Catalogue of High Security Locks v1.00

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Notes and disclaimer:

- ⋆ The author is a lock enthusiast, not a qualified locksmith, so some of the terminology may be incorrect. Furthermore, the author makes no claim as to the accuracy of the information presented in this document.
- ⋆ This catalogue is meant only as a sample of some of the world's more interesting and unusual locks.
- ⋆ The material reflects the author's taste and experience in locks and is not intended to favour one country's locks above those of another.
- ⋆ A list of car locks, magnetic locks, combination locks and electronic locks, together with some mystery locks has been included at the end of the document. However, no operational descriptions have been provided for these locks. Please feel free to comment on these if you know how they work, so that they may be included in future versions of the catalogue.
- ⋆ Where several locks brands are considered to be equivalent, these are listed together. Related locks are cross-referenced.
- ⋆ A large number of safe locks (typically Italian double-bitted lever locks) have been omitted.
- ⋆ Some of the information for this list was obtained from the 1993 Silca^{TM} 101 and 201 key catalogues, and from various manufacturers' brochures. A large part was obtained through inspection of the locks themselves.
- ⋆ Books used in the preparation of this list:

C. A. Roper, *The Complete Book of Locks and Locksmithing*, TAB Books, PA, 1983.

R. L. Robinson, *Complete Course in Professional Locksmithing*, Nelson-Hall, Chicago, 1983.

⋆ Each lock category is arranged according to the plan below.

brand	country	Silca catalogue ref.	lock, key & keyway type	picking difficulty

This is followed, in most cases, by a description of the mechanism, mode of operation, security features and other comments relevant to lock(s) in question.

⋆ The following country codes have been adopted.

A	Austria	AUS	Australia
BR	Brasil	CH	Switzerland
D	Germany	E	Spain
F	France	FI	Finland
UK	Great Britain	H	Hungary
HK	Hong Kong	I	Italy
IL	Ireland	J	Japan
NL	Netherlands	P	Portugal
RC	China	SW	Sweden
US	USA		

⋆ Picking difficulty (author's estimate only) is graded on a scale of 1 - 5 according to the table below.

1	relatively easy
2	quite hard
3	hard / special tools required
4	very hard
5	forget it!

Alpha

(J) 5 + 6-pin, horizontal keyway (3)

Used on vending machines. The keyway is horizontal and rectangular with 6 pins on the upper face and 5 profile pins. Keyway warding and small size make this lock hard to pick.

(See DOM IX.)

American

(US) wafer-tumbler, double-sided key (2)

Used in cylinder locks and padlocks. The keyway has a central ward and the key is continuously milled on both top and bottom edges, such that the bitting width is constant along the length of the blade. The wafers are adjacent, unlike in ordinary wafer locks, and all have the same size cut which may vary in offset. The wafers require no spring since they are held in place by the key. In some circumstances, the wafers may be sprung on the side by an S-shaped wire. There are typically 12 wafers.

American also make high quality pin-tumbler locks that use spool drivers and spooled lower pins to increase the difficulty in picking.

(See Bricard Locks.)

ASSA Twin 6000

(SW) 6-pin + side-bar, dealer perm key (5)

The ASSA lock has 6 conventional pins with spool drivers actuated by the top bittings of key. A second set of bittings lower down on the left hand side of the split-level key raises the 5 side-bar pins to engage the side-bar. side-bar pins are internally sprung. Each side-bar pin has several grooves around its girth, only one of which is the correct depth for the side-bar blade. The cylinder may have hardened pins inserted around keyway and side-bar to resist drilling.

The side bittings on the key are known as a "dealer perm" and are used on other dual-action locks such as Schlage Primus, Vachette 2000 and Winkhaus so that the distributor cuts the profile bittings (to a given permutation) using a special cutting machine, leaving the top part of the blade blank. The blade can then be cut using a conventional cutting machine.

Abloy

(FI) AY1 10-disc side-bar, D-profile key (4-5)

The key is half-round in cross section with angled bittings along its length. Six bitting angles are possible from 0 (no cut) to 90 degrees, with a 90 degree cut leaving a quarter circle of key profile. The keyway may have wards requiring the key to be milled out to a different profile to restrict access.

The cylinder has up to 11 discs with separators housed in a shell which has a slot for the side-bar. Discs have a D-shaped hole stamped in the centre and a stop lug on the rim to limit rotation within the shell to 90 degrees. Each disc also has a side-bar notch in its rim. When all discs have been correctly aligned by the a quarter turn of the key, pressure exerted by a bevel in the cylinder wall will force the side-bar into the groove formed by the discs. The shell is then free to turn, releasing the locking balls in a padlock or turning a connecting rod in a cylinder lock.

Mastering is achieved by cutting more than one notch in one or more of the discs. Shallow notches are usually included to jam the side-bar and inhibit picking. Pick manoeuvring is made difficult by the geometry of the keyway and the relative positions of the discs when rotated. The number 1 (front) disc may not have a stop lug, preventing tension from being applied naively to the first disc, in any case, it is only feasible to apply tension to a disc corresponding to a 0 degree cut (i.e. no cut), since it will stop in the correct position. Of course, it is not known a priori which discs are which, although discs 9 and 10 (in a 10-disc lock) are often of the latter type. In addition, fixed (non-rotating) discs can be used, so that the key blank must have warding cuts in order for it to turn.

It is possible however to defeat the lock using a reader or jig (similar to a technique used to decode keys for Chubb locks). A reader for an Abloy lock can be made using a coaxial rod fashioned to fit the keyway. The inner part of the rod tensions the core, while the outer part is free-sliding and can be rotated to test each of the discs in turn. In this way, the combination of the lock may be decoded and a key cut. Of course, if the discs have false notches, then this will only narrow down the number of possible keys which need to be cut and tried.

