

# Locks & Strikes

## **Sources:**

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*Locksmithing*, 2<sup>nd</sup>, 2010 (Phillips)

[www.kaba.com](http://www.kaba.com)

[www.corkey.com](http://www.corkey.com)

[www.kwikset.com](http://www.kwikset.com)

[www.schlage.com](http://www.schlage.com)

## **Locks:**

### **What is a Lock?**

Before getting knee-deep in the discussion of the different types of locks and their applications, it's important to take a look at what exactly a lock is. Most people probably think of a lock as something that keeps people out of something, whether it's a cabinet, a car, or a house. But, there's a broader definition that covers the definition of a lock. According to the International Association of Home Safety and Security Professionals a lock is: "A device that incorporates a bolt, cam, shackle, or switch to secure an object – such as a door, drawer, or machine – to a closed, opened, locked, off, or on position, and that provides a restricted means of releasing the object from that position."

### **Types of Locks**

#### **Warded Locks**

The Romans invented the warded lock. It is the oldest lock in use today as well as the least secure lock in use today. At one time these locks were found on most doors. Warded locks are not used for high security applications.

Warding means that the lock has a type of internal construction designed to keep unauthorized keys from operating or entering the lock. Warded locks can have a single or multiple warding system. These locks come in various shapes and sizes, but usually come in the form of padlocks and building door locks. An old style lock that uses a skeleton key is a prime example of a warded lock. Warded locks are excellent for training locksmiths due to their simple design, easily duplicated keys, and straightforward internal structure.

Warded locks have a casing that consists of two metal stampings: a cover plate and a back plate. The back plate holds the internal mechanism and forms the sides. The warded lock uses wards, protruding ridges inside the lock case, to keep unauthorized keys from entering or rotating the keyway. Generally, there are two interior wards directly across from each other on the inside of the cover and backing plates. A key with notches that correspond with the sizes and positions of the wards is required to operate the lock. The wards prevent other keys from being able to rotate the locking mechanism.

Currently, there are two types of warded door locks in use: the surface mounted lock and the mortised lock. These types offer varying degrees of security. Although they operate in the same manner, the mortise lock may have several additional parts. There are also warded padlocks.

### **Surface-mounted Ward Lock**

- The surface-mounted ward lock, also known as a rim lock, is surface mounted to the door. These locks can be attached to a door of any thickness and they are secured by screws in the door face. They have a thin case and a short latch bolt throw. They can be locked from either side and the strike can be removed when the door is closed. They have a very restricted range of key configurations and offer very weak security.

### **Mortised Ward Lock**

- The mortised ward lock is mounted inside of the door. The door must be thick enough to fit the lock and the lock is secured by screws in the side of the door at the lock faceplate. They have a thicker case than a surface-mounted ward lock and up to a one-inch latch bolt throw. They can be locked from either side and the strike cannot be removed when the door is closed. They have a restricted range of key configurations, and although they offer better security than the surface-mounted ward lock, they offer only weak security.

### **Warded Padlocks**

- Warded padlocks are the least expensive and least secure padlocks available. They are generally operated with corrugated keys, but more expensive warded padlocks use flat keys. A set of five skeleton keys sold by locksmithing supply companies can be used to open most warded padlocks. They can also be opened with a bent paperclip.

Generally speaking, the security of any lock depends on the type of key used, the number of possible key variations, and how much access is allowed to the locking

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mechanism through the keyhole. These factors make warded locks the least secure type of locks.

Usually, surface-mounted and mortised locks operate from both sides of the door. Doorknob spindle holes and keyholes go through both sides of the lock body.

A key must be cut to correspond to the single or multiple wards inside the locking mechanism. Once the key passes the wards it contacts the locking mechanism. Then, the cuts on the key lift the lever to the correct height and throw the deadbolt into the unlocked or locked position. When the doorknob is turned it activates the spindle, and as long as the deadbolt is retracted, allows the door to open.

Warded locks generally have only 50 different key variations. Therefore, a person with 50 different keys can, in theory, open any warded lock. It is also possible to cut away parts of a key to make it fit into and open a warded lock. These locks can also be bypassed with a widely available thin key called a skeleton key.

Damaged warded locks are generally not worth repairing, as it is usually cheaper to replace them.

## **Lever Tumbler Locks**

Lever tumbler locks, also called lever locks, rely on levers within the lock for security. These locks are often found on luggage, school lockers, mailboxes, desks, and bank deposit boxes. These locks generally use flat keys.

In general, lever tumbler locks are marginally more secure than warded locks. However, there are some high security lever tumbler locks made for safe deposit boxes that have six tumblers.

A basic lever tumbler lock has a cover and back cover. These covers house the parts of the lock, which are the: trunnion (or key plug), lever tumblers, and bolt. There is a post fixed on the bolt called the bolt post. The correct key has tumbler cuts, which correspond in both height and width to the lever tumblers.

Most lever tumbler locks have five tumblers or less (usually three to five). The tumbler consists of six parts: a saddle, a pivot hole, a spring, a gating slot, a front trap, and a rear trap. The lever tumblers are held in place by spring tension and sit on the bolt. The gate and traps are open areas on the tumbler and they restrict the movement of the bolt post. The bolt extends or retracts when the bolt post moves from one trap to another. When the correct key is inserted, it will slide over the saddles of the tumblers lifting each to the necessary height, which will allow the bolt post to move from one trap to the other. Newer lever tumbler locks have tumblers with staggered saddle and trap heights, which make them more difficult to pick.

