The spring and collisions

We begin with springs. The spring is a very interesting subject.

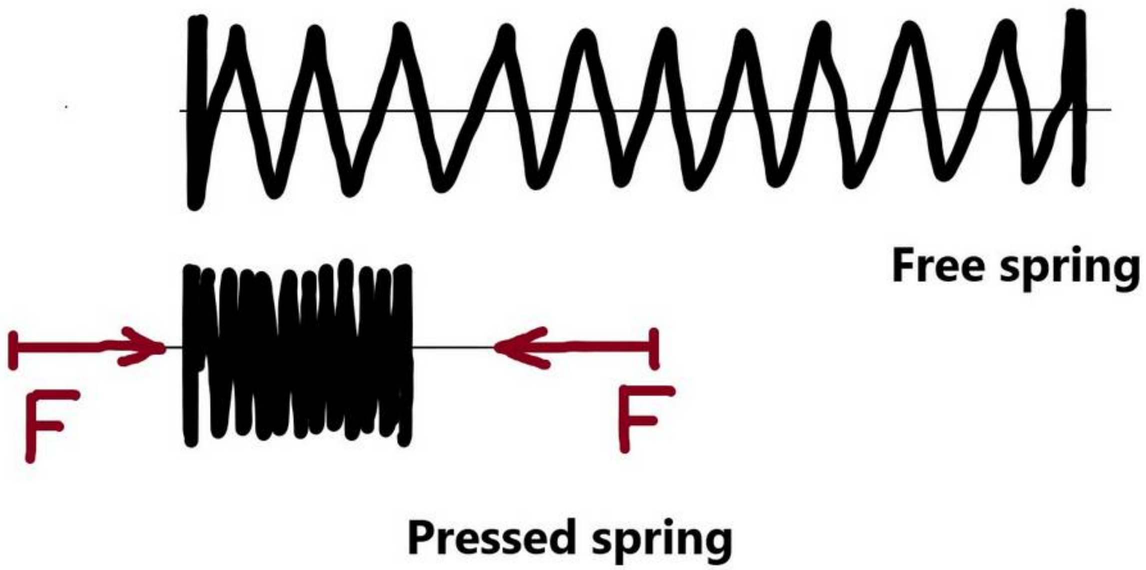

Fig. 1 – the spring with free lenght and with pressed lenght

As we see from Fig. 1 the lenght of the pressed spring is quite small instead of the lenght of the free spring. Yes, if we use a pretty piece of a wire, the ratio between the free lenght and the pressed lenght could be very big.

Anyway. The spring keeps the energy and its weight is quite small. The ratio **R** between the energy **E** to its weight **m** could be very big.

$$\mathbf{R}=\frac{\mathbf{E}}{\mathbf{m}} \qquad \textbf{Eq. 1}$$

The ratio **R** depends from which alloy the spring is made.

Yes, we never reach the famous ratio where **c** is the speed of light in vacuum

$$\mathbf{c}^2=\frac{\mathbf{E}}{\mathbf{m}} \qquad \textbf{Eq. 2}$$

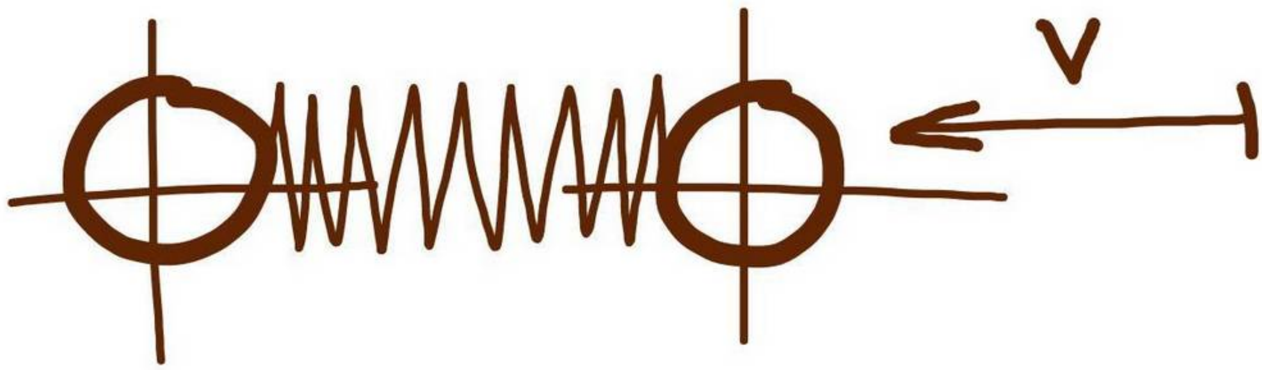

Fig. 2 – the spring between two equal balls

We have two balls with a spring between them in one direction (Fig.2)
The balls are equal with their mass. The first of the balls is moving by the velocity v. After the collision between them the first ball had stopped and the second one was moving by the same velocity v. That´s O.K. But imagine the next example.

