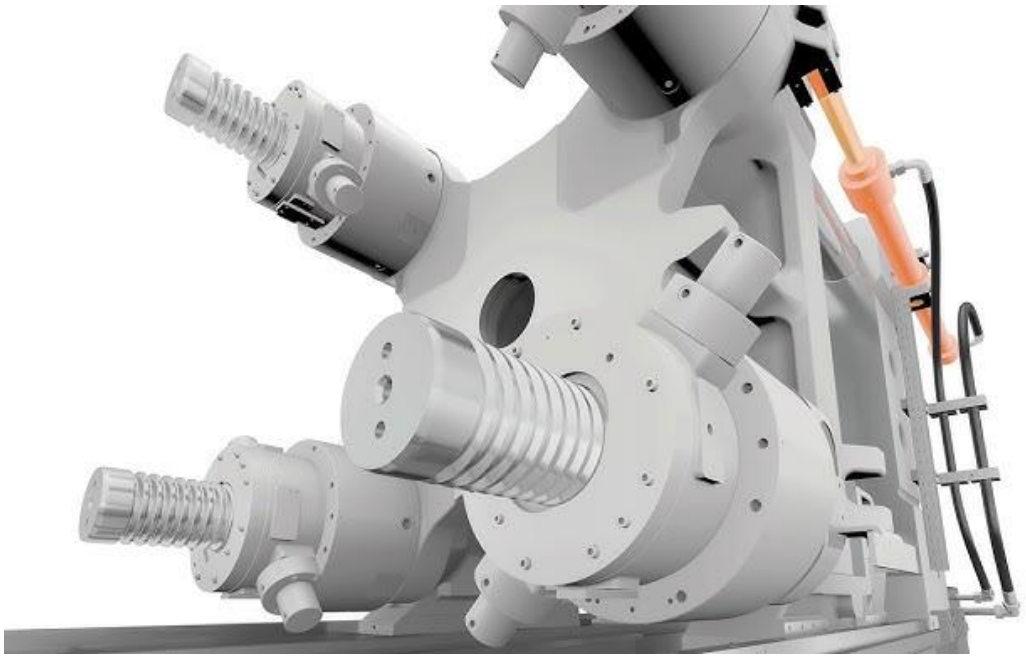

Figure 7 - Hydromechanical Clamp

Servo Driven Clamp

A "servo driven clamp" refers to the clamping mechanism on an injection molding machine where the force applied to close the mold is controlled by a servo motor, Figure 8, allowing for precise control of clamping pressure and faster, more efficient operation compared to traditional hydraulic systems; essentially, the servo motor provides precise

