How Mechanical Safes Work

Analog Hacking In A Digital World
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Kinds of Safe Locks

Safe and Vault locks are broken down into two categories:

- **Mechanical**: A dial must be turned left & right, in the correct order and amounts to open the lock.

- **Electronic**: A small digital processor opens the lock when the correct code is entered.

We are going to look at how common mechanical safes operate.
It All Starts With The Combination

How to dial the typical 3 number combination safe:

- Turn the wheel LEFT landing on the 1\textsuperscript{st} number the fourth time you come around to it.
- Turn the wheel RIGHT landing on the 2\textsuperscript{nd} number the third time you come around to it.
- Turn the wheel LEFT landing on the 3\textsuperscript{rd} number the second time you come to it.
- Then turn the wheel RIGHT until the lock opens.
What Does Dialing Do?

- As you dial the various numbers of the combination you are actually moving 3 wheels (plus a special Drive Cam wheel) inside the lock.
- Each of the 3 wheels have a single notch cut into them. This notch is called the Gate.
- Once all of the Gates on the wheels are lined up, a bar called the Fence can fall into these notches, allowing the lock to open.
- Dialing the combination lines up the Gates on the wheels underneath the Fence.
The Dial And Drive Cam

The spline key (see previous page) locks the drive cam, spindle and dial together.

- **Spindle**
- **Drive Pin**
- **Drive Cam**
- **Safe Dial**
The Drive Cam and each of the wheels have a Drive Pin. When the Drive Cam is rotated by the dial of the safe, eventually it’s Drive Pin will hit the Fly of the 1\textsuperscript{st} wheel. Then the cam and the 1\textsuperscript{st} wheel will turn together. When the drive pin of the 1\textsuperscript{st} wheel hits the Fly of the 2\textsuperscript{nd} wheel, then all three (the cam and wheels 1 & 2) move together. This can continue until the cam and all 3 wheels turn together.
When you turn the Dial & Cam four turns to the left, the Drive Cam rotates enough to pick up Wheels 1, 2 and 3. Wheel 3 then gets turned until the Gate is directly under the Fence by dialing the first number of the combination.
My moving the Dial and Cam three turns to the right, you leave the 3\textsuperscript{rd} Wheel in place and only turn enough for the Cam to move the 1\textsuperscript{st} and 2\textsuperscript{nd} Wheels. The second Wheel’s Gate is left under the Fence as the second number of the combination is dialed.
Next, by turning the Dial and Cam two turns to the left, only the 1\textsuperscript{st} Wheel is moved. The last digit of the combination brings the 1\textsuperscript{st} Wheel’s Gate under the Fence.
Finally by turning the Dial and Cam right one last time, you move The Cam’s Gate under the Lever and allow the Lever & Fence to fall.
By continuing to turn the dial right, the Fence (and Lever) stuck in the Gates, pull the Bolt inside the lock’s case so the safe will open. 

*Note: From the back, the cam and wheels appear to turn left as the dial turns right*