Lever tumbler locks are used for a variety of everyday applications such as:

### **Safe-deposit Boxes**

- These locks have at least six and as many as fourteen levers and require two keys. One key is given to the customer and the bank holds the other. Both keys are needed to open the lock; therefore, these locks have two sets of tumblers and two bolt pins must pass through the lever gates at the same time. Often safe-deposit boxes have a security feature comprised of a compression spring bearing against the upper lever. This spring forces the lever stack down, which allows no play between the levers. Without this security feature, the levers would be able to move a fraction of an inch when a lock pick artist probes the lock. The fraction of an inch movement would provide clues for the lock picker and allow for easier picking of the lock.

### **Suitcase Locks**

- Many suitcase locks are warded locks, but high-end suitcases have lever tumbler locks. Suitcase locks are not generally built for high security. It is not uncommon for one key to open many different suitcase and luggage locks. By cutting down any standard suitcase key, it is possible to make a skeleton key to open most suitcases.

### **Locker and Cabinet Locks**

- There are some high quality lever tumbler locks. The Lock Corporation of America makes a locker and cabinet with a locking spring design. This design has a free-turning keyway that makes the locks pick resistant. They are made from a one-piece heavy-duty steel case and are designed to fit into current master key systems. They fit left- or right-handed steel locker and cabinet doors.

Generally, keys for lever tumbler locks are flat and do not have a keyway running along the side of the key. Several styles of flat keys exist.

The repair of lever tumbler locks depends on the lock style. Lever tumbler locks come in three different styles: a solid case lock (usually spot-welded or riveted), a pressed form lock with the back and sides of the case one piece (tabs are bent to hold the cover in place), and a lock with a cover plate secured by a screw.

It's cheaper to replace a solid case lock than to repair it.

Pressed form locks can often be repaired. A pressed form lock can be disassembled easily. After bending the tabs, the cover can be removed. The most

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likely problem with a malfunctioning pressed form lock is a small object jammed in the keyway. Usually, this can be easily removed and solves the problem.

Lever tumbler locks with a cover plate secured by a screw can often be repaired, as they are also easy to disassemble. These should also be checked for small objects in the keyway.

Broken springs are a common problem with lever tumbler locks. To fix a broken spring, the lever with the broken spring must be located. If the broken spring is not on the top lever, levers must be removed until the broken spring is located. As they are removed, the levers must be kept in order so that the lock can be reassembled properly. Once the broken spring is located, remove the lever and broken spring. Cut and bend a piece of spring steel into an appropriate replacement spring. Then, replace the spring. Finally, reassemble the lock, making sure to replace the levers in the proper order.

## **Disc Tumbler Locks**

Disc tumbler locks, or cam locks, have disc shaped tumblers. These locks are commonly found on desks, automobiles, cabinets, and coin-operated machines. Disc tumbler locks offer greater security than warded locks. The design of the lock offers the same level of security as a lever tumbler lock, but disc tumbler locks have a greater number of possible key configurations (over 3,000).

The basic parts of a disc tumbler lock are the: lock housing (or shell), bolt, cam, retainer, plug, springs, and disc tumblers.

The disc tumblers are steel stampings with rectangular holes in their centers. They are arranged in slots in the cylinder core. They have a leg on one side for a spring to sit in. All of the disc tumblers in the lock are the same width and height, but the rectangular holes in the center vary in height. Opening the lock requires a key with cuts that correspond to the rectangular cutouts on the tumblers, which are the same size but are at varying positions. The position of a cutout determines the depth of key cut needed to move the tumbler into alignment. The correct key will align the tumblers along the upper and lower shear lines, which allows the plug to rotate.

The plug is the cylindrical part of the lock enclosing the keyway. Rotation of the plug moves the bolt to the locked and unlocked positions. It has rectangular slots that each hold a spring and disc tumbler. The springs keep constant pressure on the tumblers, which forces them to protrude outside of the plug and into the shell. The key pulls all of the tumblers into the plug allowing for full rotation.

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Keys for disc tumbler locks look similar to pin tumbler cylinder keys (house-type keys), but are generally smaller and have only five cuts. Manufacturers produce these locks with five possible positions for the cutouts relative to the tumblers.

To key these locks the tumblers must be arranged in a sequence that matches the key cuts. Once the sequence has been determined, install the tumbler springs over their respective hooks. Then, mount the tumblers in the plug. The tumblers are spring-loaded and are free to pop out until the plug is installed in the cylinder. Stake the tumblers in place with a punch or the corner of a small screwdriver. Install the assembly inside the cylinder. Inserting the key will release the tumblers.

Generally, disc tumbler locks are cheaper to replace than to repair. However, some good quality locks may be worth repairing. These locks will have a small hole on the face of the plug. Inserting a thin wire (like piano wire) into this hole will release the retaining clip. The key can then be used to withdraw the plug. If the key is not available a second piece of thin wire can be used to withdraw the plug. A few locks will have the plug and cylinder brazed together, in which case it is necessary to file off the brass to remove the plug.