This lock gets my vote for the most ingenious design in that it contains relatively few moving parts yet is very hard to pick or drill.

(See Abus Plus.)

Abus Plus

(D) AB32 disc side-bar, symmetric key (4)
Chubb SMI (AUS)

A close relative of the Abloy but with a rectangular keyway and a symmetric key that may be inserted either way round. These locks have typically 10 discs which, when rotated to the correct angles, allow the side-bar to drop into the channel formed by the notches and the core to rotate in the cylinder. Because the key is cut from both sides, it tends to be prone to shearing off in the lock, e.g. when not inserted to the correct depth, although this is less of a problem with Abus.

ACE

(US) 7-pin-tumbler, tubular (2-3)
GEM (US) CH9T

These locks have 7 or 8 push-in pins arranged around a central plug. The plug (or spindle) passes

through the barrel and has a threaded end to which a locking cam is attached. The plug and barrel assembly is mounted inside the lock shell and the barrel secured with a retaining pin. The retaining pin should be hardened to protect against drilling. The key is hollow and cylindrical, usually with a bitting that engages a slot in the plug to provide turning force and to keep the pins depressed as the key is rotated. There are 7 pin sizes ranging from 0.020" to 0.110" in increments of 0.015". Some ACE locks have a ball bearing imbedded in the plug to guard against attack by drill or hole-saw. Since all the pins are exposed, these locks are not hard to pick with a tubular lock pick that can maintain the pins at the correct depth once they are picked. The plug will relock at fractions of a turn if the pins are allowed to spring back up.

There also exists an ACE variant that has a 5-pin conventional, flat key extending through the tubular part of the key. I've only seen these in U.S. airport lockers.

BiLock

(AUS) 12-pin double side-bar, U-profile key (3-4)

The 2-bladed key is formed by folding a flat plate, cut along two opposite edges, to form a "U". There is no warding in the keyway, so that the pins are easily accessible when a two-pronged tensioner is used. Each blade has 6 bittings with four possible cuts. Thus there are nominally 16 million differs. The lock is a twin side-bar type with spring-loaded lower pins (no drivers). The pins are machined with a hole in the side facing the side-bar, and a vertical channel to constrain rotation within the chamber. Each pin may have one hole or several holes (for mastering), with false-depth holes to jam the side-bar and render picking difficult. The plug has hardened inserts to resist drilling.

Bramah

(UK) radial wafer pump, end-bitted tubular (3)
Supra-C (Aus) 6-wafer pump, internally milled tubular key (3)

Bramah is the original "tubular" lock and the model for many other radial and pump-type locks. It was devised by Joseph Bramah in 1784. A set of 5 or more wafers arranged around the circular plug prevents rotation. A bit on the key stem locates the key in the keyway and provides turning tension. The correct key depresses each wafer to the required depth at which it clears fixed notches cut in the front and back plates of the cylinder barrel. The first reported picking of a Bramah lock was by A. C. Hobbs at the 1851 Great Exhibition.

The Supra-C is often used in keysafes and has a cylindrical key with internally milled bittings that depress the wafers. These locks are often made or cast with soft metals and are easily drilled.

Bricard

(F) XBD1 7-disc tumbler, 3-sided key (4)

The key has a "T" profile with 7-8 bittings along each of the 3 sides. The neck of the key has a smaller diameter than the blades. The plug consists of a stack of 7 preformed circular plastic inserts inside

a fixed brass barrel. Each insert houses a disc wafer that is ball-driven by the key. The assembly of barrel and plug is mounted inside a fixed shell that is plated to resist drilling. The keyway is such that the key blades are obscured by the shell when the key is turned, and this makes picking/tensioning difficult. Each wafer disc can have any one of 3 possible orientations, corresponding to the key blade which will displace it. There are several different sizes of cut. Mastering is accomplished by using extra bitting cuts, with 7 being the minimum and 21 the maximum number in total. The wafers may have "V" notches, similar to the anti-picking notches in conventional wafer-tumbler locks, which catch the bevelled edge of the barrel if incorrectly aligned, thwarting a picking attempt.

Bricard Bloctout

(F) BD100 14-wafer tumbler, 2-bladed key (3)

Essentially a wafer-tumbler lock with closely-spaced, free-sliding wafers. The key consists of two blades pressed together, the bittings are staggered and have constant width. The wafers are arranged in 7 pairs and have a constant height cut on one inside face and a larger cut on the other which bypasses one blade of the key. In each pair, one wafer is straddled by the left and one by the right side of the key blade. The last few wafers are sprung so that they stay put when the key is removed, the other wafers being loose in their chambers. Picking is difficult since there is less tactile feedback than in a lock with sprung wafers.

(See American.)

Central

(F) 7-pin pump, 8-fin key (4)
FTH (F)
JPM 505 (F) 5JM1 5-pin pump, 6-fin key (4)
Pollux (F) 5PX1

These locks all have pump-type keys with a cylindrical central stem and several radial fins. Bittings are milled into the end of the fins, and these depress the pump pins to the appropriate depth. One fin has a larger width/diameter than the others and this is what provides turning tension and locates the key in the keyway. The pump pins are constrained to slide in a channel under spring action. The pins are slotted around their circumference in such a way that, when correctly depressed, the slot aligns with a blocking plate fixed in the body of the lock. When all slots are so aligned, the plug can rotate. False depth slots are provided to hinder picking. As in Bricard locks etc., the keyway is such that the the larger fin or bit is obscured by the shell of the lock when the key is turned, making tensioning by external means difficult. So, unlike common tubular locks (GEM, etc), the pins do not remain accessible as the core of the lock rotates. Presumably some picking tool exists for this kind of lock, but the presence of incorrect notches in the pins would make picking considerably harder. Central locks have an armoured collar that surrounds the cylinder and prevents it from being sawed off.