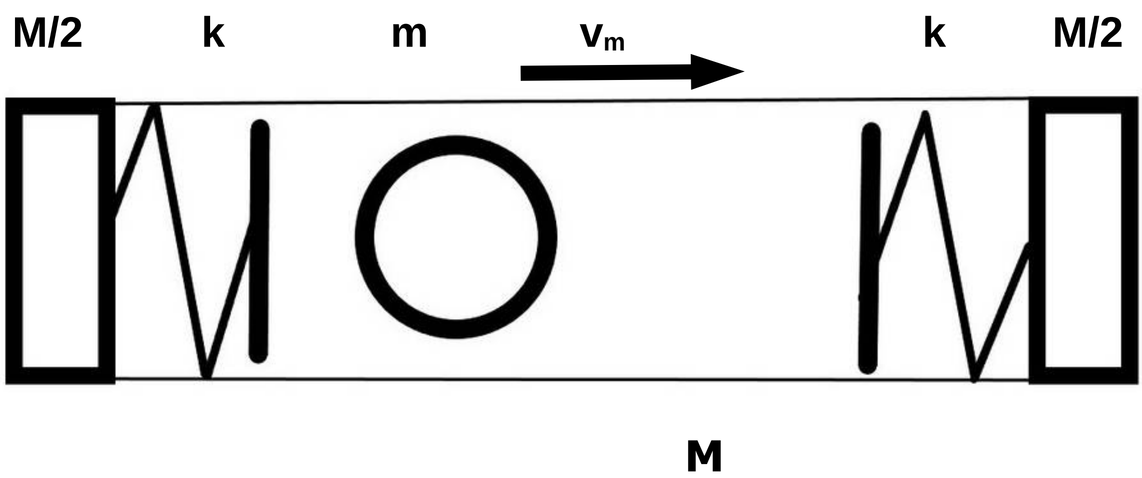

Fig.3 – the ball with the frame and with two springs with a stiffness **k** in the end of the frame, there are rods to keep the frame together

The ball is placed inside the frame (Fig. 3) The mass of the ball **m** and the frame **M** is equal. What will it happen then? It depends on the initial conditions. In the beggining there is a rest. We must deliver the energy to the frame. Only from outside. We could have fourth kinds how to deliver the initial energy (call it the impuls).

1) – to give the initial velocity $\mathbf{v_m}$ to the ball **m .** The framework **M** is in the rest and the ball **m** is moving. After some time the ball **m** reaches the first part of the frame **M** and gives it all the kinetic energy. After that the ball **m** will be

in the rest and the frame will have the velocity $\mathbf{v_M = v_m}$. But as we know the mass **M** of the frame is divided to the two parts **M/2**. After some time the second part of the frame reach the ball **m** in the rest and returns its the kinetic energy. Then the ball **m** will again have the velocity $\mathbf{v_m}$. The frame will be again in the rest and the situation will repeat itself again and again, step by step.

2) – to give the initial velocity $\mathbf{v_M}$ to the frame **M .** The ball **m** is in the rest and the frame **M** is moving. After some time the first part of the frame **M** reaches the ball **m** and gives it all the kinetic energy. After that the frame **M** will be in the rest and the ball will have the velocity $\mathbf{v_m = v_M}$. But as we know the mass of the frame is divided to the two parts **M/2**. After some time the ball **m** reaches the second part of the frame **M** which is in the rest and returns it the kinetic energy. Then the frame **M** will again have the velocity $\mathbf{v_M}$. The ball will be again in the rest and the situation will repeat itself again and again, step by step.

3) – to press the spring **k** between the first part of the frame and the ball **m**. There wil be the potential energy. After release of the spring **k** the frame and the ball will have the same velocity $\mathbf{v_m/2 = v_M\,/2}$. After some time the ball **m** and the second part of the frame **M** reaches each other through the second spring **k**. After exchanging energy the ball **m** and the second part of the frame **M** will move apart and the situation will repeat by the oscillation around equilibrium position.

4) – to give the initial velocity $\mathbf{v_M/2}$ to the frame **M** and the same initial velocity $\mathbf{v_M/2}$ to the ball **m** against each other. After that there will be the same oscillation around equilibrium position as the point 3.

We see – there are different kinds of the moving which depends on different initial conditions. Very important there is the stiffness k which allows the energy storage and exchange.