## **Side Bar Wafer Locks**

Automobiles manufactured by General Motors use a disc tumbler lock called a side bar wafer lock. These locks have a V-notch on one side of each disc, a V-shaped side bar, and a special slot within the lock housing. The slot allows a portion of the side bar to protrude into it when the lock is in the locked position.

To rotate the plug, the side bar must be fully retracted from the slot in the housing. In order to fully retract the side bar, all of the V-notches of the disc tumblers must be aligned to allow the V-shaped part of the side bar to fit into the V-notches.

The side bar is under spring pressure, which keeps it constantly pressed against the discs. When the correct key is used, all of the disc tumblers align properly, the side bar pushes into the V-notches, and it clears the slot in the lock housing.

## **Pin Tumbler Locks**

Pin tumbler locks use a pin tumbler cylinder. The pin tumbler cylinder is the most popular lock currently in use. A pin tumbler lock can be easily identified by looking into the keyway, as one or more pin tumblers can be seen hanging down. Pin tumbler locks are used in rim locks, key-in-knob locks, deadbolt locks, padlocks, automobile door locks, and automobile ignition locks.

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Pin tumbler locks are fairly simple mechanisms, but can also offer a very high level of security. They are generally self-contained and come in a variety of shapes and sizes.

The basic parts of a pin tumbler lock are the: cylinder case (or shell), plug (or core), upper pin chambers, lower pin chambers, keyway, drivers (or top pins), springs, and bottom pins.

The cylinder case houses all of the parts. The plug contains the keyway and rotates when the key is turned. The keyway is the opening in the plug that accepts the key. There are drilled holes (usually five or six) across the length of the plug. These holes are the lower pin chambers, and each contains a tapered bottom pin. Inside the case, aligned with the lower pin chambers, and above the plug are (five or six) additional drilled holes. These are called the upper pin chambers. The upper pin chambers each hold a spring and a driver. A corresponding set of pin chambers (top and bottom pins) is called a stack. Each stack has two pins (a top and bottom pin).

When operating a pin tumbler lock, the position of each pin determines whether or not the cylinder can be rotated. If there is no key in the cylinder, gravity and the downward pressure of the springs drives the drivers (top pins) partially down into the plug and prevents the plug from being rotated. Since the bottom pins vary in length from one lower pin chamber to another, the top pins will drop different depths into the lower pin chambers. A pin that is in its upper pin chamber and lower pin chamber at the same time obstructs the plug from turning. Attempting to rotate the plug forcibly when the pin is in both chambers will likely bend the pin and cause a lockout.

The design of a cylinder always allows for space between the case and the plug. Without this space, the plug would be jammed in tight and never turn regardless of key or pin position. The space between the plug and cylinder is called a shear line. A correctly cut key inserted into the keyway will slide under all of the bottom pins and lift each bottom pin to the shear line. The correct key will fit into the keyway and have correctly spaced cuts of the right depths to match each bottom pin length. When all bottom and top pins meet at the shear line, none of them obstruct the plug from rotation. Upon rotation, the top pins separate from their respective bottom pins.

The plug of a pin tumbler lock contains a keyway, which is generally off-center. Most plugs have five or six lower pin chambers, but some have four or seven. The lower pin chambers are spaced evenly along the upper surface of the plug. The plug is held at the rear by a cam and screws, a retainer ring, or a driver that locks the plug into the cylinder. Often, the plug is machined with a shoulder at its forward surface. The shoulder mates with a recess in the cylinder. The shoulder provides a reference point for pin chamber alignment in the case and plug. The shoulder is also a safeguard that prevents the plug from being driven through the cylinder. The

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shoulder also deters a thief from shimming the pins, as without it, it would be possible to force the pins out of alignment with spring steel.

The pins in a pin tumbler lock are usually made of brass and come in a variety of diameters, sizes, lengths, and shapes. Although small in size, the pins are very strong. Certain pin shapes can make pin tumbler locks more difficult to pick. A cylindrically shaped top pin can easily be lifted to the shear line with a lock pick while a tension wrench is used to apply a turning force to the plug. However, a top pin with a broken profile will hang up before it passes the shear line making the lock more difficult to pick.

Pin tumbler cylinders have either a tailpiece or a cam attached to the rear of the plug. The tailpiece is loose and allows flexibility in the auxiliary lock on the other side of the door. Alignment needs to be as accurate as possible and the tailpiece should not be more than  $\frac{1}{4}$  inch off the axis of the plug. However, pin tumbler cylinders for mortise locks do not have this tolerance. These are generally driven by a cam on the back of the cylinder. Mortise locks used on office equipment usually have a cam that is a milled relief on the back of the plug. It is essential that these locks are aligned with the bolt mechanism.

Pin tumbler mortise locks are often used in apartments, homes, large institutions, and businesses. They are popular and offer excellent security. A pin tumbler cylinder mortise is far superior to a bit key mortise lock, and it's important to never confuse the two.

Key-in-knob pin tumbler locks are operated by simply inserting a key into the knob. These do not offer the high level of security that deadbolt locks offer.

Deadbolt pin tumbler locks are commonly found in residential and business settings. These locks have a bolt (usually about 1 inch in length) that extends into a strike plate in the door frame when locked. These locks offer very high security when installed with a proper strike plate.

