

Evolution of Abloy (Part 2)

My name is Han Fey and I am a (pad) lock collector from the Netherlands. I like to write and informing people about the workings and techniques used in different high security locking systems.

In my first article about Abloy I discussed the Classic and the (High) profile. In part 2, I intend to go further into the evolution of the Abloy system. With their evolving systems, you will see that Abloy has indeed improved their system in terms of both user interface as well as anti-lock picking security. In this article, I will tell about the techniques that are employed as well as the advantages that are gained from these new techniques. I will discuss the Disklock, Disklock Pro, and Exec.

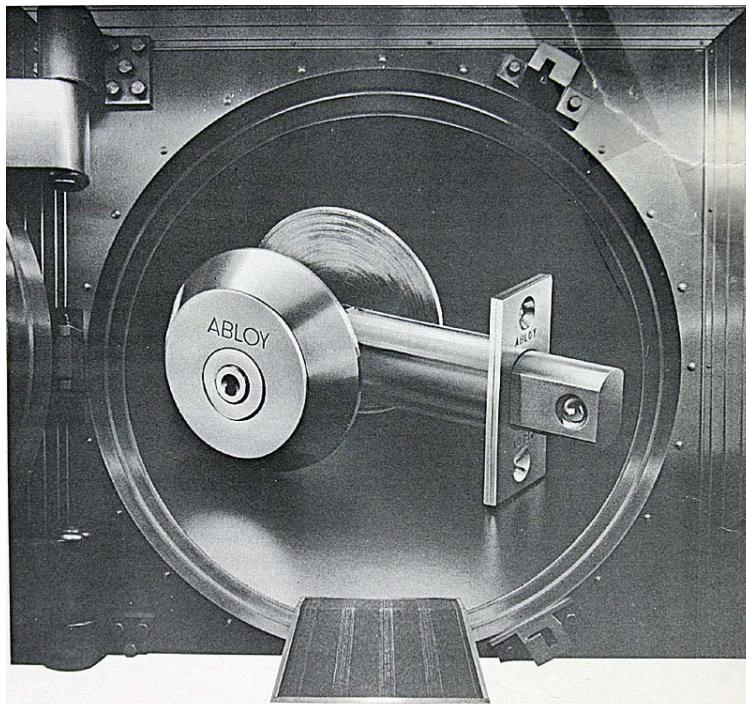
In my upcoming third article, I will discuss Abloy's newest system, the Protec. Because some parts in the Disklock are also used in the Protec, I will explain some of these parts in the Protec part (part 3). In my personal collection, I have about 150 different padlocks made by Abloy. This article is the result of my personal observations with the Abloy locks in my collection. As such, they largely represent my impressions and understandings of this topic. I can therefore not be responsible for the following contents, I however did write this article to the best of my abilities.

Disklock (D)

In 1985 Abloy introduced their first two-way system the Disklock. This means that a key can be rotated clockwise and counterclockwise. This locking system does, like all Abloy systems, not contain pins subject to sticking and/or breaking, rather they employ rotating detainer discs which operate much like the tumblers in a bank vault. Abloy has compared the working of their rotating detainer disk design with the tumblers employed within a bank vault. Hence, this advertisement from the 80's, with the slogan:

“THE ONLY DEADBOLT LOCK THAT WORKS LIKE A BANK VAULT LOCK.”

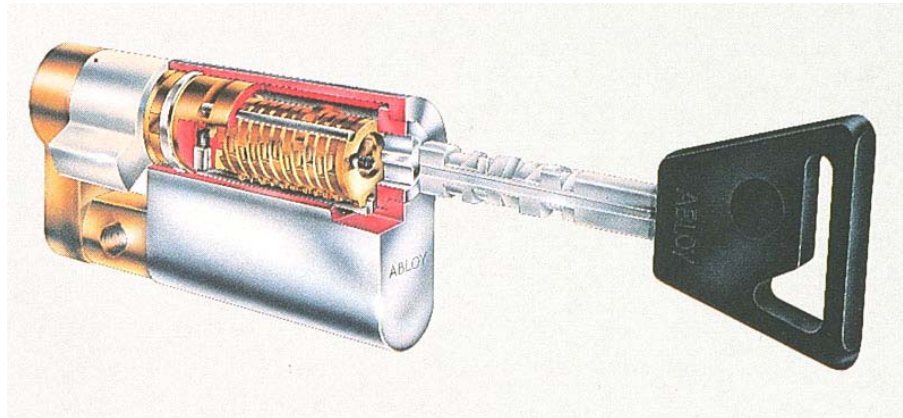
Some manufacturers of high security deadbolts use hardened steel inserts in the cylinder to resist drilling. Abloy claimed that the entire cylinder is made from hardened steel. The shaft of the key is made of nickel silver in order to provide for easy machining, unbeatable corrosion resistance, high torsional, and bend strength.