Every material has its own stiffness. Without the stiffnes the forces could be infinite. Where the stiffnes came from? From Pa uli´ exclusion principle. The classic spring we can imagine as the a very long steel wire. For the purpose of the space such wire is condensed by spiral to the spring.

There is also interesting subject a collision among three or more balls. What does it mean? There is a way how to explain the arrow of the time. In other words, how to explain the second law of thermodynamics. We know from our experience, it is almost impossible to transfer kinetic energy from ball with low speed to ball with a high speed. To say - almost.

See the next figure.

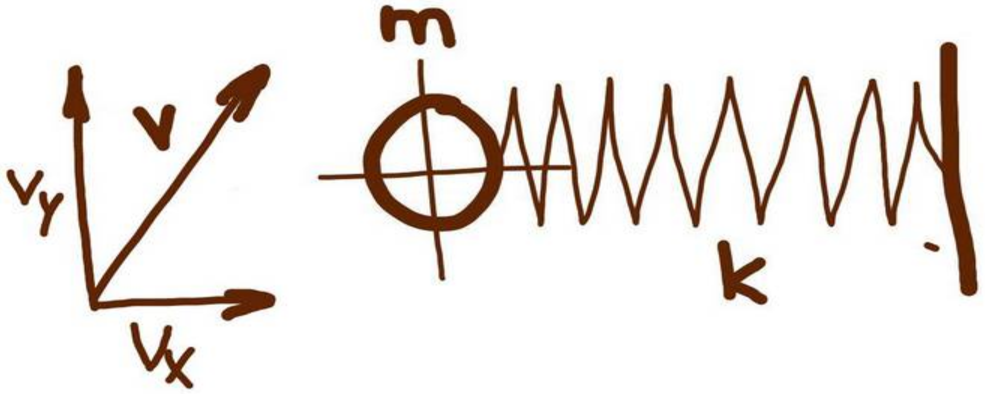

Fig. 4 – the ball with a speed v in other direction instead the axis of the spring

There is a ball with the speed **v**. The speed is nearly with the angle 45° to axis **x** of the spring. We could apart the speed **v** to two directions x and y. After that we obtain the speed $\mathbf{v_x}$. Such speed will be absorbed by the spring. But there is two important conditions. The first one is the size of the spring. Here it is the diameter D. And the second one is the stiffness of the spring **k**. We obtain the ratio **T**

$$\mathbf{T}=\frac{\mathbf{k}}{\mathbf{D}} \qquad \textbf{Eq. 3}$$

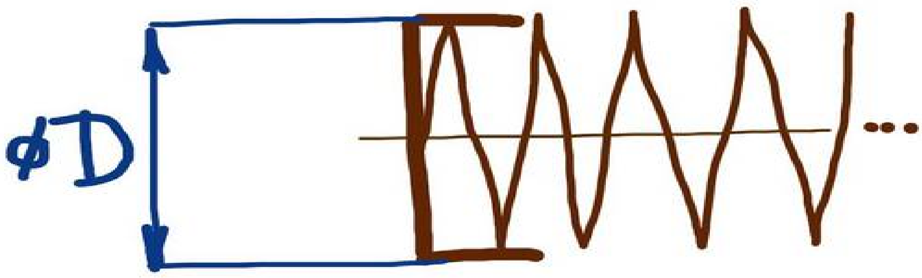

Fig. 5 – the diameter D of the spring

Yes, we could mention the speed as the third condition. But the ratio **T** of the stiffnes **k** to the diameter **D** is sufficient. The ratio **T** tell us how long the collison will take in the time. In the other words, how much of the speed $\mathbf{v_x}$ will be absorbed by the spring. After that we could model two balls with a different speed and try to explore, if there is a chance to absorb the kinetic energy from the ball with low speed by the ball with high speed.