Pin tumbler locks are the most common type of lock. Since they offer high security and are ubiquitous, it's important to be familiar with some of the characteristics of the various locksets available. These characteristics include:

### **Security**

- Pin tumbler locks provide above average security because of their internal design. In general, the more pins in a pin tumbler cylinder, the more security the lock offers. But, security also depends on the quality and application of the lock.

### **Quality**



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- This depends largely on the application of the lock. There are light-, medium-, and heavy-duty locksets available.

### **Visual Appeal**

- Locksets of various styles and colors are available. They should match the general décor of their surroundings (particularly in new construction).

### **Type**

- Different types of locksets serve different functions. Some functions include: residential, industrial, classroom, and lavatory.

### **Hand**

- The location of the hinges and swing of the door determine the hand of the door. The lockset should be matched to the door hand. If they don't match, this can cause bolt/striker misalignment and result in an upside-down installation of the cylinder. If the cylinder is rotated 180°, the weight of the pins will be on the springs. Although the pins are very lightweight, they have enough force to collapse the spring and thus disable the lock if the lock is installed upside-down. Mortise locksets are generally right-handed, but can be ordered left-handed, and some can be modified in the field.

Pin tumbler locks are generally expensive enough to be worth repairing. A common repair needed in the field is the removal of a broken key. The lock must be checked to be sure that the broken key is in the position that a key would normally be inserted into the lock (at the 12 o'clock or 6 o'clock position). This ensures that the pins are properly aligned for key removal. It may be necessary to use pliers to get the key into the proper position, or in some cases, it may be possible to simply remove the broken key with pliers. It's also possible to insert a hooked piece of wire into the keyway, hook the key, and pull it out. However, in many cases it's necessary to use a broken key extractor, which can be found in a locksmith supply shop.

Pin tumbler cylinders can be rekeyed. This involves removing the device that retains the plug (a clip, cam, or cap) and removing the plug from the cylinder body. The pins are then removed from the plug. Then a new key is inserted and appropriately sized pins are added to the plug. The bottom pins must reach the shear line when the key is in place. This can be done using a reference book that lists key and pin combinations, by taking measurements with a caliper or gauge, or through trial and error. Once the proper pins are fitted into the plug, it can be reinserted into the cylinder and tested.

## **Pushbutton Locks**

Pushbutton locksets are becoming more popular as technology advances. Operating the lock requires inputting a series of numbers or letters. Buttons, or in some cases, a touchscreen, on the face of the lock serves as the input device. The user sets the number series (combination, so to speak). Multiple combinations can be programmed into the lock. Some locks can track user codes with a time stamp. They generally have a keyway as a backup feature.

Pushbutton locks are ideal for high traffic use such as dormitories, employee entrances, and apartment lobbies. They are especially useful for businesses with a high number of employees, as they offer thousands (and even millions) of possible combinations. Even a lock with only five buttons can make it very difficult to guess the combination, provided it is not something obvious that an unauthorized person could easily determine (like a birthdate).

Combinations on pushbutton locks can be changed easily and quickly. This feature is ideal for businesses as it can eliminate the cost of collecting, issuing, and reissuing keys.

## **Padlocks**

Padlocks are useful for securing things like toolboxes, buildings under construction, bicycles, lockers, and gates. Although they differ in appearance from locksets, their function and operation are similar to other locks. Padlocks can use wards, wafers, levers, pin tumblers, or a spring bar. Some padlocks make it necessary to shackle the lock closed before the key can be removed. This is accomplished with a spring-loaded coupling. This feature improves key security and makes it less likely that the lock will be left open.

### **Considerations when choosing a padlock:**

- Are the width, case length, and shackle appropriately sized for the intended latch? The lock must fit the latch well.
- In what location will the lock be used? Will the location affect the type of lock needed? (High crime area versus low crime area).
- How often will the lock be opened? The price of the lock is proportional to how often it will be used.
- Will the lock secure valuables? Cheap lever locks are adequate for locking a backyard fence. A heavier-duty lock is more appropriate for a storage locker.

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- Will the lock be used indoors or outdoors? Outdoor locks need protection from the elements.

### **Common Types of Padlocks:**

- **Warded Padlocks** – These padlocks have limited lifespans, especially when used outdoors. The cheapest versions only last for a few thousand openings and offer minimal security. These generally have three wards, although the cheapest have only two. The keys are either flat or corrugated. These padlocks are not worth repairing, as they are very cheap to replace.
- **Wafer Disc Padlocks** – These padlocks use the wafer disc mechanism and have double-bitted keys. They are more secure than warded padlocks. These can be difficult to service if the key is lost as they must be picked or one must find a test key that will open the lock.
- **Pin Tumbler Padlocks** – There are numerous pin tumbler padlocks on the market. There are high security models available. They generally fall into two categories: laminated or extruded. Laminated pin tumbler padlocks are made up of a series of steel plates held together by four rivets at the casing corners. Extruded padlocks are made from a single piece of metal and are generally made out of brass

## **Lock Grades**

An important aspect to consider when considering locksets is the lockset grade. The American National Standards Institute, Inc. (ANSI) has guidelines for the manufacturing standards of building hardware. Manufacturers often build products to meet or exceed ANSI standards because architects, builders, and locksmiths specify products based on the standards. ANSI 156.2 contains provisions for locks to be Grade Certified. Lock grades range from 1-3. The lock must pass a series of rigorous tests to receive a grade. Grade 1 locks are the strongest and are often used in industrial applications. Grade 2 locks are generally used in light commercial and residential applications. Grade 3 locks are the lightest and are generally used in residential applications. Locks undergo an operational test, a strength test, and a cycle test. When concerned about security, it's always best to use an ANSI Grade 1 lockset.