(See Bramah.)

Chubb

(UK) CHC 5-lever, single-bitted (3-4)

The original lever lock, traceable to inventions by Barron and Chubb (late 18th century) seeking to make the warded-key lock more secure. Key bittings raise the 5 (or more) levers or detainers to the correct height and drive the bolt stump through the gate. Gates and stump have mating "V" grooves to hinder picking. A "curtain" or rotating sleeve restricts access to the interior of the lock and makes tensioning/picking difficult. Mastering is accomplished by widening the lever gatings, at the expense of some security. Hardened steel plates resist drilling of the casing. The bolt has hardened roller inserts to prevent sawing. The lock can be picked (or rather decoded) using a special jig or it may be impressioned. Picking with standard lever picks is difficult when notched gatings are present. May also feature a "detector" lever which jams all the levers when over-raised.

There is an interesting episode in the history of the lever lock, concerning a convict reputed to be the best lock picker in England. The UK crown had offered a reward to anyone who could design an unpickable lock. In 1818 J. Chubb designed the detector lever lock. The convict was given a full set of picking tools and offered a free pardon should he succeed. He finally gave up in desperation after three months and served out his jail term.

Chubb AVA

(UK) ACH 10-lever, double-bitted (4-5)

The AVA lock comprises a cylindrical shell (c.f. Abloy) which is slotted down two sides and housed in the cylinder body. The levers are roughly circular with two rectangular protrusions, and hole in the centre for the keyway. Levers are stacked 10 high in the shell and can slide transversally. The shell is sprung from below, pressing the levers up and against the body of the lock, and retained by a cover with a concealed C clip. The levers are not sprung. The key has a cylindrical stem with a narrow double bit that extends most of the length of the stem. The keyway cover is fixed, creating a ward that traps the key as it is turned. This makes it difficult to tension the levers in the case of picking. Bittings have a constant width from one side to the other but vary in offset. The respective bittings displace the levers either to the left or right as the key is turned. When all 10 levers have been fully retracted into the shell, it is free to rotate, thus releasing the locking balls (in a padlock) or driving a cam (in a latch). Each lever has notches that will jam against the sides of the slots in the shell if not correctly retracted.

Code

(?) 6-pin pump, ribbed key(2)

Code padlocks and cylinder locks have a rectangular keyway with 3 channels milled on each long side. Pump pins are arranged in the channels and depressed by the corresponding slats on the key. When each pump pin is aligned at the correct depth, they clear the locking ring and allow the plug to turn in the cylinder. Unlike radially symmetric pump pin locks, the Code lock has no fixed covering on the keyway so that the pins are always exposed. This renders the lock more susceptible to picking.

(See Couillet, Vachette.)

Codem

(F) 5-pin-tumbler, H-profile key (2)

The codem lock cylinder is a standard size euro-profile cylinder with an H-shaped keyway. There are 5 conventional pin-tumblers in one line along one side of the H. Keyway access is restricted as compared with standard pin-tumbler locks. The key is symmetric and can be inserted either way round.

Corbin Emhart

(US) CB20 6 pin-tumbler, flat key with angled bittings (5)

An ingenious pin-tumbler lock using 6 specially constructed, rotating-interlocking upper and lower pins. The driver pins are cut to form a "T" at the bottom which mates snugly with a T-shaped gap in the top of the lower pin. The active end of the lower pins are V-shaped with the axis of the "V" aligned at one of number of possible angles with respect to the "T" cut at the top. The base of the T-shaped cut in the lower pins must be raised to the shear line and also rotated to the correct angle by the angled bittings in the key so that they can disengage from the driver pins. Since the top of the T-section protrudes past the shear line, grooves must be milled in the circumference of the plug to allow clearance for the pins. In addition, the bottom edge of the key must have crenellations so that it will not be obstructed by the driver pins as it turns through 180 degrees. The plug also contains hardened rods and a drill-resistant crescent to hamper drilling of the cylinder.

For further details refer to chapter 9 of Roper.

Couillet

(F) CU401 6 lever pump, end-bitted flat key (3)
Vachette VAC 45 (F) 6 lever pump

These locks are mainly found in padlocks and use a flat, end-bitted key to depress levers located at the bottom of a rectangular keyway. All 6 levers must be depressed simultaneously the correct amount in order to open the shackle. No turning is required.

(See Code Locks.)

Deny

(F) 5DY1 warded 3 lever, symmetric double-bitted (2-3)

The Deny lever lock is a very unusual lock. The core of the lock is fixed and is constructed with a stack of pressed steel laminations. The laminations are cut away in places to leave room for 3 levers

mounted on rods. Other laminations form the intricate internal warding of the cylinder. The key is symmetric and double-bitted, with as many as a dozen cuts in each side. The only active parts of the key are those that contact a lever inside the core. These bits must be sufficiently long to actuate the levers, which occurs in a particular sequence due to the positioning of the rods around the core. The rods pass through the back part of the core to a chamber whose entry is blocked by a movable cover. The cover is held fast by two interlocking latches fixed to the rods, with the last rod arranged to rotate the cover once the latches have been displaced by turning the key through 90 degrees. With the cover rotated by a first 90 degree turn of the key, the key is in a position to slide through the gate and into the chamber. The stem of the key must then be long enough to enable the bit to engage a locking cam at the rear of the cylinder, which is slotted so that the key will turn it once introduced. The difficulty in opening a lock such as this is in locating the active parts, *i.e.*, the levers, and operating them in sequence to access the gate. The lock may be defeated by impressioning, and a fair portion of the warding is visible in the keyway.

