**TYPES OF SHOOTING SYSTEMS**

1. **SPRING MECHANISM**

The first category contains systems based on mechanical stored energy in a spring. This system is a very simple mechanism. A spring is wound up, held, and released at certain moment of time. It is applied in various configurations. Varying from basic spring systems to crossbow based mechanisms. Figure 1 contains a simplified model of a standard spring mechanism.

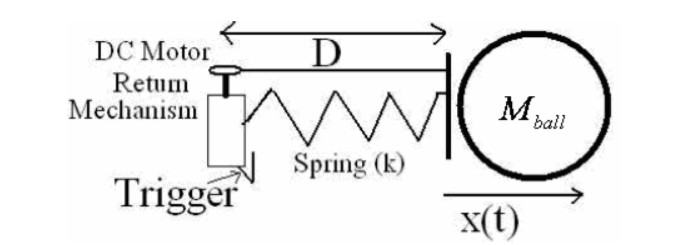
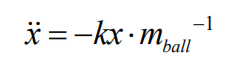
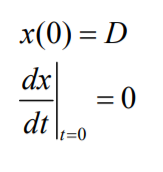


Figure 1 : Schematic model of a spring-based shooting mechanism

For this simple model the equation of motion holds.



With Initial Values:



**Advantages:**

* The system is very powerful due to much energy can be stored in a spring
* The number of shots is almost unlimited, because it works on battery power

**Disadvantages:**

* It takes a lot of space, weights several kg and it takes about time to reload
* It is also very hard to control the shooting power
* There are 2 ways to obtain variable shooting power, by varying the spring’s displacement or by taking energy away with a variable damper. These are difficult solutions and is rather impossible to achieve variable shooting power “on demand” without any time lag

1. **PNEUMATIC SYSTEMS**

There are also shooting mechanisms which are based on pneumatic pressure. This is also a very basic technology. A large gas tank is placed somewhere in the robot and is brought on pressure before a match. At the front are one or more pneumatic cylinders connected with tubes to the air tank. In the tube(s) are solenoid valve’s which can operate as a “switch” or they can be controlled so they can regulate the airflow and shooting power. Shooting force depends on the pressure in the gas tank. High pressure is needed for a decent shooting force end thus a strong and heavy tank is needed. The number of shots depends on the size of the gas tank.

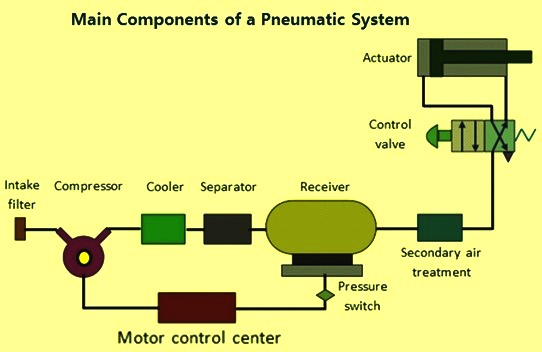


Figure 2: Schematic model of a pneumatic-based shooting mechanism

**Advantages:**

* *High effectiveness* – There is an unlimited supply of air in the atmosphere to produce compressed air. Also there is the possibility of easy storage in large volumes. The use of compressed air is not restricted by distance, as it can easily be transported through pipes
* *High durability and reliability* – Pneumatic system components are extremely durable and cannot be damaged easily
* *Simple design* – The designs of pneumatic system components are relatively simple. They are thus more suitable for use in simple automatic control systems. There is choice of movement such as linear movement or angular rotational movement with simple and continuously variable operational speeds.
* Economical – As the pneumatic system components are not expensive, the costs of pneumatic systems are quite low

**Disadvantages:**

* *Relatively low accuracy* – As pneumatic systems are powered by the force provided by compressed air, their operation is subject to the volume of the compressed air. As the volume of air may change when compressed or heated, the supply of air to the system may not be accurate, causing a decrease in the overall accuracy of the system
* *Processing required before use* – Compressed air must be processed before use to ensure the absence of water vapor or dust. Otherwise, the moving parts of the pneumatic components may wear out quickly due to friction
* *Noise* – Noise is usually produced when the compressed air is released from the pneumatic components

1. **SOLENOIDS**

The third principle used for shooting devices is self-inductance. By sending a current trough a turn of wire a magnetic field can be build. As the number of turns or current increases, the magnetic field increases too. With magnetism ferromagnetic materials can be attracted or repulsed.

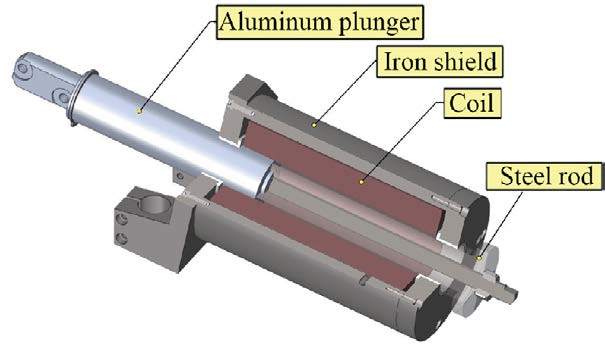


Figure3: Schematic model of a solenoid-based shooting mechanism

**Advantages**:

* It is able to shoot very fast
* It is rather small and lightweight
* Only a transformer, a capacitor, some resistors and a switch is used so it is in theory very reliable
* Shooting power can be varied by varying the time of the applied current

**Disadvantages**:

* The use of a solenoid is that it operates at a high voltage and current, so it can be quite dangerous.
* It uses a lot of power for a really short time
* Due to internal resistance, heat is generated when activated