## **Common Residential Locksets**

There are some specific pin tumbler cylinder locksets that are noteworthy. Kwikset and Schlage make some of the most common locks in use today. Additional

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information about these locks can be found on the manufacturer's website. The following is an overview of some of the most common current lockset technology in use today (supplemented with information from the from the manufacturer's website(s)):

### **Kwikset Corporation**

Kwikset offers key-in-leversets as part of their Premium line. These leversets are constructed of solid brass and steel. They are engineered to meet most building code requirements, including handicapped codes. They are engineered to absorb heavy use in high-traffic areas. They are available in many different styles and finishes. Kwikset locks are backed by a 10-year limited warranty.

The Kwikset Series 500 Premium Entrance Lockset was designed and built for the building industry. This series offers improved, heavier-duty locksets for offices, apartments, townhouses, condominiums, and fine homes. They have a panic-free operation feature on the interior knob; a solid steel reinforcing plate to protect the spindle assembly; a reversible deadlatch with a 2/3-inch throw, solid-brass, a beveled latchbolt; a solid steel strike plate and heavy duty screws; and a free-spinning exterior knob for protection against wrenching.

Kwikset also offers their Smartcode electronic pushbutton lock series. There are several models available. This series offers pushbutton and touchscreen models as well as handle locks and deadbolts.

### **Schlage Lock Company**

The Schlage B-Series deadbolt locksets are very common in the United States and are adequate for both commercial and residential applications. The B-Series locks use a standard key and feature: The Unique Snap & Stay™ design enables easy installation (making installation a one-person project), ANSI Grade 1--professional grade security, the biggest adjustable bolt available, pick and bump resistance, they adjust to fit all standard door preparations, quality finishes for lasting beauty, a lifetime finish and mechanical guarantee.

Schlage has a line of digital battery-operated keypad (pushbutton) locks. These have the following features: an innovative turn lock feature allows you to lock & leave without a key, they provide the convenience of keyless access, they are customizable to fit your security needs (ideal for front doors, side & back doors, garage entry doors, etc.), they easily replace most existing deadbolts using only a screwdriver in about 30 minutes, no programming is required (they are preset with two user codes and ready to use right out of the box), ANSI Grade 2 Certified, they fit standard door preps, there's no need to run wires (they are battery operated with over a 3 year battery life).

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Schlage has a line of touchscreen digital (pushbutton) locks. These have the following features: a numeric touchscreen that's fingerprint-resistant, works in the rain, and works when you're wearing gloves; a slim profile that's sleek without sacrificing strength and the lock easily fits between the front door and screen door; a durable, smart design; ANSI Grade 2 security rating; a 2-year battery life with a 9V battery backup; LED down lighting that illuminates the numbers when needed; dedicated icons for both low battery and programming mode; enhanced security, 100% bump-proof, 100% pick-proof; they do not require cutting keys or re-keying locks; they install in minutes with just a screwdriver; they have enough memory for 19 access codes.

## **High Security Locks:**

There are numerous high security locks on the market. High security locks have a place in government installations, public and private institutions, and commercial and residential applications. Additional information can be found at each manufacturer's website.

## **Schlage Primus Cylinders**

For high security applications, Schlage offers their Primus Security cylinder. These cylinders use a unique key. They are available for Schlage Series A, B, C/D, E, H, and L locks. These cylinders have six pins and are precision built to tight tolerances. The cylinders are machined to accept a side bar and a set of five finger pins. The side bar and finger pins, together with the six-pin keying system, afford two independent locking systems that are operated at the same time by the Primus key. The lock features hardened steel pins in the plug and housing which protect the lock from drilling and other attacks.

Schlage offers different levels of security within the Primus line. There are four levels of control for Primus keys. Each level requires registration and an identification card when duplicating the key.

## **The CorKey System**

CorKey Control Systems, Inc. offers kits that can be used as replacement doorknobs and cylinders on most brands of rim, deadbolt, and key-in-knob locks. These kits change standard locks into card-operated access control systems. Generally, there is no need to modify the mechanical locks.

The kits, called CorKits, are used at the Honolulu International Airport, the U.S. Mint Building in San Francisco, and many hotels and universities worldwide. Once the kit is installed, locks can be opened using a magnetically coded card called a CorKey. The key looks like a military dog tag. The key fits into a slot at the top of

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the knob or cylinder. The kit makes the slot the new keyway for the lock. The CorKey can be coded to operate one or more locks within a system. The keys can be decoded and recoded as needed. CorKey Control Systems, Inc. provides encoding equipment when the system is installed.

## **The Dom IX KG System**

DOM IX KG System cylinders feature a horizontal keyway and two rows of mushroom and teardrop-shaped pin tumblers. These tumblers make the cylinder nearly impossible to pick. The tumblers are in an offset position from each other. The heads of the pins are in the form of cutaway, beveled half-discs. These are stabilized in their lateral position using an elliptically shaped cross-sectional design for the pin tumblers.