DOM IX

(D) DM22 10 pin-tumbler, horizontal keyway (4-5)
Spider (IL) SPR1
Tesa (E) TE4
Yard-Yardeni (IL) YD3R

The DOM IX lock is recognisable by its horizontal keyway. There are two rows of five pins which protrude vertically into the keyway. The two rows of pins are staggered. The plug and barrel can contain up to 5 hardened roller inserts and a ball to protect against drilling. Often the active end of the lower pins is cut away on both sides, leaving only a thin wedge which is operated by indentations in the key blade. The lower pins come in 5 different lengths, so that the number of key differs is nominally 9.7×10^6, not counting profiling options. Driver pins are tear-drop in cross section (so they cannot rotate in the pin chambers) and come in several styles including hardened pin cores, spool drivers and even special stacked-spool drivers of multi-disc construction that can skew at several different shear lines and block the plug.

DOM IX-10 cylinders have up to 10 profile control pins in addition to the 10 pin-tumbler pairs. These are arranged as 5 vertical and 5 lateral control pins. Lateral control pins act on one edge of the key blade and the key must have corresponding dimple cuts to allow the pins room to retract and clear the shear line as the plug is turned. Vertical control pins act in the centre of the underside of the key. The key is symmetric and 3 of its 4 sides are active simultaneously when it is inserted. In addition the keyway has many variations in the warding to control keyway access. The profile pins do not increase the lock's resistance to picking, they are an adjunct to the fixed keyway warding.

The DOM IX-5 cylinder uses a single row of 5 pin-tumblers plus up to 10 vertical/lateral profile control pins. In the space formerly occupied by the second row of pin-tumblers bittings, there is a longitudinal channel in the key with a hole bored through the blade between the 4th and 5th pin positions. A steel ball is mounted in this hole and is free to move a limited distance either side of the key blade. The plug contains a fixed pin or ward (the ball-deflection pin) which slots into the corresponding channel of the key as it is inserted. Behind this fixed pin is a movable blocking pin that must be raised to enable plug rotation. The keyway in the vicinity of the blocking pin is

enlarged slightly to form a ball-deflection chamber. The ball in the key blade is able to manoeuvre under the first fixed pin (and into the ball-deflection chamber) and reposition itself in the channel so as to raise the blocking pin. The mode of operation is similar to what happens when a feeler pick is used to raise a single pin. Clearly a fixed-blade key cannot change its width to mimic this effect.

DOM even makes a split-bladed key for safety deposit boxes, requiring both halves of the key to be inserted to open the lock. All said, this is a very nice lock design.

EVVA GPI

(A) EV9 5 pin-tumbler, security keyway (3-4)
ASSA (SW) ASS4 7-pin
Best (US) BES1 6-pin (removable core)
Cisa (I) CS17 5-pin
DOM S (D) DM65-00 6-pin
Russwin (US) RW11 6-pin
Sargent (US) SAR3 6-pin
Teka (SW) TK3 6-pin
Tok-Winkhaus (D) TO18 5-pin
Vachette (F) VAC48 5-pin
Wilka (D) WK50R 5-pin
Yale (D,UK,US,I) 5 - 7-pin
Zeiss Ikon (D) ZE11 6-pin

Although these are essentially conventional pin-tumbler locks (based on the Yale lock of the mid 1800s), they incorporate some serious security features. These include very severe keyway warding that makes the insertion of normal lockpicks very difficult; hardened inserts in plug and cylinder body, mushroom drivers; and up to 7 pins. Access control is achieved using high precision multiple side wards.

The DOM S 5-pin profile cylinder, for example, uses torpedo-shaped (tapered) anti-picking lower pins as well as stacked-disc spool drivers. These drivers consist of a casing pin that houses 4 independent discs. Each of these can jam across the shear line in the same way as an ordinary spool driver. There are a total of 1024 profile variations on the keyway, allowing a very high level of mastering and access control.

Ezcurra

(E) 5EZ1 lever, double-bitted (3-4)
Elzett (H) 7308E
Kromer (D) 10-lever, double-bitted
Mottura (I) MT
MultiFort (F) 6-lever, double locking
Nova Acytra (Arg) 6-lever, double locking

Key bittings have constant width measured across both bits. Lock has 4 or more alternating sprung lever plates each with a gate at a certain height. In locks that may be opened from either side of door, the centre bitting operates the bolt. The lock has 4 or more alternating levers with the centre bitting operating the bolt.

Fac

(E) FAC1R 5 + 5 pin-tumbler, single sided (3)

Like two standard pin-tumbler locks set end to end. The key is single-sided and has space for 10 bittings.

Fichet "sans souci"

(F) 6FT12 10-lever, two bit key (4-5)

The first time I saw a key for one of these locks, I thought it was a joke. The key has two separate bittings, each like a conventional 5-lever (Chubb) key, which have a combined length of about 4cm. You're doing well if you can fit the key in your pocket. The bittings are mirror images, so that the key may be used from either side of the lock. I imagine that the lock consists of two 5-lever locks, set one behind the other, that are opened simultaneously by the two key bittings. I'm not sure if the two parts of the lock are independent. By the way "sans souci" is French for "no worries".

