

Evolution of Abloy (Part 3)

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.

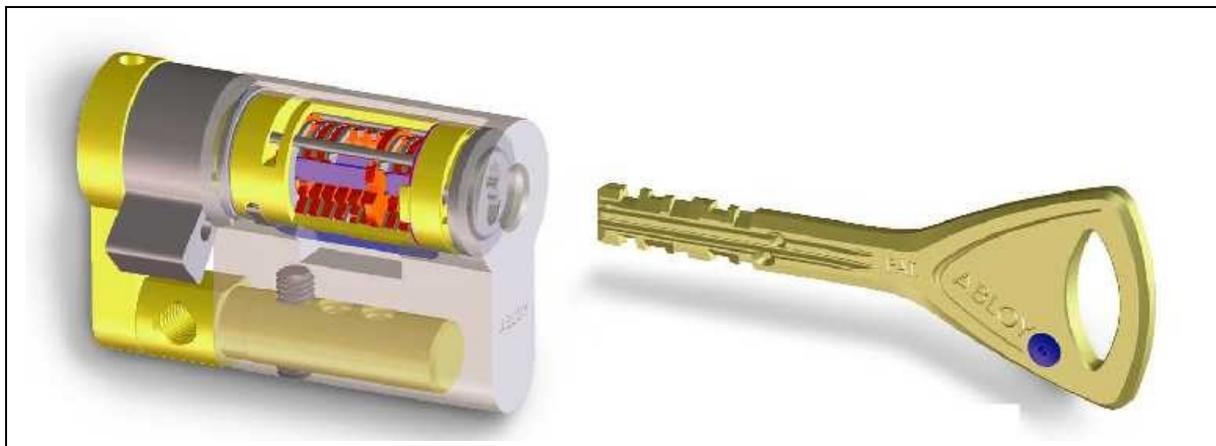
In my first article about Abloy I discussed the Classic and the (High) profile. In part 2, I discussed the Disklock, Disklock Pro, and Exec. In this third article I will discuss their newest system the Protec in detail. I have about 150 different (pad)locks made by Abloy. The techniques I viewed in my collection locks I tried to write down in this article. I can therefore not be responsible for errors in the content; I however did my best to record it as accurately as possible.

In 2006, I became an Abloy Protec dealer because I believe so much in these locks that I decided to sell them. For errors, corrections and for ordering these locks, at the end of the document you can see my contact details.

Protec (N)

In 2001 Abloy launched their latest system, the Abloy Protec, a patented cylinder system. This system represents the pinnacle in the development of the rotating disc principle. The cylinder contains 11 discs which means that there are theoretical 1.97 billion key combinations possible. Abloy also claims that this lock is virtually pickproof. I am at the moment also not aware of a pick or decoding tool for this lock. The disc principle guarantees a durable and reliable operation.

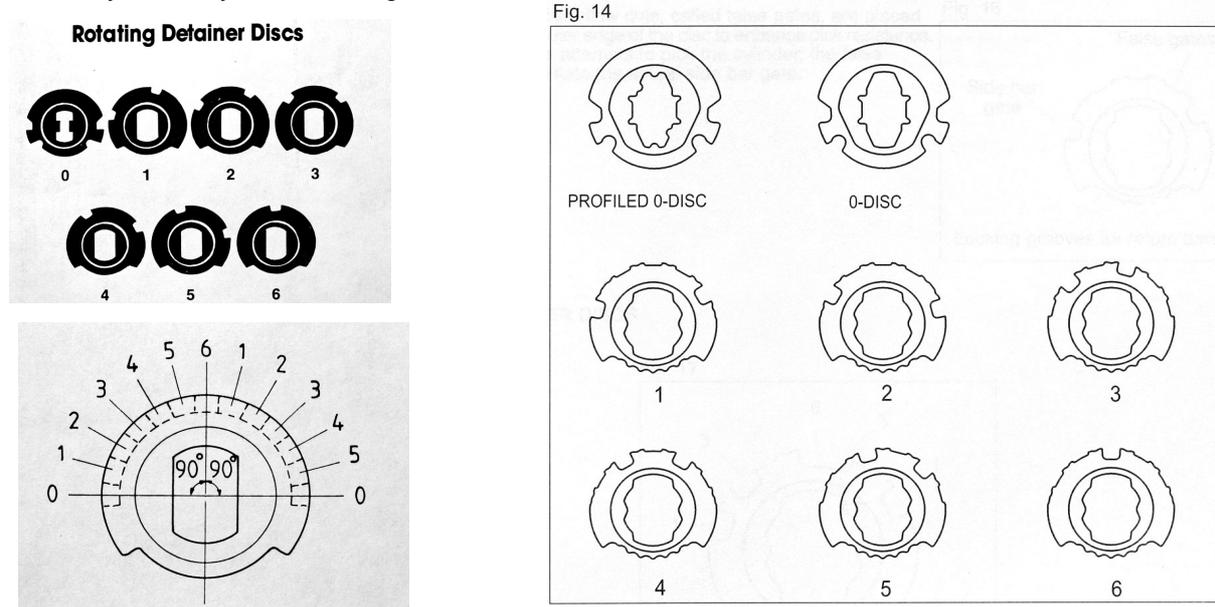
The lock works on the same principle as all Abloy locks, 11 discs must be aligned properly so that a lockingbar can drop in and the cylinder drum can then rotate in the cylinder housing. Besides the 11 discs there are a many more security features which I will be describing below.