The DOM IX KG System uses dimple keys, which make unauthorized duplication very difficult. The keys have an integrated (patented) floating ball, and locking is not possible without the ball. A deflection pin inside the keyway is overridden by the floating ball, which is the only way to actuate the tenth blocking pin. The ball has just enough mobility in its ball cage to allow deflection of the override of the deflection pin.

Upon complete insertion of the key, the floating ball is pressed down by the lifting pin, which in turn, operates the blocking pin. Once all pin tumblers and profile control pins are in the correct position and the blocking pin is operated correctly, it is possible to operate the cylinder.

The profile pins of the lock are not controlled by springs, they operate laterally and vertically. Upon insertion of the key, the pins fall into their own respective borings, either from above or from the side. When all pin tumblers are in position and the profile control pins are resting in their borings, the cylinder can be operated.

Lock picks are prevented from operating the blocking mechanism of these locks due to the deflection pin protruding into the keyway. This prevents them from being inserted. Additionally, each row of tumblers has two tapered core pins that jam whenever an opening attempt is made with a lock pick.

Key control is conducted through DOM's registration certificate program. Authorized personnel can obtain duplicate keys from the factory with proper identification. It's also possible to get a "split key", which is a key split into two pieces, thus requiring two people to open the lock. This is commonly used in banks, evidence rooms, and drug cabinets.

## **Kaba Gemini (Lori Corporation)**

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Lori Corporation produces the Kaba Gemini cylinder. Dimple keys that have cuts drilled at precise angles are used to operate the cylinder. These keys are Underwriters Laboratories-listed (UL-listed) and are remarkably difficult to impression or pick.

The Kaba Gemini cylinder can be used in deadbolts, key-in-knob locks, and padlocks.

## Medeco Cylinders

Medeco cylinders are some of the most well-known and longstanding high security cylinders on the market. Medeco Security Locks, Inc. has been manufacturing high security locks and cylinders since the 1960's. Medeco cylinders are UL-listed and are resistant to impressioning, picking, hammering, prying, and wrenching. Cylinders are available for key-in-knob, rim, mortise, and deadbolt locks.

The cylinders have several high security design features. They have a set of pin tumblers that must be elevated by the cuts of the key as well as a side bar within the cylinder that requires the pin tumblers to be rotated to specific positions by the key. Rotation aligns a slot in each pin tumbler. Once the pin tumblers are properly rotated and elevated, the fingers, or projections, on the side bar are able to enter the pin tumbler slots; this frees the plug to rotate to the unlocked or locked position. The cylinders also feature hardened steel inserts that protected it from drill attack. Anti-drill rods surround the keyway. Hardened inserts protect the side bar and shear line from attack.

Medeco keys must be made on a special key machine, thus the availability of duplicate keys is limited.

## Keys:

There are eight types of keys: bit, barrel, corrugated, flat, tubular, cylinder, angularly bitted, and dimple. Although each key type is different, virtually all keys have a bow (a handle). The bow is what a person holds when inserting the key into a lock. Bows come in different sizes and shapes and have identifying information on them. One can recognize a house key (as opposed to a car key or padlock key) by the bow.

### **The different types of keys explained:**

- **Bit** – This is a skeleton key and is made of iron, brass, steel, or aluminum. The parts include the bow, shank, shoulder, post, and bit.

Author: Tim Baron

- **Barrel** – These keys look similar to bit keys, but they have a hollow shank and do not have a shoulder.
- **Flat** – These keys are flat on both sides. They are generally made of steel or nickel silver. These are usually used for operating tumbler locks.
- **Corrugated** – These keys look similar to flat keys and have the same parts. However, these keys have ripples (corrugations) along the length of the blade. These usually operate warded padlocks.
- **Tubular** – These keys have a short tubular blade with depressions milled in a circle around the end of the blade. The parts include the bow, blade, tumbler cut, and nib (a small protrusion at the tip). These keys operate tubular key locks.
- **Cylinder** – These are the most common type of key. These are used for most pin tumbler and disc tumbler locks. The parts include the bow, shoulder(s), blade, keyway grooves (milled grooves), and tip. The shoulders are used as stops when cutting keys. The keyway grooves run along the length of the key and allow the key to fit into a lock's keyway.
- **Angularly Bitted** – These keys are used with high security locks. They have cuts that angle perpendicularly from the blade. They cause pin tumblers within a cylinder to rotate to specific positions.
- **Dimple** – These keys are used in high security locks. They have cuts that are milled into the blade surface.

Keys can be cut by hand, but are more commonly cut on key cutting machines. Locksmiths generally learn key cutting methods during an apprenticeship.

## Strikes:

Strikes are metal fastenings on the doorframe into which the bolt of a lock is projected to secure the door. The best lock in the world will not offer security if the bolt does not go into a properly installed, high quality strike plate. In most residential homes, the doorframe is made of thin plywood. The strike is attached to the frame, and when the door is locked the bolt goes into the strike. If the strike is simply attached to the thin plywood with short screws, even the best Medeco cylinder lock on the market won't stop someone from kicking the door in. With such short screws into such a weak material, the kick will force the bolt through the plywood doorframe, leaving the lock intact, and a piece the doorframe smashed out. Intruders can breach the door with one kick.