THE ONLY DEADBOLT LOCK THAT WORKS LIKE A BANK VAULT LOCK.

note: Another slogan from Abloy about the Disklock is:

DISC – COVER The difference



Exploded view Disklock Euro profile cylinder with key

A note about the discs in the Disklock

There are seven different Disklock rotating detainer discs, each corresponding to the differing cuts on a given key. A 0-disc is used wherever a 0-cut exists; a 1-disc is used wherever a 1-cut exists and so on. These discs are not reversible. They must be used with the embossed side facing down. Every 15° there is a gate in the code disc, and so there are 6 different code discs.

The code discs 1 till 5 have two gates: a left gate for clockwise turns and a right gate for counter-clockwise turns. A 6-disc has only one gate since it does not rotate with the corresponding 6-cut key. Disc 0 is used for steering the return bars.

This system has a total of eleven discs. Nine of these are code discs and two of these discs are 0-discs which are used for controlling the return bars. Abloy claims that this lock has 1.900.000.000 combinations.



Numbering different Disklock discs

A note about the washers in the Disklock

There are pick tools and decoding tools in the marketplace that one could stick between two discs. These tools could be used in the older Classic and Profile systems. In the Disklock, Abloy made the washers solid to make it harder to use that kind of tool. These washers, also called spacers, work as a guide posts for the locking bar and hold the discs at the proper spacing.

In cam locks and padlocks, the two-way turn feature is sometimes unnecessary. Therefore, Abloy uses two different washers, the one-way turn washers and the two-way turn washers. These washers are slightly different from each other. On the bottom of the washers you can see the differences. This difference blocks the return bar and prevents it from rotating the cylinder the opposite direction. The one-way washer is reversible and can be used on both sides, depending on the direction you want the cylinder to rotate.



Disklock Two-Way washers (left) and One-Way washer (right).

Disklock security levels

In the 80's Abloy already offered various key control systems to satisfy the security requirements of the end user. They had for the Disklock already the following security levels:

- Dealer restricted

Duplicate keys are provided by authorized Abloy dealerships

- Factory restricted

Total control of key duplication by Abloy, this insured maximum protection

- Market restricted

Duplicate keys are provided by factory authorized facilities, under contractual agreement, providing security services to specific markets.

- Customer restricted

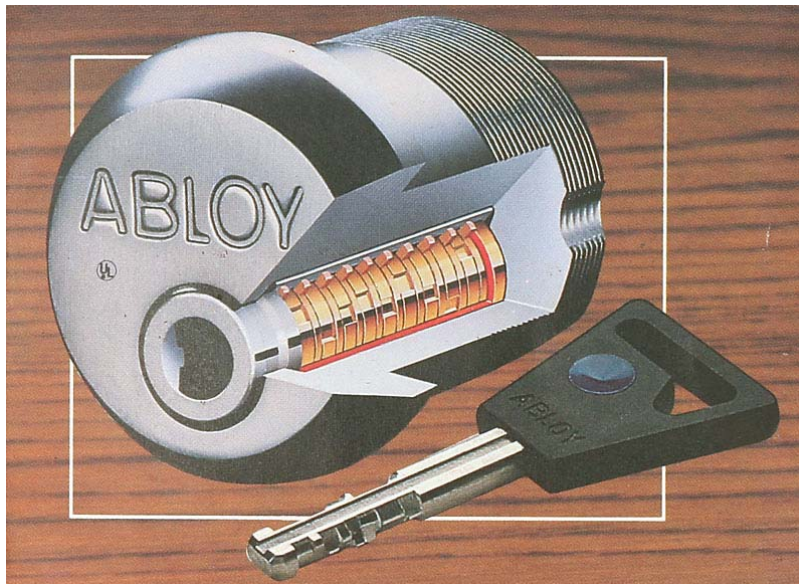
Where applications required, exclusive keyways were available. Duplication of keys can be controlled by Abloy or exclusively by the customer to allow total in house control.