Exploded-view of the Abloy Protec with key

A note about the discs in the Protec

To show the difference between the two systems, review the detailed pictures of the Disklock Pro discs and the Protec discs. Although the parts may look similar, none of the parts in a Disklock Pro or the Protec system may be interchangeable with each other.



Detailed picture of Disklock Pro and Protec discs.

note: the Profiled 0-disc is also called the Bottom 0-disc.

As you can see the Disklock Pro discs have square keyway holes and symmetrical gates in the discs. Every 15° there is a gate in the disc, both equidistant from the disc's line of symmetry. Two gates are used because the lock has a two-way rotation and therefore there are created two different shearlines, one in the clockwise rotation and one in the counter clockwise rotation.

You can also see that the Disklock Pro discs do not have grooves, notches, or gates on the underside of the discs where the return bars are, unlike the Protec discs. This because of the Disc Blocking System (DBS). The DBS prevents the cylinder from being picked, more about that later.

On the right picture you see the Protec disc. The gates on the LEFT side of the line of symmetry are making nice jumps from 15° from the left in the middle (1-disc) to the top (6-disc). The gates on the right side of the line of symmetry don't make these nice jumps.

The Protec 1-disc and 2-disc on the RIGHT side of the line of symmetry make nice jumps from 15°. The 3-, 4-, and 5-discs are the same. The reason for that are the two radii in the key, more about that later. The Protec 6-disc has only one gate since it does not rotate when used with the correct key.

You see the eight different variation discs which can be used in a Protec cylinder. The bottom 0-disc has a notch that prevents the key from going further into the keyhole, this disc also controls the profile on the tip of the key.

In the padlocks with the Protec system there is no Disc Controller, but there is a system which is similar to the Exec system mentioned in the Abloypart2.pdf.

Different numbers of discs used

There are Protec systems which contain nine discs or eleven discs. The key on top is an example of a key with only nine discs, that means the cylinder contains 7 code discs. The key in the middle and the bottom have the standard 11 discs (9 code discs). The 9-disc cylinders are specially used in camlocks and they have only one dimple hole at each side of the key. The keys in the middle (Sapphire level) and on the bottom (Ruby level) can be used in the longer camlocks and the normal Euro profile cylinders. They have therefore 2 or 3 dimple holes on each side.



One Protec 9-disc key (top) and two 11-disc keys (below)

Protec security levels

In the Protec system there are 4 different key security levels:

- Diamond Level

Additional keys are only available direct from Abloy. Full details of registration must be provided (e.g. Official order and signatories) and will be checked thoroughly before additional keys are provided.

- Ruby Level

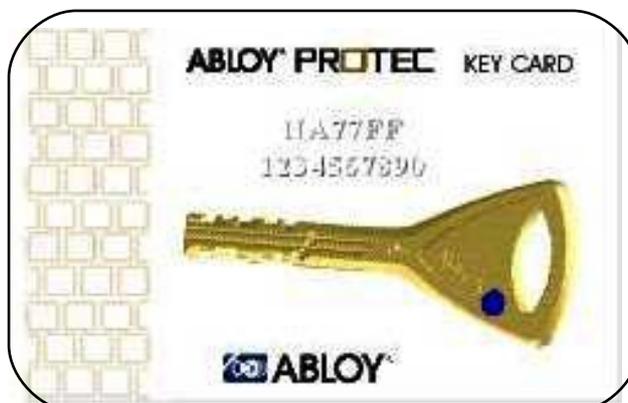
All ABLOY® PROTEC Centres can use an exclusive keyway for locks supplied. Only the Centre that issued the keys originally, can provide additional keys.

- Emerald Level

Similar level to Ruby with the original supplier providing additional keys. Keys are marked for identification and Abloy should be contacted for guidance if the original source is unknown.

