



Pin-Tumbler Locking Mechanisms

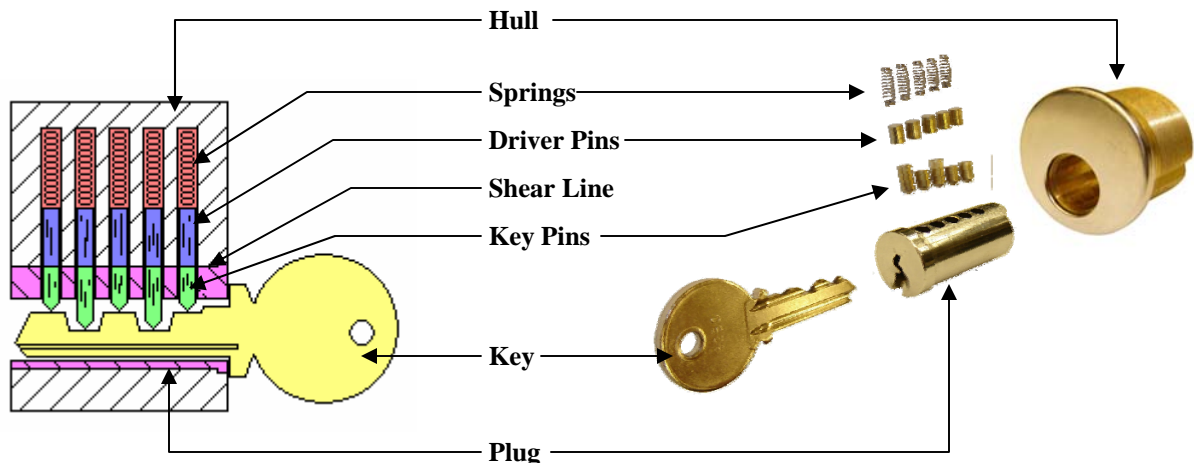
By: Steve Beck

Locks are a very common fixture in the modern world. They are so common that many people take their security for granted. Locks can be found in the exterior doors of houses, in automobile doors and ignition switches, in padlocks used on bicycles and fence gates, on safe boxes and vaults and in almost every door in a business.

The oldest known lock was found by archeologists in the Khorsabad palace ruins near Nineveh, Iraq. The lock is estimated to be 4,000 years old and is believed to be a forerunner to the pin-tumbler type lock. The first modern pin-tumbler lock was designed by Linus Yale Sr. in 1848 and his son patented the design in 1861. Since then pin-tumbler type locks have become the most widely used locking device used in the United States and around the world, yet very few are familiar with their operation. How does a pin-tumbler lock keep one's possessions safe and potential thieves foiled? These relatively simple locking devices perform these tasks with complex combinations of pins and keys that, when matched properly, operate the lock.

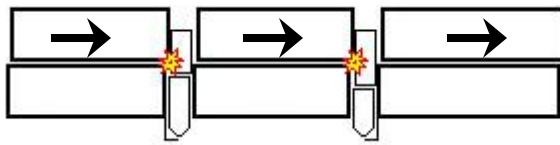
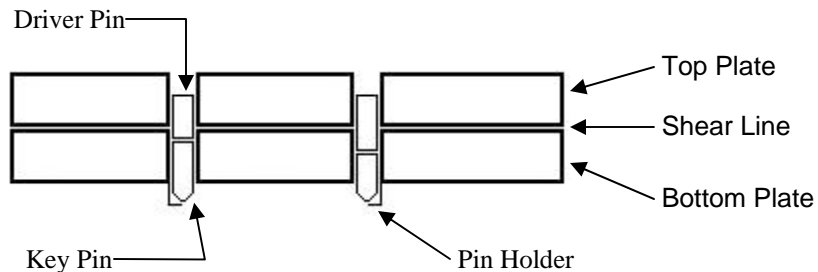
Parts of a Lock

Shown is a layout of the parts of a simple pin-tumbler lock with both an assembled diagram and an exploded view.