Fichet

(F) 5FT1 6-lever, double-bitted (3-4)

The lock has 6 or more crescent-shaped (horse shoe) levers mounted on a rotor that form a system of interlocking cams. The levers are sprung at one end and arranged in two stacks. Each lever can pivot about its midpoint and interlocks with the lever that opposes it. The key is double-bitted, non-symmetric and has constant width bittings. The end of the key bit actuates the bolt. Under-lifting a lever causes it to block against one of two stumps in the lock housing. Over-lifting causes the horse-shoe arms of the opposing levers to jam, preventing the key from turning further. The correct key withdraws all the levers, such that they clear the two stumps and allow the plug assembly to turn.

Fichet

(F) FT500 10-wafer twin side-bar, H-profile key (4-5)

The plug has 2 rows of 5 alternately sprung discs that counter-rotate when they are ball-driven by the key. Notches in the discs when aligned permit retraction of the twin side-bars and rotation of plug within cylinder. Anti-drill balls may be installed at vertex of the keyway and on the side-bar ends. False-depth notches on the wafers hamper picking. If you want a look at one of these, try

the local French Embassy. Unfortunately, these interesting locks seem to be obsolete now, like many locks that do not conform to the popular euro-profile dimensions, or are otherwise not easily adapted.

(See Fichet Surfinor.)

Fichet Surfinor

(F) FT4 7-wafer side-bar, M-profile key (4)

Similar principle of operation to the Fichet FT500. The key is double-sided and has an M-shaped profile. Viewing the key with the "M" lying on its left side, *viz.* Σ, there are 4 cuts on the lower edge and 3 cuts on the top edge. The plug holds 7 wafers, each with a large centre cut-out that can move in a vertical plane and are alternately sprung (4 from below and 3 from above). Along the left hand edge of the plug there are two channels. Each of these contains a long strip, of which one is fixed and the other movable. The movable strip is sprung out from the plug. Two saddle pieces are arranged on the ends of the strips, and a side-bar rod is balanced in the central notch of each saddle. The left edge of each wafer is notched, and when all 7 notches are correctly aligned by the key, the movable strip retracts into the channel as the side-bar is forced from its groove in the side of the barrel. Some of the wafers may have false-depth notches to inhibit picking.

Fichet-Bauche

(F) radial pin-tumbler, 8-fin key (3)

A radial pin-tumbler lock with 8 pins arranged in two rings of four pins. The keyway has the shape of an 8-pointed star, and the key has 8 corresponding fins arranged on a circular stem that tapers to a point at the end. One key fin is wider than the others and this is used to locate the key correctly in the lock. Each channel of the keyway contains a ball-driven radial pin-tumbler pair that must be depressed the correct amount to allow the plug to rotate. The plug and barrel are covered by a fixed shell that only allows the key to be inserted and retracted in one position. This also increases the difficulty of tensioning the plug during picking.

Fichet 5000

(F) 10 lever pump, end-bitted (5)
Fichet-Bauche (F) 6 lever pump, end-bitted (4-5)
ISEO (I) 5IE5 lever pump, end-bitted/E-profile keyway (4-5)
Mottura (I) MT2 lever pump, end-bitted/flat key (4-5)

The Fichet 5000 is the successor to the Fichet FT500 and may be found adorning the doors of expensive Paris apartments. The key stem is butt-joined onto the bit which has 10 lever cuts on each side. The plug is protected by a fixed cover which conceals the bit when the key is turned.

The Fichet-Bauche 6-lever pump lock is sometimes used in safes. The key is bit is butt-joined to the stem, but is slightly off centre, so the key may only be inserted one way. The end of the key has 6 cuts at a 45 degree angle to varying depths. The lock mechanism is mounted inside a domed

housing, with a long barrel that extends to the front of the lock and forms a protective cover over for the keyway. The key bit depresses a set of parallel bars that extend down the barrel to the rear of the lock. Each bar operates a rocker arm whose other end is semi-circular and contains a notch. When all the notches are aligned, the bolt stump moves under spring action into the groove in the rockers. The bolt will then clear the housing and allows the plug assembly to turn. As in Fichet FT500 locks, the locking dog that drives the cam is in a retracted position until the key is inserted. There may be false depth notches in the rockers which jam the bolt stump.

Mottura (MT2), Fichet (FT7), ISEO (5IE5), YALE (5YA1), Autori, Megablock etc. all have end-bitted keys and are similar to Fichet-Bauche except that the bitting cuts are perpendicular to the blade rather than at an angle.

(See J. J. Muel.)

Head

(RC) HEA1R 5-pin + 4 profile pin, flat key (2)

As well as the usual row of 5 pin-tumblers at the top of the keyway, an additional 4 profile pins project into the keyway from the right hand side. The key is single sided with bittings in the top of the blade and dimples in one side that address the profile pins. Despite the presence of side pins, the lock is not difficult to pick due to the poor quality of construction.

Helason

(A) 5HS2 4-sided pin-tumbler, round key (4)
YBU (J) 10-pin radial, tubular (3)
Prefer (I) PF10TP

The Helason cylinder lock has 4 rows of 4 pins (16 in total) arranged symmetrically in a cylindrical keyway. The keyway has a shallow notch to guide a locating fin in the key. The key itself is round and has 4 rows of flat-bottomed V-cuts in the stem. Each ring of four pins is at the same depth and fills the small keyway, so there is little room for a lockpick.

The YBU lock is used on security shutters and has a symmetric key that can be inserted from either side of the lock. There are 5 rows of 2 pins arranged radially around the keyway. The key is tubular with dimples cut in 5 rows of 4 (only 10 of which are active when opening the lock). A small recess in the end of the key accepts a stud protruding into the keyway that is used to turn the plug.