- Sapphire Level

The lowest level and most common level. This level is normally used only for individual locks and key cards will be issued. The card can be presented to any ABLOY® PROTEC Centre for additional keys to be provided. Mostly this profile is numbered NA77FF. You can recognize the profile by the characters A7F on the side of the key.



Protec keycard with key profile number and key number

Protec Key Profiles

There are two different profile discs in the Protec system: the profile disc where the key enters the lock, called the Profile plate and the bottom 0-disc (or also named the profiled 0-disc) in the back of the lock that engages the tip of the key.

An example of a key profile number is NF77CC. The first N stands for the Protec system, I assume. The following character "F" stands for the profile plate where the key enters the lock. The F stands for the number of the Profile plate. There are profile plates with A, B, C, etc. The numbers "77" stand (in my opinion) for the two dimple holes in the key. The characters "CC" on the end of the key number stand for the number of the bottom 0-disc. Also here are the characters, AA, BB, CC, etc possible.

There are key numbers with the numbers 11 in the middle. I assume the key has then three dimple holes on each side of the key.



Two hardened profile plates (coded A and H)

The bottom 0-disc is a very important disc for the key profile, as it has a notch that prevents the key from going further into the keyhole. The tip of a Protec key can have minor cuts to make the key profile. I have several different Protec keyways, but often the differences are so minor that they are hard to see in a photograph. This close-up of two different 0-discs has enough variation to be easily visible. The corresponding grooves are only on the tip of the key.

The left disc in the picture below is an upper 0-disc. This disc is mostly on the eight position in the lock (counted from the back) and steers the return bars. It has no profile control function.



One upper 0-disc and two different bottom 0-discs for Cam locks

The grooves over the full length of the key are the same for most Protec systems, with minor differences at the tip of the key. The most common profile is the NA77FF (Sapphire level).

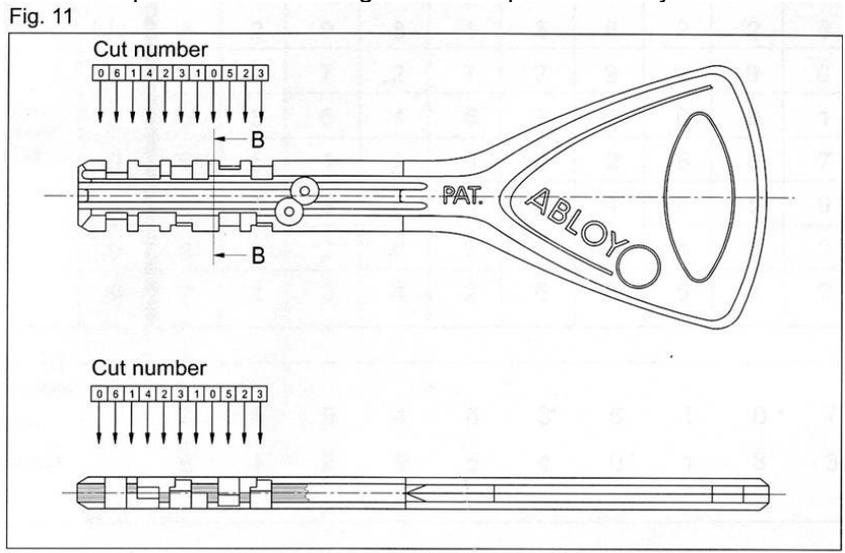
Key Cuts and Key Reading

Each Protec 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, each key for an eleven disc cylinder could have over 1.97 billion possible 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.

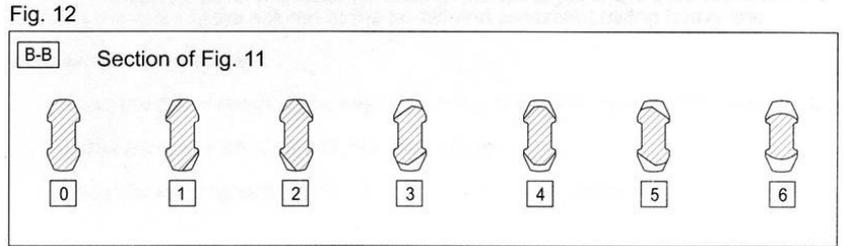
There are 10 spaces on the key for cut-angles. Starting from the tip of the key there is an uncut portion of 2.57 mm (0-cut), followed by number of 2 mm wide cuts, depending on the coding of the key, with a division of 1.5 mm. Therefore the cuts are partially overlapping.