The Disklock system has therefore, several key profiles. There is a profile over the full length of the key, from tip to bow, and with some profiles, there can be an extra groove only on the tip of the key.

Disklock key profiles

The groove over the full length of the key is controlled by the Spinner (the first disc if you look in the lock). The Spinner forms the keyway and resists drilling. On the next picture below, you can clearly see the steel spinner in front of the cylinder.

Within most keycard protected Disklock key profiles there is an extra cut in the tip of the key which has to match with the bottom 0-disc or profiled 0-disc. This profiled 0-disc is the disc in the back of the cylinder.



Abloy Disklock cylinder with steel spinner.

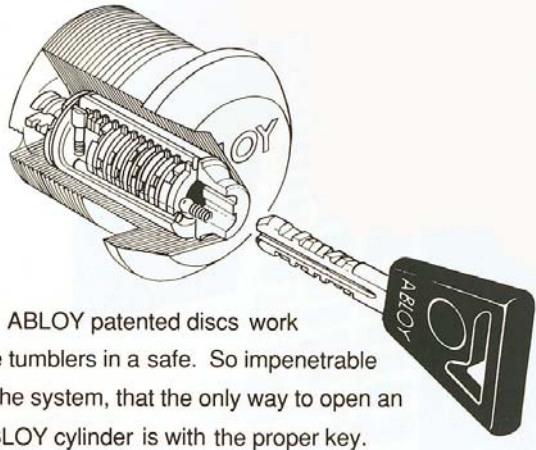
On the picture below some (formerly protected) profiles, I noticed Abloy numbered these profiles starting with JJ*. On the picture you see the standard Disklock profile and the former card protected JJH and a JJK profile (this because the patent has expired). In this picture, you can see that the standard profile only has grooves on the side of the key. The more protected keyways look more exotic and have smaller grooves on the tip of the key in different directions.



Three different Disklock key profiles: Standard, JJH & JJK.

Key Cuts and Key Reading

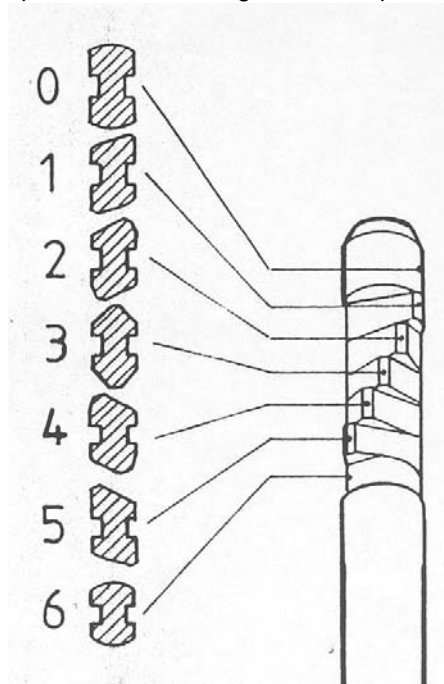
Each Disklock (Pro) cylinder key has an equally numbered and spaced pattern of cuts which correspond to the discs within the matching cylinder. Each spacing on the key can have one of seven cut "depths", actually cut angles, numbered 0 through 6. Theoretically an 11-disc cylinder can have over 1.97 billion possible key combinations. The practical key change possibilities, however, are fewer, because there are only 9 code discs. The other two discs are necessary for steering the return bars.



ABLOY patented discs work like tumblers in a safe. So impenetrable is the system, that the only way to open an ABLOY cylinder is with the proper key.

Disklock Key

There are 10 spaces on the key for cut-angles. Starting from the tip of the key there is an uncut portion (0-cut). A 0-cut is always left uncut, that is, blank. A 6-cut is cut all the way around. The following illustration depicts the various angles and shapes of the key cuts.