Ingersoll

(UK) ING1 10-lever, double-sided (4-5)

Ingersoll "impregnable" locks have a W-shaped keyway flanked by what appear to be ordinary wafer tumblers. The key is double-sided with non-symmetric cuts that are staggered from top to bottom. The wafers drive semi-circular levers arranged around the plug. Each of the ten wafers must be raised

so that the levers are flush with the plug, allowing it to turn. The rotation of the plug is heavily damped, so that very little vibration feeds back to the picker while tensioning the lock. Ingersoll padlocks are extremely large and rugged, with a suitably thick, ball-locking shackle.

A local locksmith once told me that an expert lock picker took 3 hours to pick one of these during a professional demonstration.

Kaba Quattro

(CH) KA1 22 pin-tumblers in 4 rows, dimple key (3-4)
Kaba Gemini (CH) KA5 14 pin-tumblers in 3 rows, dimple key (3-4)
Keso 2000 (CH) KE1
Efco Kaba (AUS) KA1
Lips (NL) LP11
Sargent (US) KE4
JPM 2002 2x5 pin-tumbler
Showa X-Key 2x5 pin-tumbler (3)
Vachette Radial Si (F) VAC91 (3-4)

The Kaba series of locks are pin-tumbler locks with between 2 and 4 rows of pins protruding about half a key width into the keyway. Concentrating on the Kaba Quattro, this has 4 rows of pins arranged in an "X" around the top part of the keyway. Vachette Radial is similar, but the rows of pins are clustered around the top right hand side of the keyway, spanning an angle of about 130 degrees, and the pins are smaller in diameter. The key is reversible, so that it can be inserted either way round to operate the lock, and is covered with small depressions called "dimples". Counting anti-clockwise from the bottom right row, there are 5, 6, 5, 6 pins per row, totalling 22. Lower pins come in 5 different lengths (from 0.126" to 0.182" in increments of 0.014") and are flanged at the top end so that they cannot fall into the keyway. The pins are extremely short and made of stainless steel. Since the overall diameter of the barrel is comparable to the standard profile cylinder, there's not much room for drivers and springs. For this reason, the drivers are hollow caps with an internal spring. Some of the lower pins may be spooled to render the already delicate job of picking more difficult.

The pins, drivers and springs are inserted into the core and then covered by a thin metal retaining sleeve. Kaba Gemini has three rows of pins: one at the top of the keyway and two opposing rows further down. The Japanese X-lock has only two opposing rows of 5 pins.

The keyway is basically rectangular, with perhaps a couple of shallow side wards. Mastering is accomplished by replacing some of the lower pins by blank tumblers that are at the shear line and so do not need to be lifted (in fact they do not extend into the keyway at all). This compromises slightly the security of the lock by reducing the number of active pins.

These locks can be picked using special tools, but very light tension is required so that pins do not bind at the wrong height. Once picked, care must be taken not to allow some of the driver pins to spring into the keyway when the plug is turned through 180 degrees.

Laperche

(F) 5LH1 5 wafer pump, round-stem key (4)
Progres Fontaine (F) 5PE5 5 wafer pump (4)
Vigie Picard (F) 5VP3 5 wafer pump (4)

These locks are all loosely based on the Bramah lock. The key bittings are milled into the end of the key stem, with adjacent cuts overlapping somewhat, such that at least some part of the stem is left to actuate the wafers. Turning tension is provided by a bit or fin in the key. The pump pins or wafers are constrained to slide in a channel and must be depressed to the appropriate depths to allow the plug to rotate. As in Bricard, Chubb AVA locks etc., the keyway is such that the bit is obscured by the shell of the lock when the key is turned, making tensioning by external means difficult. Vigie Picard locks have additional wards formed by two balls that jut into the keyway from either side. These also keep the key and pump wafers at the correct depth as the plug is turned.

LCA

(US) 8 torsion-tumbler, flat key (2)

LCA (Lock Corporation of America) locks use a double-sided flat key to operate 8 torsion-tumblers. The tumblers are unconventional in that they are housed in a cylindrical shell and have a semi-circular edge which acts as a spring as it compresses against the shell. The wafers resemble schlage wafer-tumblers in shape, except that they are not sprung. The wafers have a protrusion which normally blocks the rotation of the plug. The correct key retracts all 8 wafers into the plug which is then free to turn. LCA also make conventional flat-key lever locks, as commonly used in lockers.

Lockwood V7

(Aus) 7-pin cylinder, alternately sloped bittings (2-3)

Like its name, the V7 has a 7 pin-tumbler cylinder. Pins are arranged on alternate sides of a "V" along the top of the keyway. The key has 4 bittings on a 30 degree slope to the right and 3 on the reverse slope to the left. Warding makes keyway access to picks difficult as well as the negotiating of the "V" groove.

Medeco Biaxial

(US) 6 - 7 pin-tumbler + side-bar, angled bittings (4-5)
Medeco (US) 4-pin side-bar, angled bittings (4-5)

Medeco locks come in two basic flavours. The bi-axial, which uses 6-7 upper and lower pins and a side-bar, and a smaller-bodied version using only 4 lower pins and a side-bar. Both versions have a UL rating. Externally, Medeco cylinders look like ordinary pin-tumbler cylinders, except for the V-shaped bottoms on the lower pins. Both types are high security locks, utilising hardened inserts (ball, crescents and rollers) to resist drilling.

The 6-pin Medeco uses slotted lower pins, spooled drivers, optional mastering pins, and a 6-bar side-bar. The pins must simultaneously be raised to the shear line and rotated (to one of three or more angles) in order to engage the side-bar. Lower pins have a fin which limits the range of rotation within the pin chamber. The slots in the lower pins are sometimes visible in the keyway, allowing limited reading of the lock.

For further details refer to chapter 8 of Roper.