A 0-cut is always left uncut, that is, blank. Cuts 1–5 are pairs of flat (trapezoidal) pointed triangles positioned at 15° from each other. These cuts are formed using precise angles and depths. A 6-cut is cut all the way around.

The following illustration depicts the various angles and shapes of the key cuts.



KEY READING



Protec 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.

In this demo key the first cut is a 6-cut. With this deepest cut, the disc will not rotate during the first 90°. Then the next nine discs follow. A key number is comprised of ten numbers.

Key Code Decoding Chart

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

Table 2

		ABLOY® PROTEC decoding chart									
		code number									
cut number or disc	0							6			
	1		4						1		
	2			6							
	3									0	7
	4						3				
	5					6					
	6	7			4						

Example										
Code	7	4	6	4	6	3	6	1	0	7
disc/cut	6	1	2	6	5	4	0	1	3	3

Abloy Protec, key code Decoding chart

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

Key Decoding Tool

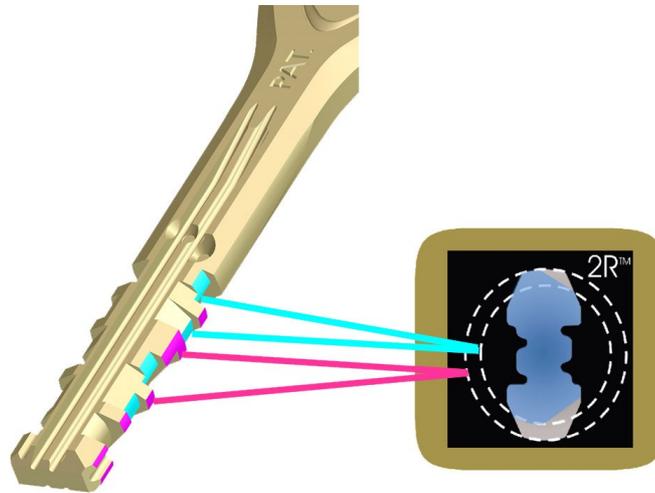
To make key reading and key code conversion easier, for all the Abloy systems there is a decoding tool. You insert the key in this tool and rotate it 90°. You then get the disc numbers (handy if you are assembling a lock) or you get the key number.



Protec key decoding tool

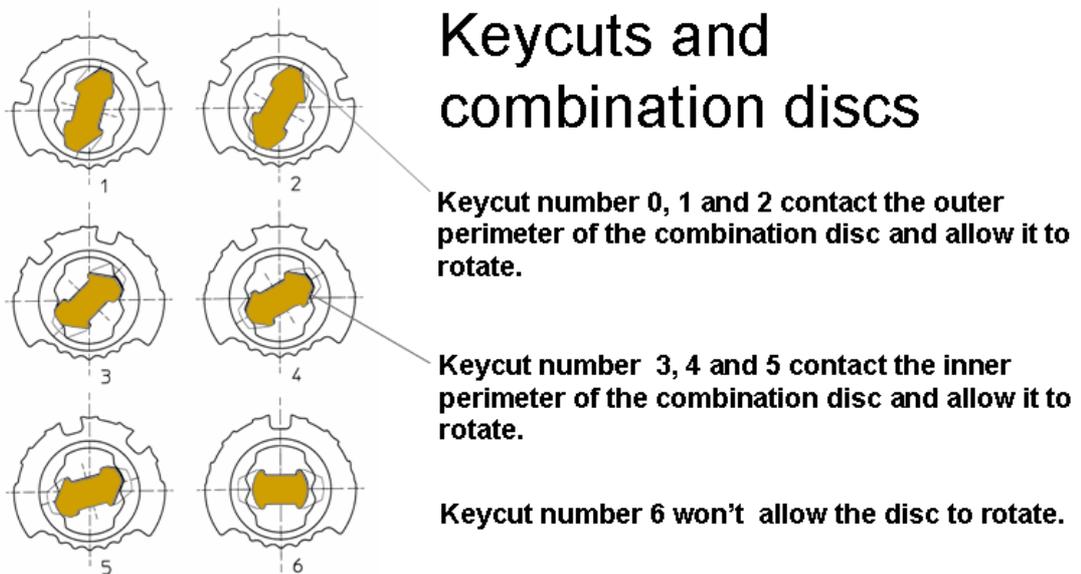
Explanation of the Two Radii in the Protec key

Protec keys are cut on two different radii, they even made a 2R symbol for this patented feature. The key cuts 3, 4 and 5 are cut for the inside and the key cuts 1 and 2 are cut for the outside.