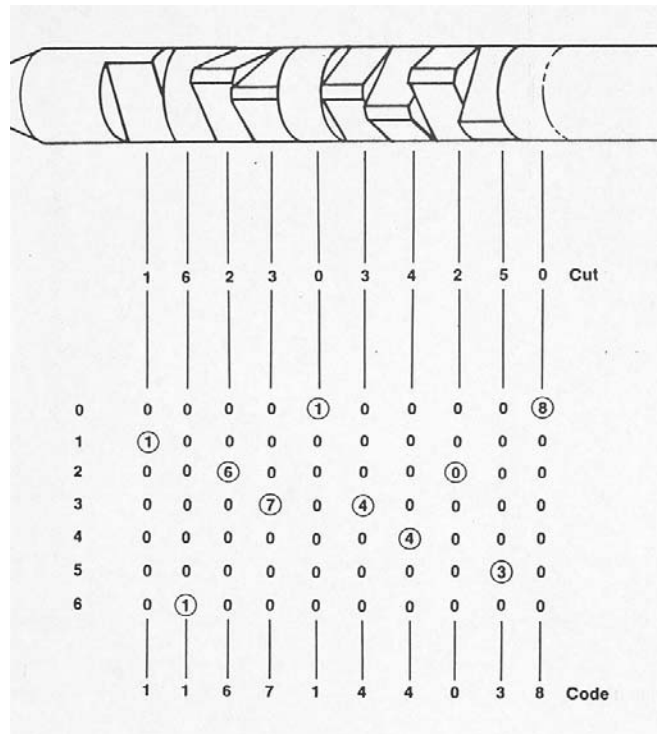


Disklock (Pro) key cuts and key reading

Here you can see the cuts in the key. They start numbering with 0 for the profiled 0-disc, that's no cut in the key. This is also the tip of the key. This 0-cut is not used in the key number.

Key Code Decoding Chart

If you have found the number of the key cuts, you can determine the key number with the Key Code Decoding Chart below. I have removed all irrelevant numbers from the chart below, to show how it should be read.



	1	6	2	3	0	3	4	2	5	0	Cut
0	0	0	0	0	①	0	0	0	0	⑧	
1	①	0	0	0	0	0	0	0	0	0	
2	0	0	⑥	0	0	0	0	⑩	0	0	
3	0	0	0	⑦	0	④	0	0	0	0	
4	0	0	0	0	0	0	④	0	0	0	
5	0	0	0	0	0	0	0	0	③	0	
6	0	①	0	0	0	0	0	0	0	0	
	1	1	6	7	1	4	4	0	3	8	Code

Abloy Disklock key code Decoding Chart

Corresponding charts are available for the Classic and Exec and Protec. This chart also works in the reverse way if you have the key number and you want to know the cuts.

Disklock Shopkeepers Lock

Abloy also designed within the Disklock system what is called the “shopkeepers lock”. The General Manager key can rotate clockwise and counterclockwise (read open and close the lock) and the dot on it’s bow is blue colored and comes with two points.

The second key with the red dot in the bow has one point and can only rotate counterclockwise. The third key with the white dot on the bow can only rotate clockwise. With the counterclockwise key for example a person can only close the lock, and not open the lock. The General Manager can do both.

In my previous Abloy article, I also wrote about this system, but then it was for the High Profile system.

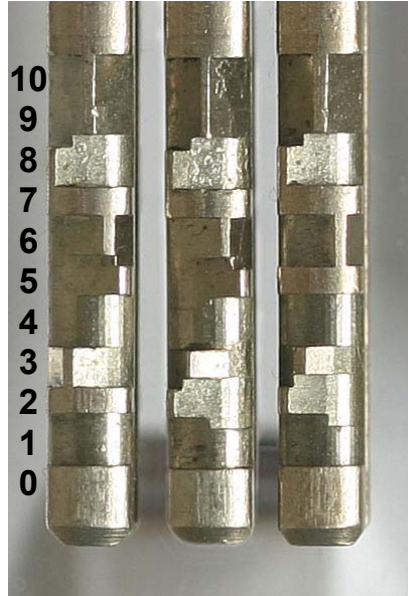
How it Works

The cylinder with all the discs is standard. The only differences are within the key. So from each Disklock system it’s possible to make the shop keeper system without modifying the lock.

The key in the middle is a “normal” key and has only a 0-cut on the tip of the key (position 0) and on key cut position 7. These 0-cuts are fixed because they steer the two return bars which scramble the discs automatically when the key is turned back in the starting position. In Abloy part 3, I will explain the working of these return bars.

It is unique that the one-way keys have an extra 0-cut in the key. The left key (white dot) has a 0-cut on the second key cut position; the other two keys have the normal cut on that position. You can imagine that if you rotate this key clockwise it operates as a normal key. I hope you can imagine that if you rotate this key counterclockwise, the cut in the key behaves as a 0-cut while a 1 cut is required. The cylinder will therefore block. A 0-cut means no cut in the key. The counter clockwise key (red dot) works on the same principal, it's only the other turning direction.