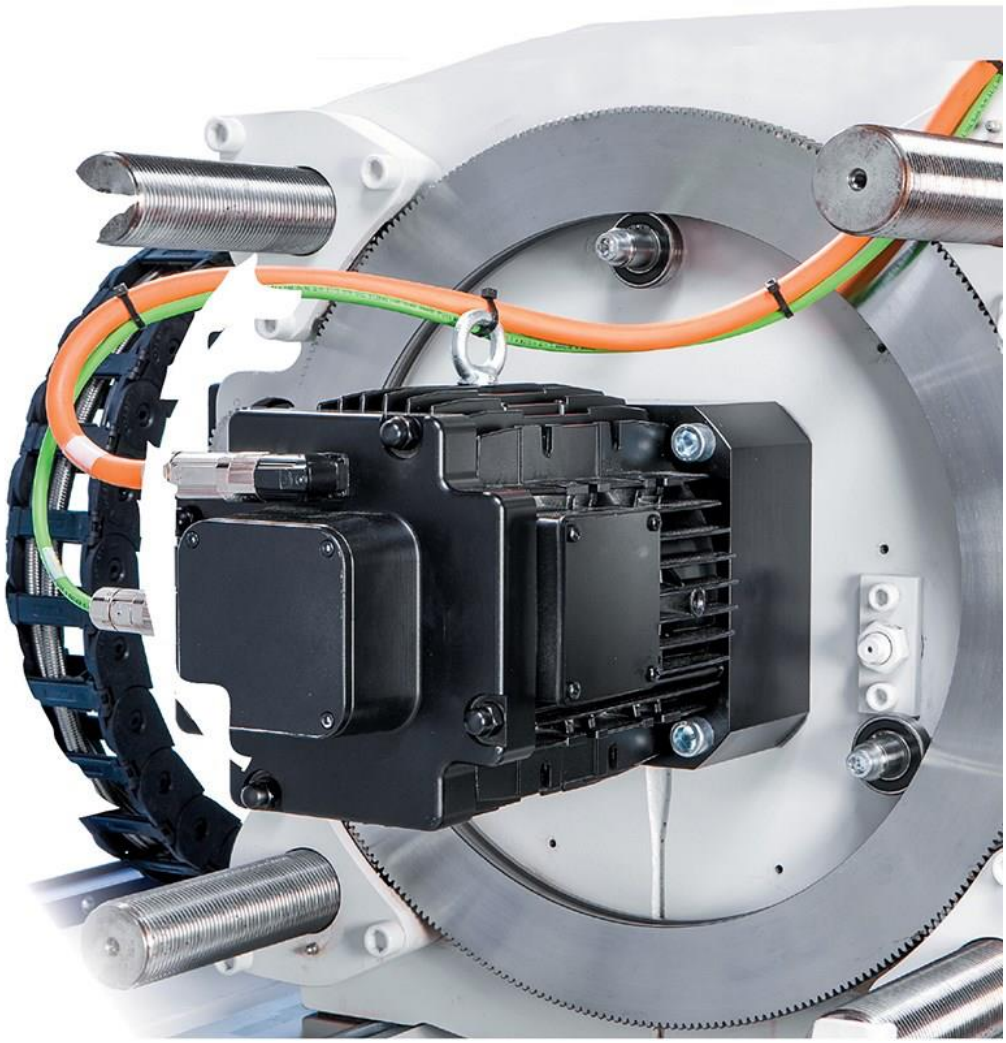

Figure 8 - Servo Drive for Clamp

movement and force to the clamping unit of the machine, enabling optimized clamping during the molding process.

Servo driven clamps mechanisms provide more control, energy efficiency and faster cycle times.

Tie-bar Less Clamping

Tie-bar less molding machines offer larger platen areas with smaller shot sizes making them ideal for applications such as multi-shot and 'odd' shaped molds that require core pulls, Figure 9.

Robot part removal is sped up as a result of the robot is able to move in one axis instead of two which is required for top entry robots.

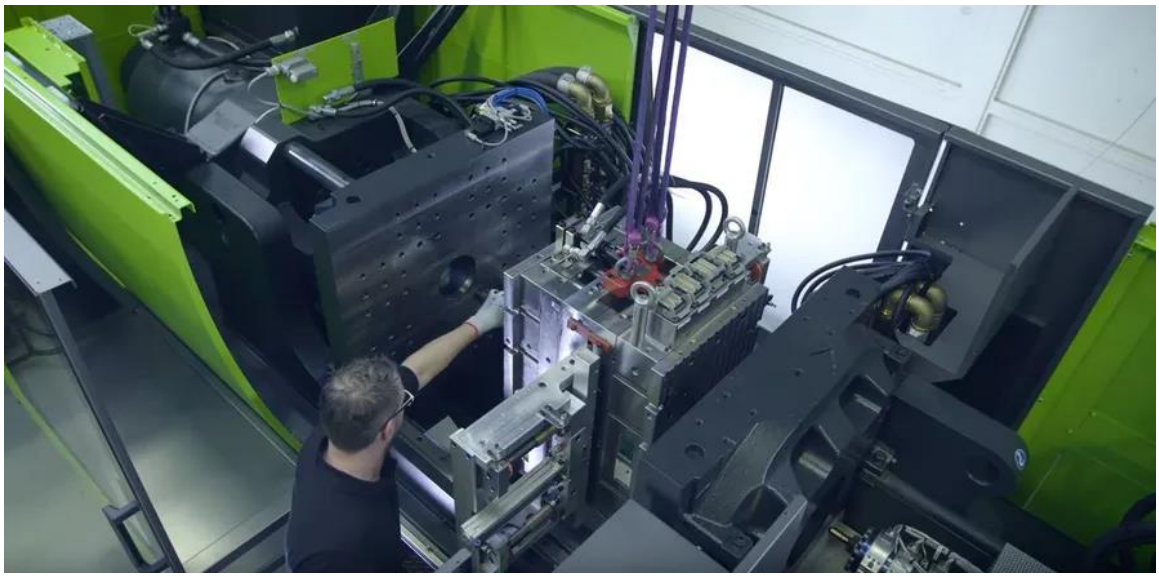

Figure 9 - Tie-bar Less Machine

Exercise Two

Clamp Units

Identify nine different machines in your shop and place a check mark in the appropriate row to define the type of clamp unit they have.

Machine Number	Toggle Clamp	Hydro-mech Clamp	Hydraulic Clamp

Instructor Date

Objective Three

Ejection Mechanisms

Ejection is the process of stripping the molded part off the core half of the mold. Each mold has its own internal ejection system where all of the ejection pins and components are attached to the ejector plate. The ejection system in the clamp end of the machine is designed to activate the ejector bar, which in tum pushes the ejector plate forward to strip off the part (Figure 9). The part is then free to fall into a bin, or to be removed by hand or robotic arm. The ejection system may be mechanically or hydraulically acti-vated. Most modem machines use hydraulic ejection since it can be operated independently of the opening stroke of the machine.