The 4-pin Medeco is like the larger 6-pin version without the driver pins. Instead, pins are sprung directly from within the plug, which has a retaining clip covering the pin chambers. Pins are limited in their angle of rotation, and have one or more holes machined radially into the side. For each pin, the hole in the pin must be raised and rotated the correct amount to align with the corresponding side-bar extrusion (or fence). Once all pins are correctly lifted and oriented, the side-bar is forced into the plug (against spring action) as the key is turned. The principle of operation is similar to that of the BiLock. False depth holes in the pins, or grooved pins, cause the side-bar posts to stick, effectively locking up the mechanism and rendering picking extremely difficult.

Miwa

(J) MIW1 10 wafer-tumbler, flat double-sided (1-2)
Schlage (US) SH1 wafer-tumbler, flat double-sided (1)

Schlage wafer locks have 8 semicircular wafers arranged linearly in a tubular shell in the barrel of the lock. The wafers protrude above or below the rim of the shell and must be simultaneously retracted by the double-sided key (which is flat apart from a central gutter) in order for the plug to turn. Miwa locks can house up to 10 wafer-tumblers and are precisely machined. Some wafers have a reduced width end that hampers picking since it will not contact the barrel at the same time as the other wafers when tension is applied.

J. J. Muel

(F) M1 1-7 lever pump, end-bitted (4-5)
Vak "Genius" (F) M7-1 10-lever pump, end-bitted key + chip (5)

The Muel "incrochetable" (French for "unpickable") lock has a rectangular keyway concealing a row of between 6 and 10 pump-type levers. These are placed like teeth across the width of the keyway. Each lever is flat at the rear end with a deep notch to accommodate the bolt stump. The levers are pivoted see-saw style across the square plug, with a their smoothly curved, active end and sprung from below. The key is end bitted with cuts at a 45 degree angle to the blade to pick up the curved end of the levers. The key blade is not reduced at the neck (unlike Fichet-Bauche end-bitted keys). Key cuts can be on either side, to suit the orientation of the levers, which are reversible. Additionally, a pitted cut in the key accepts a single scoop-type lever which would be over-raised by a normal angled bitting. The cut for the scoop lever requires a special machine to cut it, and thus keys are supplied by the dealer with this cut already in place (*i.e.*, a dealer perm). The end bittings of the key raise the levers as the key is inserted. A side bit on the key limits the insertion

depth, at which point the levers should be in the desired configuration. Further force pushes the plug assembly toward the bolt stump, against a very strong spring. The side bit in the key keeps the plug pushed in while it is turned. Small jags on either side of the notch (like those in a Chubb lock) will trap a mating V-notch in the bolt stump if the levers are not correctly aligned. The amount of force required to keep the plug at the depth where it meets the bolt stump, together with the anti-pick notches, makes picking this lock very hard. The French claim it is unpickable.

The VAK "Genius" is a 10-lever pump Muel cylinder with a microchip in the key stem. A set of pads on the key make an electrical connection when the key is inserted, and the information burnt into the chip is then read electronically by lock (like the smart cards used in public telephones). In my opinion, this one is a complete overkill, as the mechanical part of the lock is essentially redundant.

(See Fichet-Bauche.)

Mul-T-Lock

(IL) MTK1 10 pin-tumbler (concentric), horizontal keyway (4-5)

The Mul-T-Lock, like the DOM IX, has a horizontal keyway. There is a single vertical row of what look like five fat pins located close to the right hand edge of the keyway. These are actually concentric (or coaxial) pin pairs which function totally independently, bringing the pin tally to 10. The key is symmetric and can be used both ways round. There may be longitudinal wards flanking the pins on each side, making it hard to manipulate the pins. Each pin pair consists of an inner pin with its own (mushroom) driver and spring operating inside a hollow outer pin. The outer driver is capped at the top to house the inner pin spring and may also be spooled. The spooled drivers make the lock extremely hard to pick, as keyway access is already limited. As is the norm in high security locks, the front of the plug and cylinder contain hardened steel rollers to defeat direct drilling. The key is especially hard to duplicate since some of the inner pins may have to be raised above the level needed by the outer pins. This creates a bump in the centre of the main flat-bottomed cut for the outer pin that requires a special machine to cut the key. The lock is susceptible to front shimming if the lip of the plug is ground down.

Rivers

(UK) 6 pin-tumbler, extended-stem (2-3)
Wally (I) KK1 9-pin, extended-stem (3-4)

Rivers locks usually have a dummy key-in-knob at the front which is free to turn. The key is unusually long and must be inserted past the handle part to reach the pins at the rear of the lock. There are typically 6 pins in the cylinder, which is geared to retract heavy bolts set in channels at the back of the door. When the correct key is inserted, it links the handle to the plug and enables the bolts to be withdrawn by turning the handle. The active part of the lock can be reached with sufficiently long picks and tensioner.

Schlage Primus

(US) 6-pin + side-bar, dealer perm key (4-5)

A standard schlage 6-pin cylinder supplemented by a row of 5 profile pins on one side of the key blade. The indentations in the side of the key are grooved to depress and rotate the pins to allow side-bar posts to slot in. The vertical pins must of course be at the shear line at the same time as the side-bar is retracted.

A description of a Schlage Primus cylinder was posted in article 2686 (Date: 19 Nov 1993 17:24:03 EST) of alt.locksmithing by "Hobbit" (e-mail: hobbit@babyoil.ftp.com).

Sea

(CH) SEB1 bar-tumbler, 4 track key (3-4)
Hasler (D)
Bell (US) 2-track key (3-4)
Vachette (F) VAC41 1-track key (3)

Sea locks contains 6 or more alternating bar-tumblers (like a wafer-tumbler cut lengthways in two) arranged on both left and right sides of the keyway. The bars are sprung either from above or below and have a peg that protrudes to about 1/3 of the width of the keyway. The key is a 4-track type with two milled grooves in each side of the blade. The grooves diverge at the end of the track so as to pick up the pegs as the key is inserted. The pegs are lowered or raised by the track and all must be aligned with the rim of the plug to allow it to rotate.