Cut / Disc Position:



Position	Number of Key cut		
	White	Blue	Red
10	3	3	3
9	3	3	3
8	1	1	1
7	0	0	0
6	4	4	4
5	5	5	0
4	6	6	6
3	2	2	2
2	0	1	1
1	6	6	6
0	0	0	0

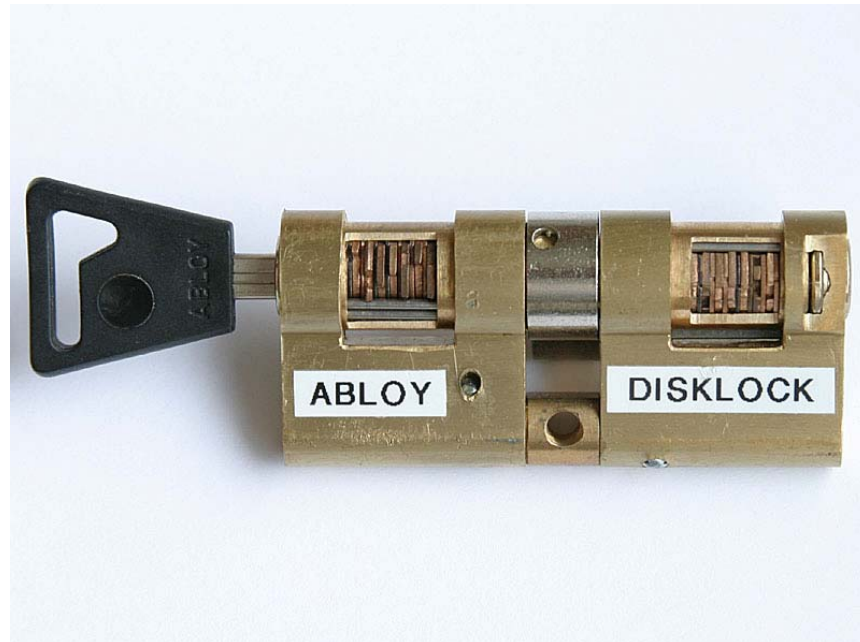
(Counter) clockwise rotation keys (white-blue-red).



Round shopkeepers cutaway

Disklock cutaway

In the cutaway below you can see both return bars on the left side of the cylinder. On the right side you can see only one return bar on the top of the cylinder. This is the locking position of the cylinder. You can also see the free spinning drill protected plate in front of the cylinder called the Spinner. The Disklock cylinder does not contain a Disc Controller Element.



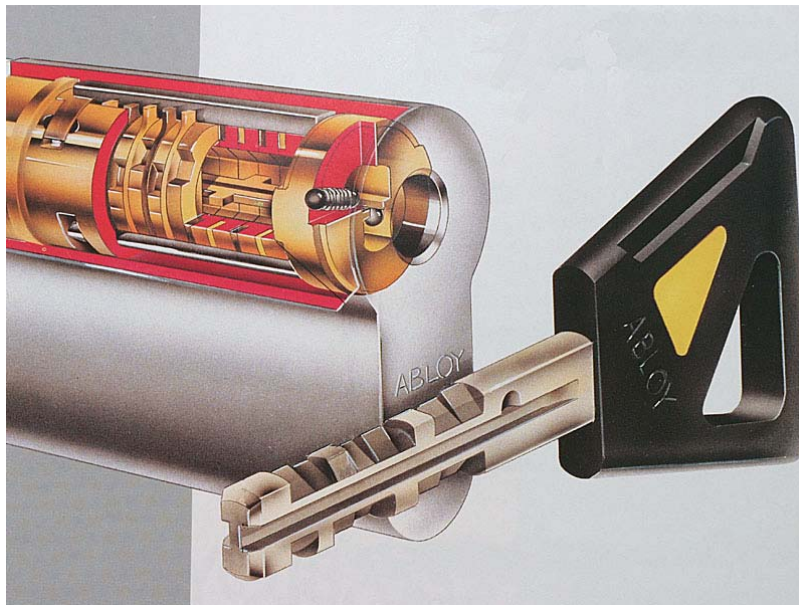
Disklock cutaway profile cylinder

One great disadvantage of the Disklock was the fact that a key could be inserted half way and then rotated 90°. The lock of course did not open in this action, however this action could cause malfunctions of, or damage to, the lock, as it was possible to significantly bend the return bars. This is the reason that Abloy quickly improved this system and came with the Disklock Pro.