Cut Protec key on two radii

The picture below shows the contact points of the key with the inside of the discs. These contact points vary by cut due to the two radii in the key. You can also see that the key is not symmetrical, and if you rotate the key counter-clockwise, the key makes contact with the discs at a different angle. This is the reason why you don't see two straight shear lines in a Protec cylinder. There is only one shearline for the lockingbar to drop in. You can see this clearly in the cutaway.

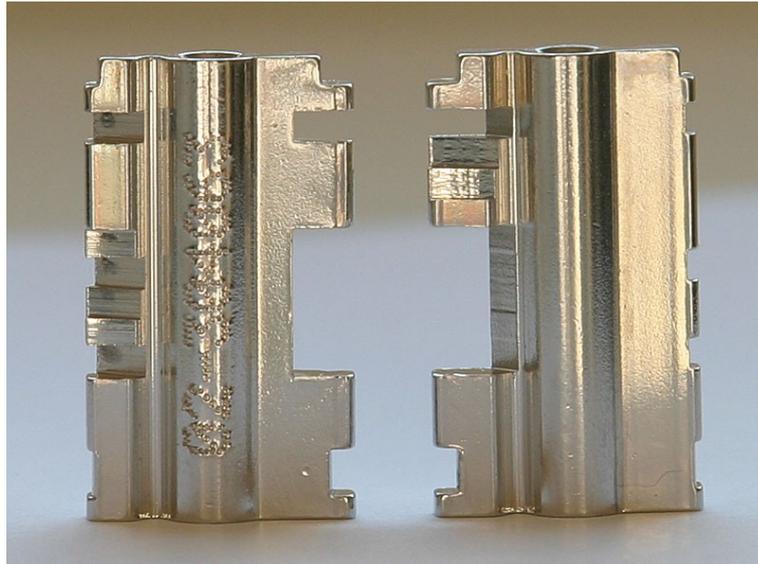


This is an example of the two radii in the key. The picture clearly shows the different contact points on the inside of the disc, with the key.

Rosengrens RKL10 vs. Abloy Protec

I recently purchased a Rosengrens RKL10 safe lock. It is a Swedish safe lock which can be easily programmed to use another key. This RKL10 lock is one of the few locks in the world which does not have a decoding or pick tool at the moment. I disassembled this lock (in all, it has 70 parts) and noticed that the Abloy Protec has taken some techniques from Rosengrens—the two radii in the Protec system is, in my opinion, one of them.

One of the security features of the Rosengrens is that the keys have angled cuts. This is to make it hard to read the key, which is nearly impossible if you are not familiar with the system. The picture below is one RKL10 key, photographed from both sides. As you can see, the key looks very different when viewed from each side.



Rosengrens RKL10 key

Note:

Normally a new Rosengrens safe comes with a “blank”. This blank comes on the outside of the safe. If you open the door with this key, you find a sealed package in the safe with 2 or 3 keys. Now you can re-key your safe lock and you are certain that there are no other copies of your key.