Bell locks have two tracks, and Vachette (VAC41) a single track. Both of these operate in the same way as the Sea lock. The bars do not actually need to be sprung, as they are constrained by the track in the key. A special pick is required for these locks.

Tok-Winkhaus

(D) TO11 5 + 5-pin, dealer perm (3-4)
Vachette 2000 (F) RO41 5 + 5-pin, dealer perm (3)

Winkhaus and Vachette locks look deceptively like conventional pin-tumbler cylinders. However, in addition to the severe warding on the keyway, there are 5 cleverly concealed profile control pins (dealer perm). In Vachette locks, there are 2 conrol pins on the lower left and 3 on the lower right side of the keyway, distributed between the 2nd and 5th pin-tumblers (counting from front to back). The profile pins are ball driven and are of a smaller diameter than the main pin-tumblers. The bore for each profile pin is drilled parallel to the conventional pins, but off the main axis of the plug, so that it cuts through the warding into one side of the keyway. A control rod with tapered ends rests atop the ball, and is raised when the profile ball is displaced by the profile notches in the key. The rods must be raised slightly (in varying degrees) to bring the driver pins to the shear line. The off-axis driver pins are cylindrical with flat ends, unlike DOM IX pins which have a curved surface that matches the curvature of the plug.

Since the control rods are not centrally located in the plug, only rods on one side will be active depending on the direction of opening (the other rods will slide under the drivers as the plug is turned, as long as they are not over-raised) - this is a slight aid in picking the lock. Despite this, it is a difficult job picking the profile pins to allow the top pins to be picked - there is very little room to manoeuvre.

Zeiss Ikon

(D) XZ1A 16 pin-tumbler, cruciform key (1-2)
Moreaux (F) XM1
Papaiz (BR) XPZ1
Tuff (HK) XTF3

Moreaux and Zeiss Ikon locks have a cruciform keyway in which there are between 3 and 4 rows of pins (up to 4 pins per row). One of the channels is usually wider than the others and this locates the thicker part of the key blade. The key is bitted on 3 or 4 sides as appropriate. With ordinary pins, these locks are not difficult to pick, although a double-sided tension wrench may be needed. Sometimes these locks are used in safes, in which case the lock is set a long way back and the key has an extended stem.

Zenith

(F) 7-pin tubular, pronged key (2-3)
Izis Arnov 5-pin tubular, pronged key (2)

Basically a glorified ACE/GEM tubular lock. The pins, which are push-type, are flush with the front of the barrel and are depressed by prongs on the key. The turning force is provided by the key prongs themselves, making it hard to tension the lock. In Izis Arnov locks, a hole in the plug, at the centre of the circle formed by the pins, accepts the stem of the key which also has a locating fin to do the tensioning.

Zenith Cavith

(F) 5-pin pump + 3 pin-tumbler (4)

See description for Central locks. The only extra is the presence of 3 standard radial pin-tumblers in the groove occupied by the locating fin of the key. The key has bittings on one fin to fit the side pins while the other fins are cut to depress the pump pins to the correct depths. The radial pins seem to be an unnecessary add-on to an already well-designed lock.

Magnetic/Electronic/Combination Locks

Anker (F) magnetic

Card-Key

Cor Key (US)

Cyphalok

DKS (AUS) 12 magnets per side

Elzett (magnetic) + profile ball

EVVA MCS (A) 4-magnet + control pins (at 3 angles)

GEC Guestkey (UK) 8 binary bittings/side

Lockwood Digital

Maglock

Marlock† (US)

Miwa (J) + profile ball 2x4 magnet

Monoblok (F) + profile ball

NT magnetic cylinder lock (8 per side)

Omnicard (card lock)

Schlage Magnetic entrance set

Simplex†

Vendpass card lock

Ving card†

† A description of these locks has appeared in Hobbit's directory on ftp.com /hobbit/flamage/mine/hotel.lox

Car Locks

Toyota (Lexus, Landcruiser) (c.f. Bell, Sea)

Ford EB (AUS) FO21P (c.f. Abus. Abloy, Chubb SMI)

Ford Tibbe (D) FO19P

Giobert S.A.F.E. (I) GT2

GM Holden VN Commodore (AUS) GM9 HUF YMOS (D) OPEL YM27 inverted 2-sided 10-wafer

Mercedes 2 track (D) HUF YMOS (D) HU39P symmetric bilateral wafer

Mercedes 4 track

BMW (D)

Renault 20TS, Errebi (F), Vachette VAC64S, Neiman NE33S (c.f. Helason) double-sided round-stem key

Porsche HUF symmetric bilateral wafer 45 degree

Neiman (D, F, J, UK, US) NE55 hole in blade, NE20 warded

Unknown

Alke (I) ALK1 (looks like red phone key - lever + pin)

DUO (3-sided wafer)

O. Novox (F) ON1, Decayeux, DAD (F) DD1 precut, square (not tapered) end

MSV (P) MSV1, SOFER (P) SOF1 - centre ward, double blade

Perino (I) PN1, IMSI (PG)

GEM + 5 (US) 7-pin tubular with embedded 5-pin flat key

Monarch shutter (grooved wafer) (like American) MCM, Mondragon MC3

Takigen (J)

Yale (UK) YA101 (mail box)

Other Locks

Pay Phone Locks

Post Office Box

Safety Deposit Box Locks

Safes

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