Disklock Pro

The Disklock Pro made some improvements on its predecessor system, the Disklock. The most significant improvement was that the key had to be fully inserted before it would turn. This was due to the introduction of the Disc Controller (DC). The DC makes for smoother operation and mandates that the key must be fully inserted before key rotation is possible. In the Protec section (Abloy part 3), I will explain the workings of the DC. Besides the DC, this system also has two return bars (just like in the Disklock) which allow the system to operate in either direction.

You can recognize the differences between these two systems by the bow and the dimple hole in the key. The Disklock Pro has an extra dimple hole on both sides of the key. A ball-bearing is caught in this hole, so the key cannot be removed during a rotation. The Disklock system does not have that dimple hole in the key.



Exploded view Disklock Pro

Note: In padlocks with the Disklock Pro system, there is no Disc Controller, but a Disc Steering System like in the Exec system. In the Exec part, the Disc Steering System will be explained.

A note about the discs in the Disklock Pro

This system has just like the Disklock a total of eleven discs. Nine of these are code discs and two of these discs are 0-discs which are used for controlling the Return bars and the Disc Controller.

These are the 6 different code discs used in a Disklock Pro. As you maybe can see the inside of the disc is not totally square like the discs in the Disklock. There are small rounded cuts on the right and left side in the keyway. In the Protec part which comes later, you will notice that the inside of the Protec disc is totally different in comparison with the Disklock Pro (more rounded cuts).



Code discs (1-6) used in the Disklock Pro

In the picture below you see some Master key discs which I found in my collection. This shows some discs with additional gates for Master keying. Coincidentally, I also put a Protec disc between these discs (right, below).



Some Disklock Master key discs

A note about the washers in the Disklock Pro

Another improvement in the Disklock Pro is the different thickness of washers. Pick tools exist which can rotate, manipulate, or read each disc in the lock exactly, by inserting a pick/decoding tool between two discs. This is of course very precise. By measuring the depth in the cylinder you can exactly determine what your position is in the cylinder. To make it harder to see what your position is in the lock, Abloy uses two different thicknesses of washers. By randomly alternating between thick and thin washers, the distance between the discs varies. You can recognize these washers by color: a copper washer is 0.59 mm thick, whereas a black washer is 0.49 mm thick. These discs are placed randomly and their number is also random.

As these discs could be used in door cylinders with two-way rotation, and padlocks and cam locks with one-way rotation, Abloy had to design four different washers.



Different thickness Disklock Two-Way and One-Way rotation washers

Disklock Pro security levels

In the Disklock Pro system there are three different security levels:

- Gold (Factory level)

Total control of keys by the Abloy OY factory or sales office provides optimum protection. Customer personnel must submit a written authorization to obtain duplicate keys. These are special profiles which are only available from Abloy.

- Silver (Customer Level)

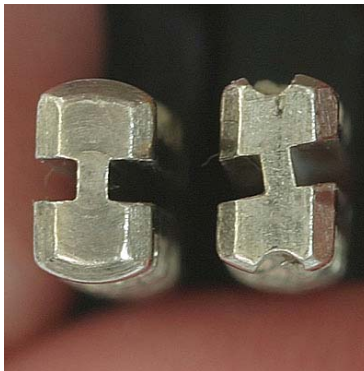
Where applications require, exclusive keyways are available. Duplication of keys can be controlled by the Abloy OY factory or that specific Abloy Disklock Pro Centre.

- Bronze (Authorized level)

Duplicate keys are provided by any Abloy Disklock Pro Centre. However this is a NO CARD – NO KEY system.

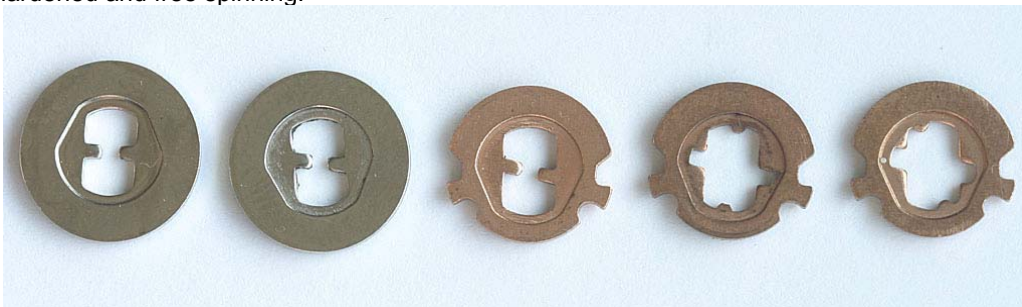
Disklock Pro key profiles

On the picture below, you see some Disklock Pro key profiles. You can see that the right key has an extra groove on the tip of the key. Therefore there are two profile control discs in this cylinder.