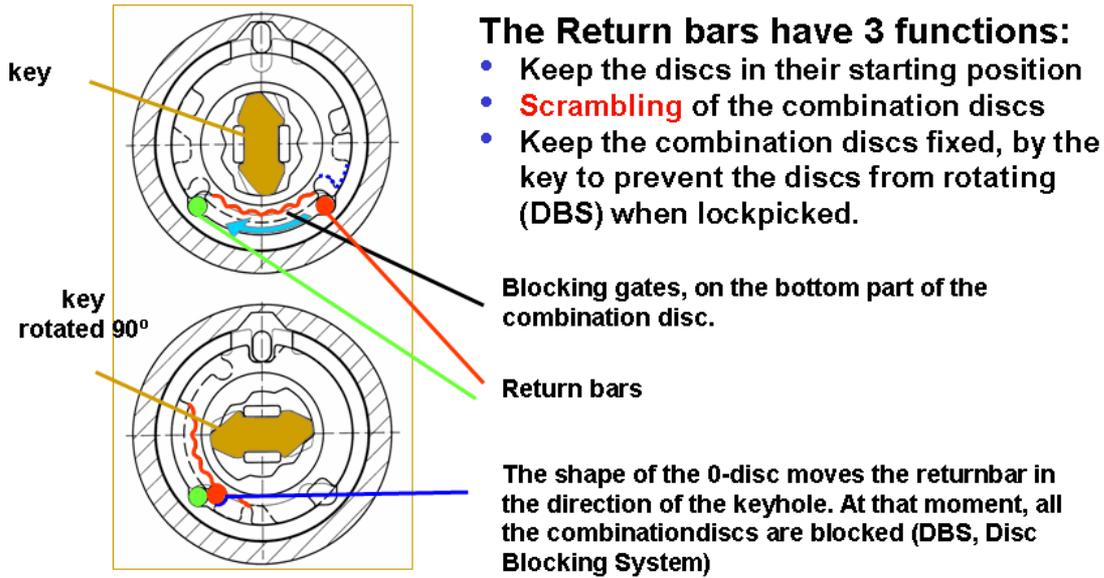
The Return Bars

The return bars are steered by the bottom 0-disc (0-position) and the upper 0-disc (8-position) in the normal cylinders. These two discs require two extra grooves on the outside, so the return bars can ride in these grooves as they are steered by these two discs. Two return bars are required, because of the two-way rotation.

The return bars have three functions, as you can see in the next picture:

1. They keep the discs in their starting position.
2. They rotate the discs back to their starting position after a clockwise or counter-clockwise rotation, to ensure the discs are scrambled (the return bars make both clockwise and counter-clockwise rotation possible)
3. They enable the Disc Blocking System (DBS)

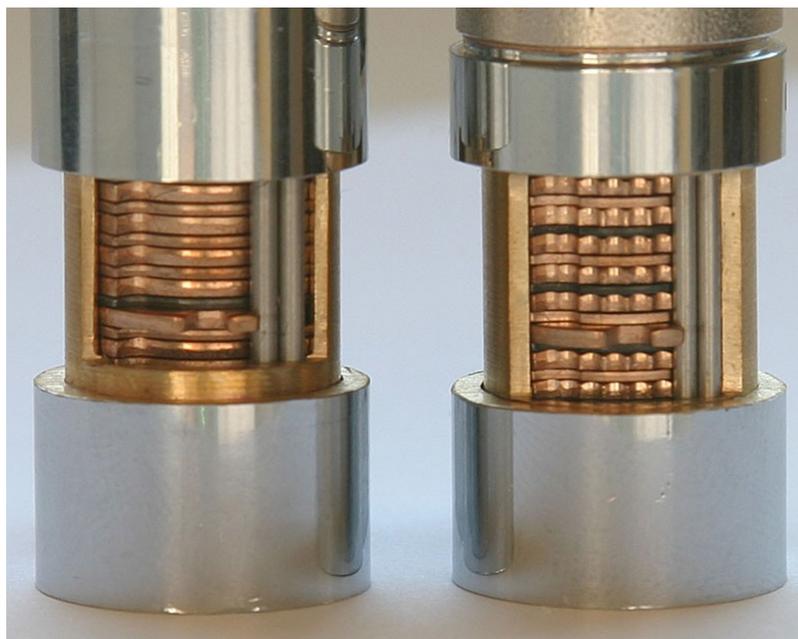
The combination discs are rotating independently the first 90° after inserting the key. If the gates are aligned correctly after the 90° rotation the two return bars are laying against each other (see the picture below), and the whole package of discs can rotate because the locking bar has dropped in.



How the DBS (Disc Blocking System) works

In the Protec the return bars are incorporated into the Disc Blocking System (DBS). On the bottom of the Protec disc you will see fine notches on the outer circle of the discs (highlighted in red above). After 90° of rotation, the moving return bar (red) is pushed into these notches as it binds with the stationary return bar (green), binding the discs and preventing their further rotation. If a disc in the middle for example is rotated 45°, there is a notch in the locking bar (top, entering notch) which corresponds with that rotation. After a rotation of 45°, that specific disc will then be blocked. DBS aids in preventing the lock being picked.

The Disklock Pro discs do not have these notches, therefore they do not have a DBS function. You can check this function with a cut-away by inserting the top of the key in the cylinder and only rotating the Disc Controller Element. On the picture below you can see the difference between the not blocked discs in Disklock Pro (left) and the blocked discs in the Protec (right).