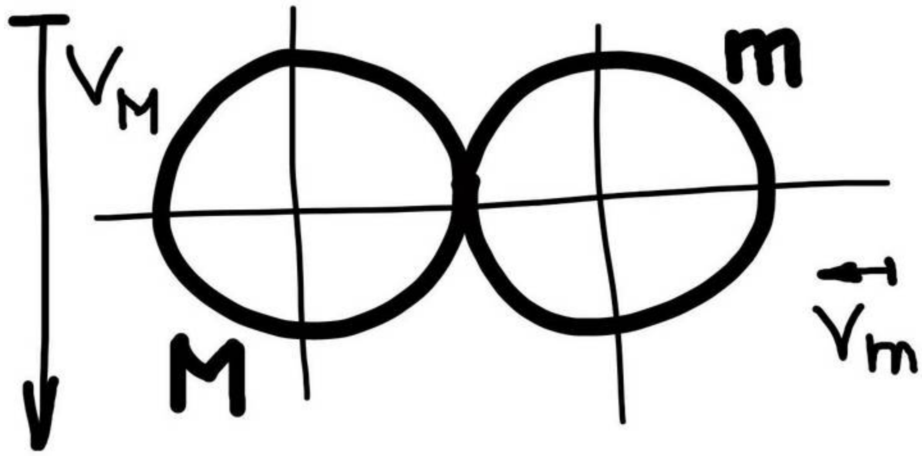

Fig. 5 – two balls M and m with different speeds

We know the kinetic energy could be transfered from low speed to high speed only by the perpendicular way. See the Fig. 5. If there is a high speed $\mathbf{v_M}$ then the speed $\mathbf{v_m}$ must be very low. There is a rule – the more the speed $\mathbf{v_M}$ the less the speed $\mathbf{v_m}$ for fixed stiffness **k** between balls **M** and **m**.

But if we want to transfer the kinetic energy from ball with high speed to ball with low speed we could use 180° angle of the ball with higher speed. After that there is a number of balls. How many balls are there in the collisions inside closed volume? If there are only three or more balls or if there are ten, hundred ... or million or billion or more balls.

The more balls the less chance to get the initial state. The inital state is the state where only one ball is moving and other balls are still.

Yes, we could feel the reason for the second law of thermodynamics, where balls are molecules or atoms. We know the collision between two particles transfers the energy only through the ELMG field of atom´s orbits. The fine reason how to make collision is the Pauli exclusion principle. In such way we can explain the stiffness **k**.

Let´s go to solve the probability. The probability between two kinds of collisions. The first kind is the transfer of energy from the ball with higher energy to the ball with less energy. The second kind is the transfer energy from the ball with less energy to the ball with higher energy. If we want to solve such kinds of probability we must firstly quantify the possibilities. The reason is clear – for infinity possibilities we could get the inestimable value of the probability. For simplicity we divide the angle of the ball to five sections.

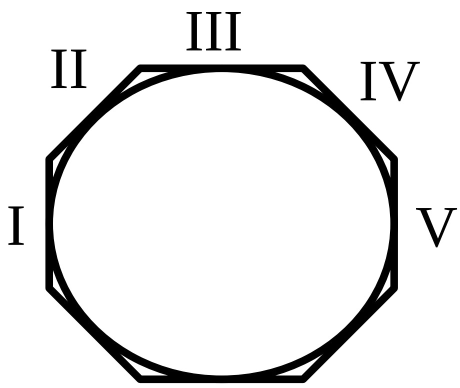

Fig. 6 – five sections on the ball

There are five sections how to transfer energy by the collision between two balls.

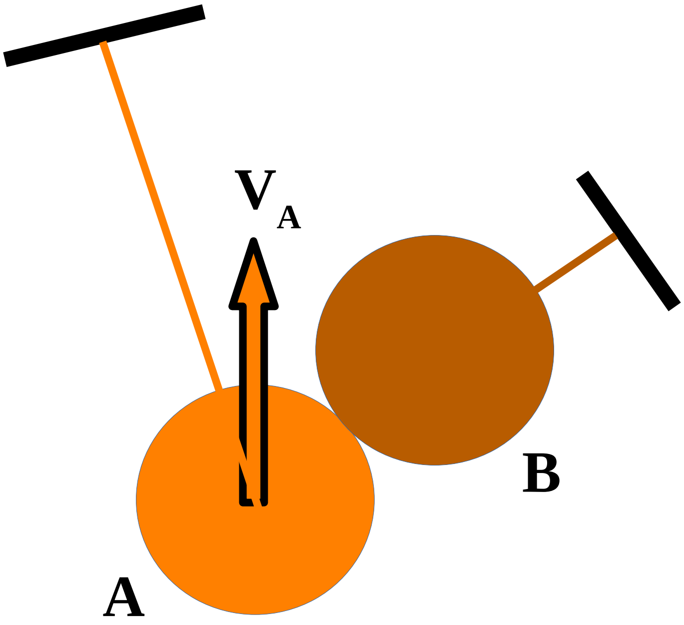

Fig. 7 – the reverse of the collison

Is it possible to reverse the collision between two balls? To give a mechanical mirror against each of the moving ball. Yes, why not. But there are difficulties. Firstly the precission of an adjustment of the mirrors. Secondly the fluctuations could influence the reverse motion. The conclusion - the same back path is impossible (including elementary particles) for the reason of changes of circumstances - not only vacuum fluctuations, but for the reason of changes of gravity force, changes of turning of the earth, the changes form external influences, and so on.

to be continued