Two different Disklock Pro key profiles

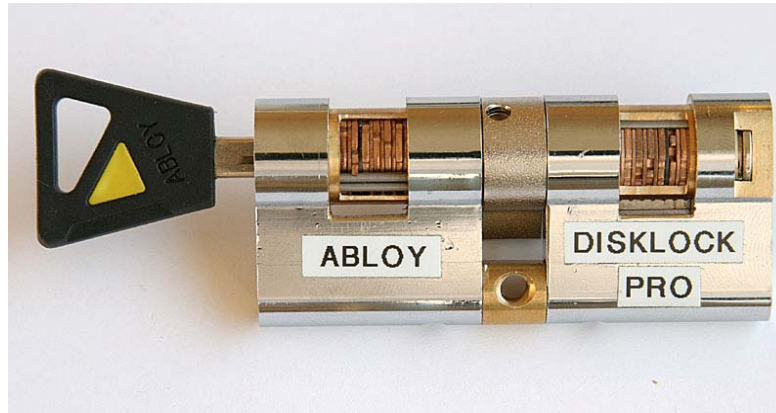
In the picture below you can see some profile plates and bottom-0 discs. The fourth disc from the left, is the disc that matches with the key profile on the right, in the picture before. The steel profile plates are hardened and free spinning.



Some Disklock Pro Profile discs and Control discs

Disklock versus Disklock Pro

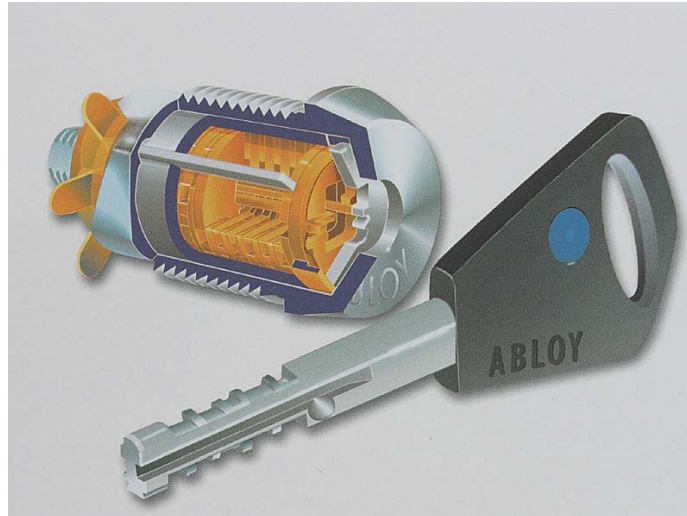
If you compare the two systems, you can say that both systems have nine code discs and two 0-discs (necessary for steering the return bars). Normally these 0-discs are on position 0 and 7, but I must say that I have keys where this is different. The only difference is that the Disklock pro has a Disc Controller and two different thicknesses of washers. In their latest system the Protec, these 0-discs are also on position 0 and 7 and they also use two different thicknesses of washers.



Disklock Pro cutaway profile cylinder

Exec (E)

Exec is the replacement for the High Profile because the patent of the High Profile ended in 1999. The discs for the Exec are controlled by an advanced Disc Steering System (DSS). This DSS contributes to an easy, smooth operation, and keeps the discs turning together. When operating an Exec lock, the key will not turn until it is completely inserted into the keyway. This is one of the big advantages from this system. The EXEC system is specifically a one-way system, and therefore mostly used in padlocks and cam locks.



Exploded-view Abloy Exec

A note about the discs in the Exec

This system has a total of eleven discs. Nine of these are code discs and two of these discs are 0-discs which are used for the Disc Steering System, so you lose two combination discs. Every 18° there is a gate in the code disc, so there are 5 different code discs. That's the reason why Abloy claims that this lock with 11 discs has >10.000.000 combinations.