Return bars in Disklock Pro (left) and Protec after 90° rotation of DC

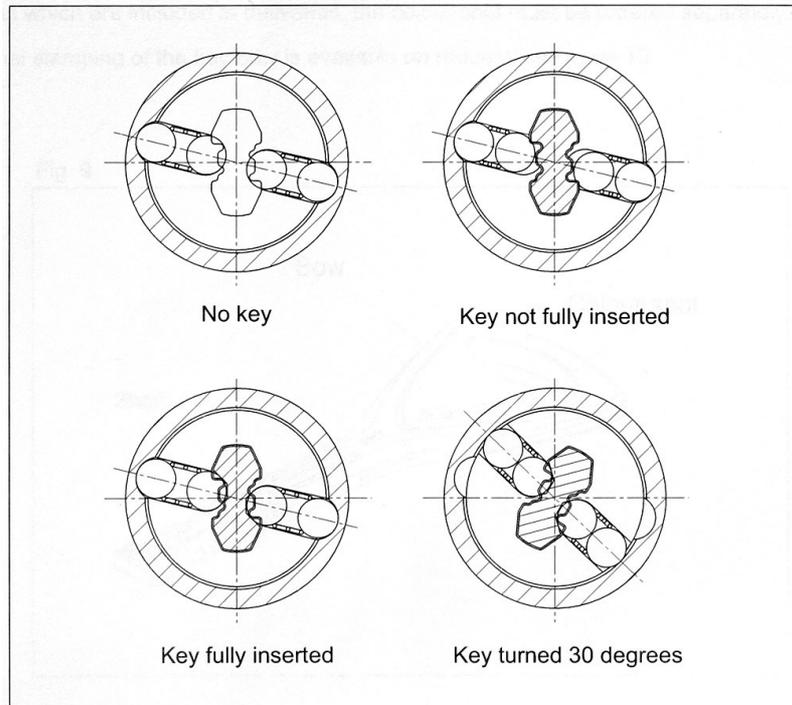
The Disk Controller

The last element I want to discuss is the Disk Controller (DC). This DC guides the key and prevents contact of the key with the combination discs during the insertion of the key. This prevents wear of the discs and takes care for a smooth operation. Another function of the DC is that it requires the key to be fully inserted before rotation can begin. The ball bearing prevents the key from being rotated until the dimple is reached. This reduces the chances of malfunction of the cylinder.

In the picture below, on the right top you can see a picture with a key that is not fully inserted into the lock. The two ball bearings are pushed out into the disc controller body and are blocking the rotation of the key. There is a dimple hole in the key where the ball bearing fits in. When the ball bearing enters the dimple in the key, the DC can rotate. Once the ball bearing enters the dimple hole in the key, it prevents the key from being removed if the cylinder is rotated.

On the standard Protec key you can see 2 dimple holes on every side of the key, the reason for that is the combined use with cam locks. In the standard padlocks from Abloy with the Protec system the DC is not used. Padlocks have the same technique as used in the Exec system, called the Disc Steering System. The dimple hole on the side of the key is then in another position.

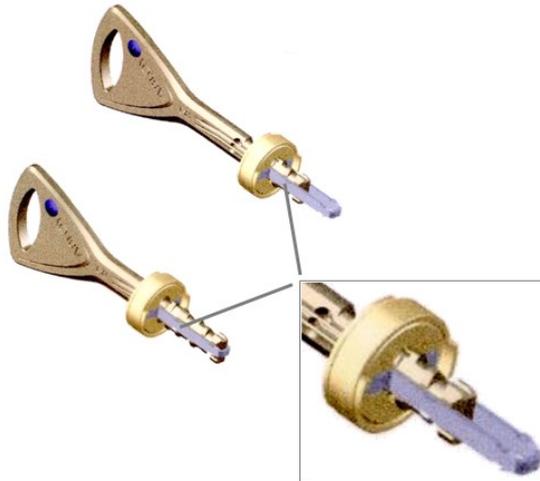
Fig. 8



Working of Disk Controller (DC)

Note:

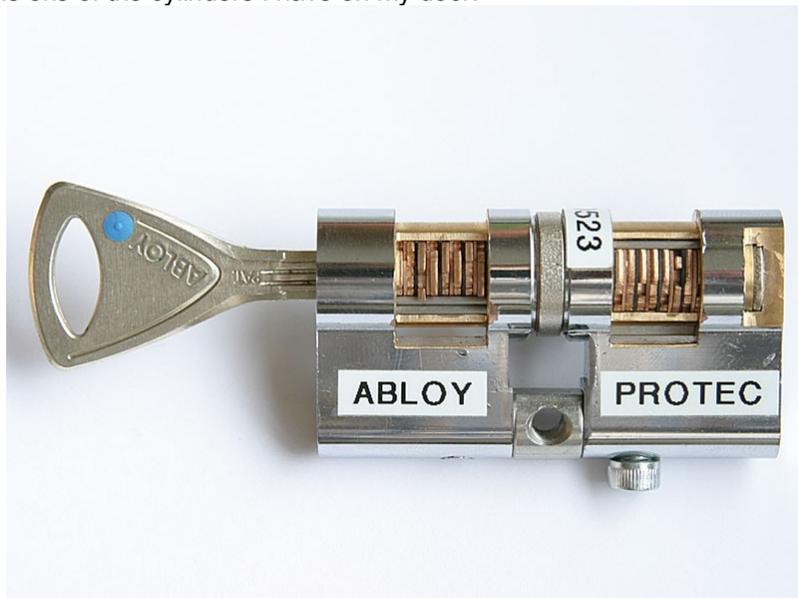
- No key
- Key not fully inserted, the balls stop the key from turning
- Key fully inserted, the inner balls are pressed into the dimple holes in the key
- Key turned, outer balls are pressed inside the collar