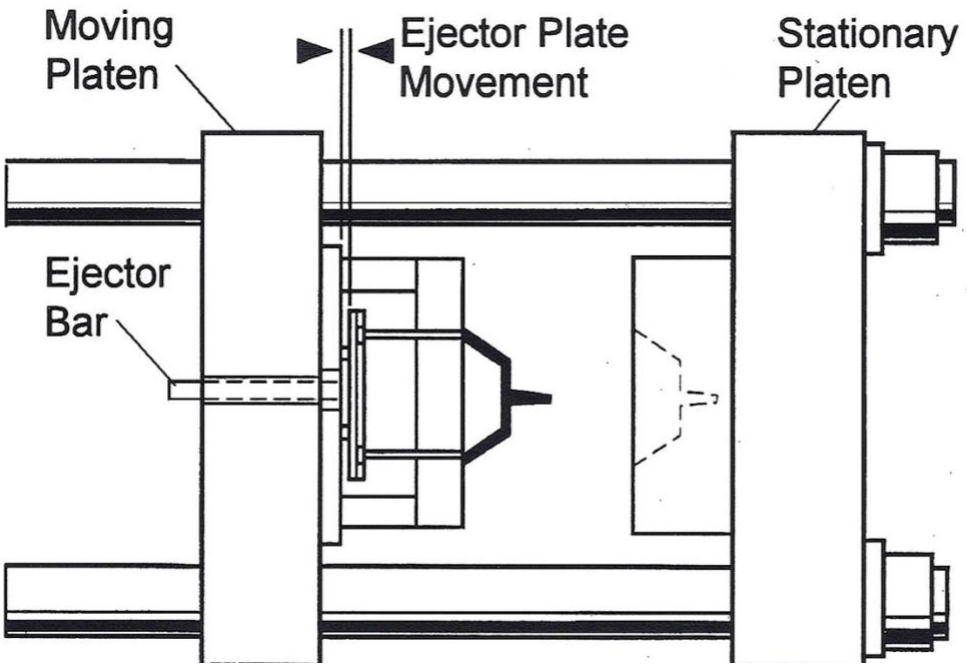

Figure 10 - Ejection System

Ejection Systems

Ejectors can be driven by hydraulics or servo motors. In both cases, a cylinder or motor drives the ejectors by moving an ejector platen to which the ejector bars are secured.

After the mold opens, the ejectors push the ejector bar(s) moving the ejector pins forward de-molding the parts and runners from the mold.

Exercise Three

Ejectors

Find four molding machines and watch the mold closely to see whether ejection begins during the mold opening stroke or after the mold is fully open.

Machine Number	Part	During Opening	Fully Open

Instructor Date

Self-Test

1. What are the names of the three machine platens on a toggle clamp machine?
   a. _____
   b. _____
   c. _____
2. What machine component contains the forces between the platens when the mold is clamped up?
   a. The machine base
   b. Hydraulic pistons
   c. Tie bars
3. What is another name for the rear platen of a toggle clamp machine?
   a. Adjustable platen
   b. Tail stock
   c. Clamp platen
4. Which type of clamp uses linkages?
   a. Hydraulic
   b. Toggle
   c. Hydromechanical

5. A booster ram provides the:
    a. High pressure clamp closing movement
    b. High speed clamp closing movement
6. Which type of clamp is easier to change over?
    a. Toggle clamp
    b. Hydraulic clamp
    c. Tie-bar less clamp
7. The ejector pins in the mold are mechanically attached to the:
    a. Ejector housing
    b. Ejector bar
    c. Ejector plate

Glossary

Booster Ram - the hydraulic cylinder used for rapid clamp movement in a hydraulic clamp system.

Closure Cylinder - the hydraulic cylinder responsible for moving linkages and opening and closing the machine.

Ejector Bar - the bar or bars that are activated by an ejection mechanism that push the ejector plate forward.

Ejector Plate - the mold plate to which the heads of the ejector pins are attached.

Linkages - the mechanical component arms that make up a toggle clamp.

Platen - large, steel, vertical plates on the clamp end of the machine.

Tail Stock - another name for the rear stationary platen.

Tie Bars - large, steel bars used on the clamp end of machine to connect and support the platens.

Toggle Clamp - a clamping mechanism in which a series of linkages and knuckle joints are mechanically straightened to move and lock up the mold.