Some Exec discs

There are two profile control discs in the Exec system: the steel disc in the front of the cylinder which is fixed in the Disc controller element and the disc in the back, the profiled 0-disc. And so this disc has two functions, guiding the Disc Controller and controlling the tip of the key. In disc numbering, the profiled 0-disc is numbered as disc number 0, because if you assemble the cylinder, this is the first disc you place. The following disc is a code disc and stands for the first disc number in the key number. In some heavy padlocks and cam locks there can be installed an extra free spinning disc positioned in front of the steel DC, but this feature only provides anti-drilling protection.

The disc on the left is the profiled 0-disc. This disc controls the tip of the key and if you look carefully you can see the notches. If some grooves in the key do not match with the notches within each and every disc, you cannot fully insert the key.

Different numbers of discs used

There can be used a different number of discs in the Exec system. You have Exec systems with the standard quantity of nine code discs and also with the seven code discs. Beside these code discs, there are of course also the two 0-discs. The key on top is an example of a key with only seven code discs. The key below has nine code discs. The seven code disc cylinders are used in small Cam locks. You can see that these blanks must differ, due to the location of the dimple hole in the key.



Exec key with 7 code discs (top) and with 9 code discs (bottom)

Exec security levels

You can recognize the system by the head (or bow) of the key. There are 3 different key security levels called Red, White and Blue. In the Red level additional keys are only available direct from Abloy, The White level keys can only be obtained at specific Abloy Exec centers. The Blue level key can be copied at every Abloy centre after showing a security card.

Exec key profiles

The grooves on the side of the key are controlled by the steel disc in front of the cylinder. The small cuts on top of the key are controlled by the Profiled 0-disc.



3 different Exec key profiles

Working of the Exec Disc Steering System

Within the key of the Exec is one dimple hole on each side of the key. In this dimple hole (both sides of the key) glides the inner notch of the half moon shaped slider if the correct key is used. On the picture below on the left you can see there are two of these sliders.

On the picture in the middle you can see that the notch on the inside of the slider, drops in the dimple hole in the key. The key can now be rotated.

If the dimple hole in the key is missing, perhaps because the key is only inserted halfway or it's a 11 disc key which is inserted in a 9 disc key, the slider is pushed out and is pushed in the Disc Steering body. In this body is a chamber where the outer notch of the slider drops in and prevents it from rotating (see the picture on the right below).

It's a very clever and simple system. Abloy padlocks with the Protec system have also this system. This is the reason why the Protec key has at least two dimple holes on each side of the key. One dimple hole is for the Disc Controller, the other for the Disc Steering System. More about this in Abloy part 3, where I discuss the Abloy Protec system in greater detail.



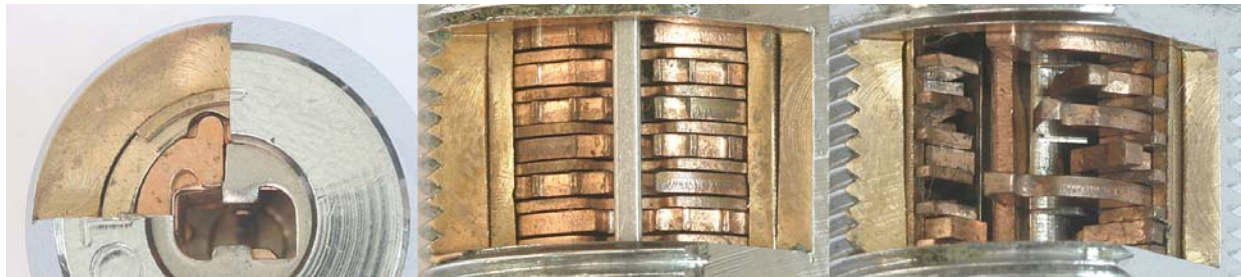
Exec Disc Steering System (DSS), Normal - Open - Blocked

Exec Camlock Cutaway

This is my most ingenious Abloy cutaway. This small cam lock is cut on three sides; the front, the left and the right side. Even the discs are cut. Therefore I made three extra close-up pictures from every side. Every working part in this model is visible.



Exec Camlock cutaway



Exec Cutaway Close up picture

Closing comments

In the third article of this series, I will discuss the working of the Abloy Protec system in detail.

If you have special Abloy locks or key profiles which are not mentioned in this article or in the previous articles before, I will be interested, because I am a real Abloy fan.

I want to thank my friend, Jeffrey Sachs (US) for editing this article.

You can contact me at: han.fey@12move.nl.

You can download this file with the next link "www.toool.nl/Abloypart2.pdf" where you can see the pictures in this article in greater detail and in color.

I hope you have enjoyed reading this article.

Han Fey