Picture of the Disk Controller (DC)

Protec cutaway

All techniques mentioned before result in the next cylinder. The entire housing is on one side made from hardened steel. The part which connects the two cylinder parts is also made from steel, to give protection against pulling the cylinder out with a corkscrew. As extra protection, there is the bolt on the bottom which serves as added protection against pulling out the cylinder. The bolt hooks behind the plate which covers the lock. This is, in my opinion, one of the best high-security cylinders in the world. Reason why this is one of the cylinders I have on my door.

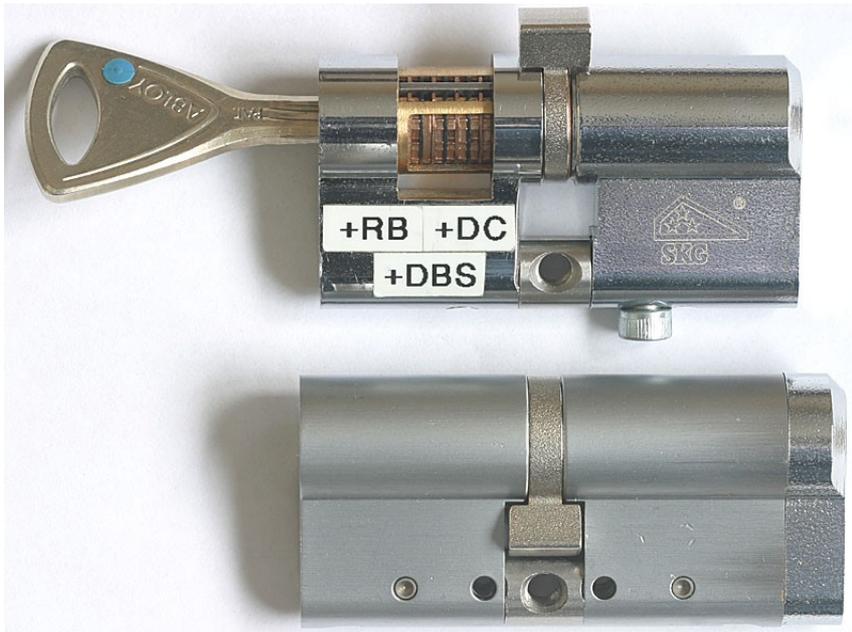


Protec cutaway cylinder with pull-out protection

Abloy Protec with CLIQ

On top of the next picture you see the hardened version of the Protec Euro profile cylinder. You can see the SKG*** mark on one side of the cylinder. Abloy does not use hardened steel inserts in their drill protected cylinders, they simply make the whole housing of hardened steel.

The last security novelty of Abloy you can see on the bottom, it is the Protec with CLIQ. It's the most expensive and secure cylinder in my collection. Besides the mechanical security of the normal 11 discs, there is also the electronic security. This is assembled in the hardened, drill protected part in the front of the cylinder.



Protec hardened SKG cylinder (top) and Protec with CLIQ system (bottom)***

More about the CLIQ system in my next article.

Some Abloy Bows

I now have discussed the most common Abloy locking techniques. As a reminder here is a picture showing all the systems. The bows mark the different Abloy systems.



Classic

(High)
Profile

EXEC

DiskLock

Protec



Closing comments

I hope to write a fourth article about Abloy, in which I will discuss some special Abloy padlocks (shapes) like the government padlock, the horseshoe, the hockey puck, the PL330 Smart Disc, AVA-system and some of the other different locking techniques they have in the program.

If you have special Abloy locks or key profiles which are not mentioned in this article or in the previous articles, I will be interested, because I am a real Abloy fan.
You can contact me at: han.fey@12move.nl.

I want to thank Brian Key (USA) and Nigel K. Tolley (UK) for editing this article.

You can download this file with the next link "www.toool.nl/Abloypart3.pdf" where you can see the pictures in this article more clearly and in color. If you have a question or discovered not correct things in this article, you can contact me at: han.fey@12move.nl.

More info about Abloy Protec and how to obtain them you can find on my website
www.hanfeylocktechnologies.com.

I hope you have enjoyed reading this article.

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