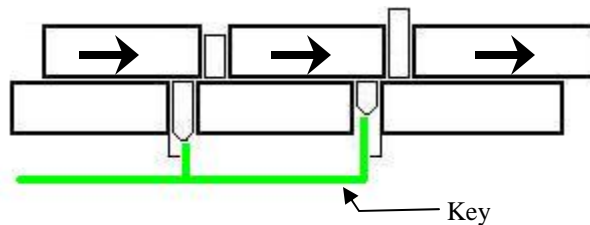
The Flatland Model

Instead of first trying to visualize what happens in a regular lock, consider the flatland model. In this model, two parallel plates set against each other with two holes through each plate that line up as shown. Through the holes are inserted two sets of pins.



When the top plate is shifted to the left or the right it cannot move because, at the shear line between the two plates, the driver pins bind.

When a key is used to lift the pins to their appropriate height, the key pins and the driver pins are then divided across the shear line and the top plate is allowed to move.



The Pin-Tumbler Lock



Photo #1

that the tips of the key pins are all even. Notice how the breaks between the pins do not line up. When a key is inserted in the lock, the tips of the key pins rest against the cuts in the key allowing the breaks to line up as shown in photo #2.

The pin-tumbler lock is essentially the same as the flatland model except there are more pins and the lock consists of two cylinders, one inside of the other, instead of two flat planes. In photo #1 are pins from a lock laid out so



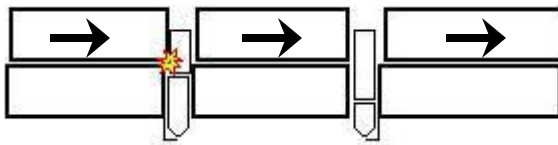
Photo #2

When the key pins and driver pins are arranged into the plug and hull of a lock and then the plug inserted into place in its appropriate position in the hull, the driver pins will fall into the plug and cause the plug to lock. To actuate the lock, the proper key must be inserted for the pins to line up at the shear line and free the plug.



The Binding Defect

Pin tumbler locks have a simple flaw that easily allows their security to be compromised called the *binding defect*. To illustrate this the flatland model will be revisited. It is common to assume that locks are perfect devices when they actually suffer from a variety of manufacturing inconsistencies. Every lock is made with very high tolerances on the amount of space given for the pins to move, but no two holes are ever drilled exactly the same. The differences in hole size and position in the plug allows some pins to wiggle more than others. In the flatland model shown previously, both



pins bound at the same time when movement of the top plate was attempted. Here only one pin is bound while the other still moves freely. This defect allows someone with some practice to insert a slender device into the lock and feel each pin for the one that is binding. When that pin is found it can be pushed up so that the break between the key pin and driver pin is at the shear line of the lock. When this happens the next pin will bind and the user can repeat the process until all the pins in the lock are in place and the lock will open without the key. This is commonly referred to as *lock picking*.

Advanced Security

Lock picking has been found to be an easy way to defeat lock security. This practice prompted lock manufacturers to add additional security measures to their locks. A few examples are outlined.

Spooled, serrated and mushroom pins

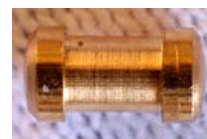
These pins, when inserted into a lock in place of regular pins create false set points designed to make someone picking the lock think that they have set a pin at the shear line when they really haven't.



Serrated Pin



Mushroom Pin



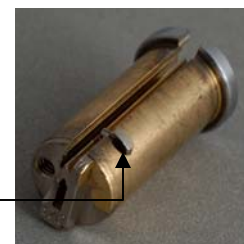
Spool Pin

Sidebars and check pins

Sidebars or check pins are added to the outside of the lock plug. Dimples in the keys or whole extra keyed patterns separate from the normal key cuts are used to activate them.



Notch cut in key to activate check pin



Check pin in lock plug

How does this affect me and how can I learn more?

Everyone, everywhere encounters locks where they live. Most see and use them every day without even thinking about them. Simply using them does not give any real understanding of the kind of security that is afforded by them. For more information about pin tumbler locks, the following websites are a great place to start.

- http://www.yalelock.com/Yale/Templates/GlobalNormalWithMenu____14.aspx
- http://en.wikipedia.org/wiki/Pin_tumbler_lock
- <http://home.howstuffworks.com/lock.htm>
- <http://www.crypto.com/papers/notes/picking/>
- <http://www.sans.org/rr/whitepapers/awareness/1333.php>