Quality deadbolt locksets will include a hardened steel strike plate. Minimally, it will have two holes for security screws. Ideally, it will have more than two holes. The most important factor, however, is that security screws of 3-inches or longer are used to install the strike plate. 3-inch screws will go through the doorframe and into the stud supporting the doorframe. Getting the screws into the stud is the key to a properly installed strike plate.

Besides the strike plate that comes with the lockset there are stand-alone strike plates available. These are generally hardened steel and can have six or more holes. These are optimal for high security, as this allows for six 3-inch screws to secure the plate to the stud.

Some companies also offer “door armor”. This consists of one or more long steel strips that fit around the inside of the doorframe. Door armor with multiple pieces can be used to reinforce the entire frame with 3-inch screws. One strip will function as a strike and it will have a cutout for the bolt. These long strips can have ten or more holes to attach the armor to the stud with 3-inch screws. The StrikeMaster II and EZ Armor are two such products currently on the market.

## **Considerations for Detention Centers:**

Detention locks are used in private, state, county, and federal sectors. There are many opportunities for locksmiths in these sectors. It is important to match up the correct locks, electric strikes and hardware to the desired security level. Security levels range through: low, medium, high, and maximum security.

Mechanical and electromechanical locks are frequently used in high-security settings. Mechanical models generally have wafer or lever tumblers and are mortise-mounted in 1¾-inch metal doors with steel bolts and shatterproof inserts. Electromechanical locks are usually positioned in frame jambs and can be locked and unlocked from an electronic console.

The mogul cylinder is also used in high-security settings. This cylinder contains stainless steel pin tumblers and can be master keyed. Moguls generally offer four keying levels: Day Key/Pass Keys, Master Key, Grand Master Key, and Great-Grand Master Key.

Mortised pin tumbler locks are generally used for low security settings. These locks are usually installed in a 2-inch wide jamb. They are available in solenoid and motor versions. The motor version is also suitable for medium security settings.

### **Considerations for choosing detention locks:**

- Know the security level of the facility and the specific areas that need to be secured.
- What types of doors must be secured?
- What functions do the locks need to perform?
- Are mechanical or electromechanical locks needed?
- Are motor or solenoid operated locks needed?
- What types of strikes are needed?

Once these considerations have been properly evaluated, the locks and hardware that meet the security needs of the facility can be chosen.

Southern Folger is a well-known detention lock and hardware manufacturer that is used in many facilities. They have lock configurations to meet all levels of security.

In addition to the lock, appropriate hardware must be chosen. For detention areas, institutional hinges are used. These hinges are heavy-duty and several types are available for the various security levels.

Heavy-duty strikes are also necessary in detention centers. Detention areas often use electric strikes because they provide both electrical and mechanical control. Low and medium security centers may use them for individual cells, but they are not used for individual cells in high security prisons. Electric strikes can be used to create a mantrap system. This is a way to control access to an area by using two electrically interlocked doors. A mantrap makes it necessary for a person to walk through and close one door before the second door can be opened. Using this system, a prisoner can be inspected, searched, or detained before going into a new area. These areas often have cameras, guards, and intercoms. The system uses a door monitor switch at each door and has a connecting switch to the electric strike power leads of the opposing door. This way, when one door is open, the power to the second door is cut. Only when the first door is closed can the second door be opened. If the second door is open, the first door remains locked.

## **Security Overview:**

### **General Security**

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The security of an entryway is a function of the cylinder, bolt, door, and strike plate. If a single one of these components is of poor quality it can compromise the security level of the door regardless of the quality of the other components. In addition there are several other considerations to keep in mind.

### **Security considerations:**

- A hollow wooden door offers no security regardless of the other components.
- It's important to keep masterkeying as simple as possible. Every split pin improves the odds in favor of the lock picker.
- Discourage demands for extensive cross keying. These usually originate with customers who insist on single-key performance for executive keys.
- Proper key-control procedures are a necessity for security.
- Supply extra change-key blanks during the installation phase of a system. Without these available, it may be necessary to cut duplicate change keys from master key blanks. This can compromise security because the change key could fit other locks.
- Always use double cylinder locks when possible (locks with a key on both sides of the lock as opposed to a key on one side and a knob on the other).
- Locksets without a deadbolt function should be specified with automatic deadlatches. If they are not, the bolt can be compromised by loiding (slipping a flat object between the bolt and the strike).
- Always use the longest bolts available to protect against attacks that spread the doorframe.
- Shield all bolts with armored inserts.
- Use reinforced strike plate mounts. These add security by increasing the contact area between the strike plate and frame.

## **Lock Picking / Forced Entry / Lock Bumping / Impressioning**

Lock picking, forced entry, lock bumping, and impressioning are skills that all locksmiths should have. Unfortunately, criminals can also use these skills to breach security. It's important to have a basic understanding of what these skills are so that security steps can be taken to minimize a security breach.

## **Lock Picking**

Theoretically, any mechanical lock that is operated with a key can be picked. With the proper skills most standard pin tumbler locks can be picked in a matter of minutes. Tools and techniques exist to simulate the action of any key. The standard tools of locksmiths (and in some cases burglars) are picks and torque wrenches. To successfully pick a lock requires the ability to visualize what's happening inside the lock while you're picking it. Since pin tumbler locks are so common, understanding the mechanics behind pin tumbler locks is essential for understanding how to pick them.

The small spaces and misalignments within the cylinder of pin tumbler locks are what allow them to be picked. When manufactured, there must be room in each of the upper and lower pin chambers for the pins to freely move back and forth. Using a pick set, the upper and lower pins can be manipulated with picks and torque wrenches so that the pins reach the shear line, and thus the plug can be rotated and the lock opened. The point here is not to teach how to pick locks, but to have a basic understanding of the methods that can be used to do so.

The most effective (and most difficult) way to pick locks is with the "feel method". Proficiency requires an immense amount of practice. This method essentially rests on the picker's ability to visualize and feel what is going on inside the lock. The picker tackles the pins one at a time through feel. There are two reasons this method works. First, the lower pin chambers of a pin tumbler cylinder are not perfectly aligned with their corresponding upper chambers. Second, the sets of upper and lower pin chambers are not perfectly aligned with each other. The sets of pin chambers form a zigzag pattern across the plug and cylinder case, not a straight line. Although small, these slight misalignments are always present and allow the lock to be picked with the "feel method".

The "rake method" is a more common way to pick a lock. This method is based on the lock itself. This method requires inserting a pick into the keyway past the last set of pin tumblers and then quickly moving the pick in and out of the keyway while applying varied tension on the torque wrench. The raking motion causes all of the pins to jump up to or above the shear line, and the torque wrench motion allows them to be caught in place.

Lever and disc tumbler locks are picked in a similar manner. The same types of tools are used. Once proficient in picking pin tumbler locks, lever and tumbler locks will be easy for a lock picker. With lever tumbler locks, lever tumblers (instead of pins) are lifted with picks. With disc tumbler locks, disc tumblers are pulled down with picks instead of lifting them up.

A side bar wafer lock is more difficult to pick due to the side bar. Getting the tumblers to the shear line is not difficult. However, the difficulty comes in applying

pressure to the side bar to force it against the tumblers so that each tumbler put in place with the pick will stay in place until all tumblers are properly positioned. This may require drilling a small hole in the face of the cylinder.

There are also lock picking guns available. With these, the pick of the gun is inserted into the keyway beneath the last bottom pin. A torque wrench is used while squeezing the trigger multiple times. The gun trigger makes the pick end slap the bottom pins and the torque wrench is used to catch them in place (similarly to the rake method).

Even high security locks like the Schlage Primus and Medeco cylinders can be picked.

### **Forced Entry**

Locks can be loided, jimmied, drilled, and pried. Padlocks can be hammered and cut. It's important to keep all of these possible breaches in mind when deciding on security hardware.

- **Loiding** – This method works with spring-loaded latch bolts like most key-in-knob locks (and some rim locks). The lock is compromised by using a thin piece of plastic or metal (sometimes a credit card, as seen in the movies) to press the latch bolt out of the strike and back into the lock. The plastic or metal is inserted between the door and the jamb. This can be protected against by using a spring-loaded latch with a deadlatching bar.
- **Jimmying** – Many deadbolt locks and spring-loaded locks can be opened by this method. This method uses a pry bar and brute force applied between the door and the jamb near the lock's bolt. Once the door is pried far enough away from the jamb for the bolt to come out of the strike, the door can be opened. This is why it's important to have a strong strike plate and minimal distance between the door and frame (when the door is closed).
- **Drilling** – This method is very effective on pin tumbler locks. Pin tumbler locks can be drilled using a  $\frac{1}{8}$ -inch or  $\frac{3}{32}$ -inch cobalt or tungsten carbide drill bit. The bit is placed  $\frac{1}{8}$ -inch above the shear line and in line with the top pins. Once all pins are drilled through, a screwdriver can be used to turn the plug. Even hardened pins can be drilled though, but this takes additional time.
- **Prying** – Mortise cylinders are especially susceptible to prying. The cylinder collar can be pried off and a wrench used to twist the cylinder out.
- **Padlocks** - Many padlocks can be compromised with brute force, such as a sledgehammer, or even more easily with bolt cutters. Also, the latch can be

removed and the lock bypassed altogether. Thus, it's important to consider not only the lock, but also the latch when securing something with a padlock.

## **Lock Bumping**

Lock bumping has become a significant security issue over the last few years. In the past, locksmiths kept knowledge of lock bumping close to the vest. Currently, however, this method is a well-known way to defeat pin tumbler locks. Lock bumping is easy to learn and very effective on most pin tumbler locks.

Lock bumping requires a key that can fit all the way into a plug and a tapping tool. The key is prepared by cutting each space to the lock's lowest depth. The full method will not be revealed, but essentially the bump key is inserted into the keyway a certain way and tapped (bumped) with a striking tool. Then the key can be turned and the door opened.

It's important that locksmiths refrain from selling bump keys. Unfortunately, bump keys are readily available over the Internet. However, lock manufacturers have started selling bump resistant (and in some cases bump proof) pin tumbler locks. High security applications require bump proof locks.

## **Key Impressioning**

Key impressioning is a method used to make a working key without having another working key to copy and without disassembling the lock. Like the "feel method", key impressioning requires a significant amount of practice. The technique involves using a blank key that is marked by the lock and then cut until the blank becomes a working key. This can generally be done with a blank key, a file, and a vise.