HANDS ON LAB ME 371

HOW THINGS WORK

SOMERSAULTING DOG

Introduction :-

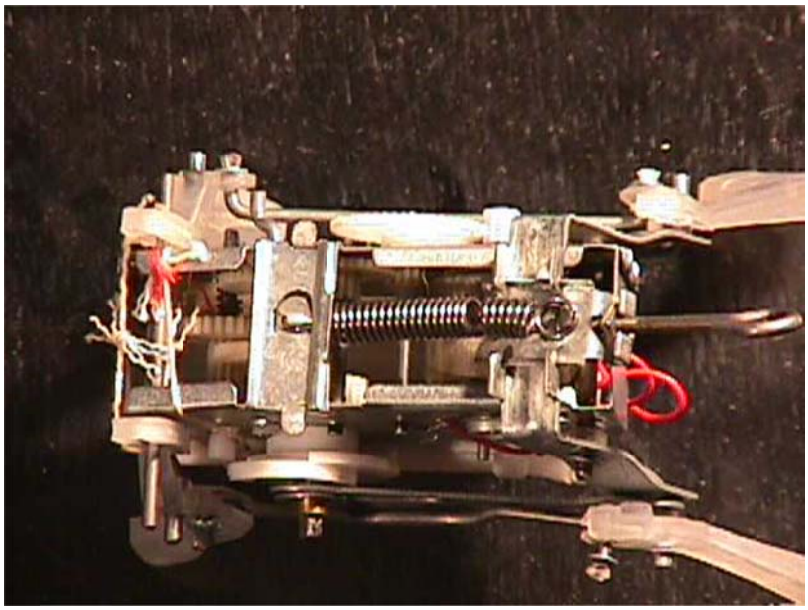
We are going to demonstrate the working of a Dog which walks over a certain distance, thereafter it crouches and then somersaults to get back to initial position. Actually the Dog is driven by a motor which is powered by a 2*1.5 volt Battery. The whole motion is due to a peculiar shaped disc which coordinates the motion between various elements of the mechanism.

Material Used :-

The body frame is made of aluminium and tin, as they are light and the strength requirements are not too high. The disc is made of hard plastic because it has to drive the slider.Gears are made of plastic.

Driving Mechanism :-

The top view of the entire mechanism is shown in Picture A.



PICTURE A

The basic driving mechanism is shown in the figure 1(a). The input to the system comes from the motor in which Gear 1 is attached. Through a set of gears(2 & 3) motion is transferred to Gear 4 . Both the Gear 5 & Gear 6 is driven by Gear 4. Gear 7 drives the crank of the 5-link walking mechanism, while Gear 5 drives the disc due to which crouching and somersaulting is made possible.

---------- SIDE A******** SIDE B----------**

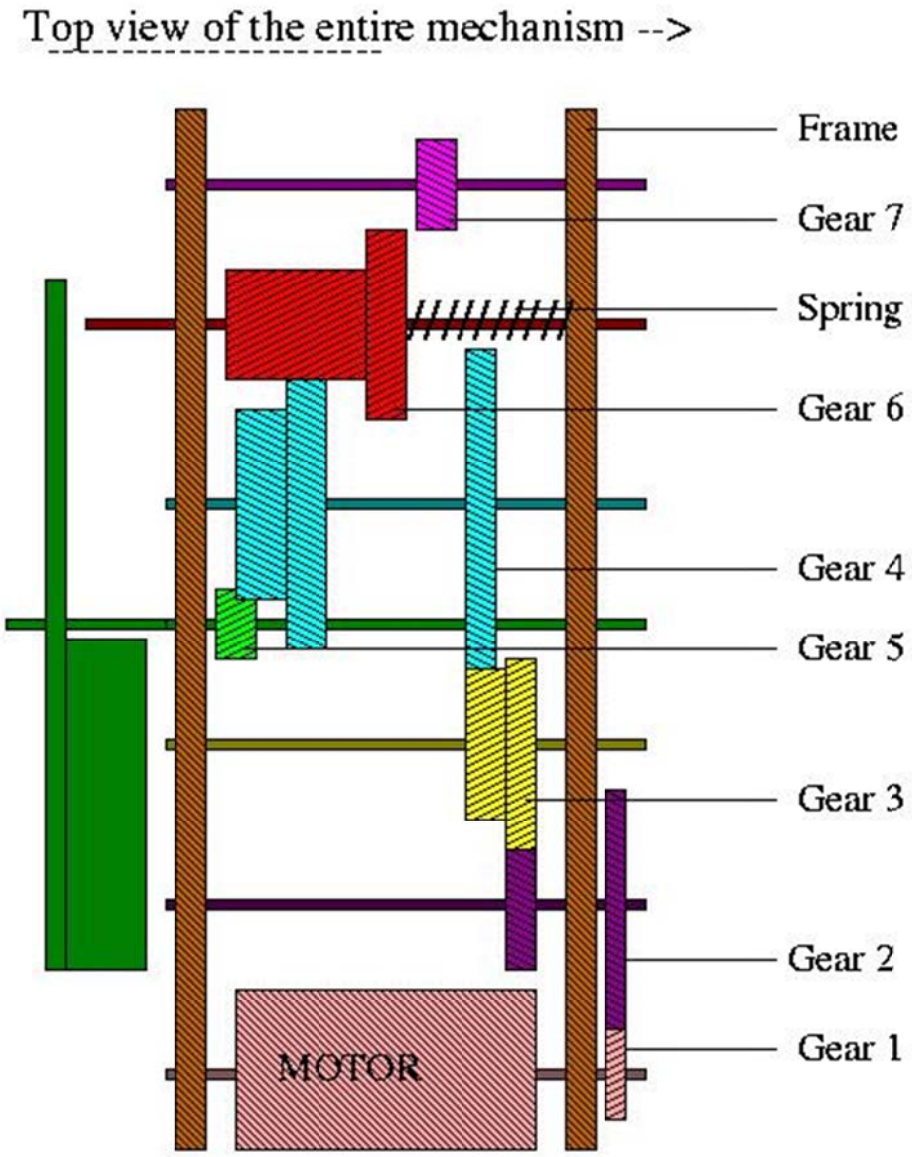


Figure 1(a): TOP VIEW OF THE DRIVING MECHANISM

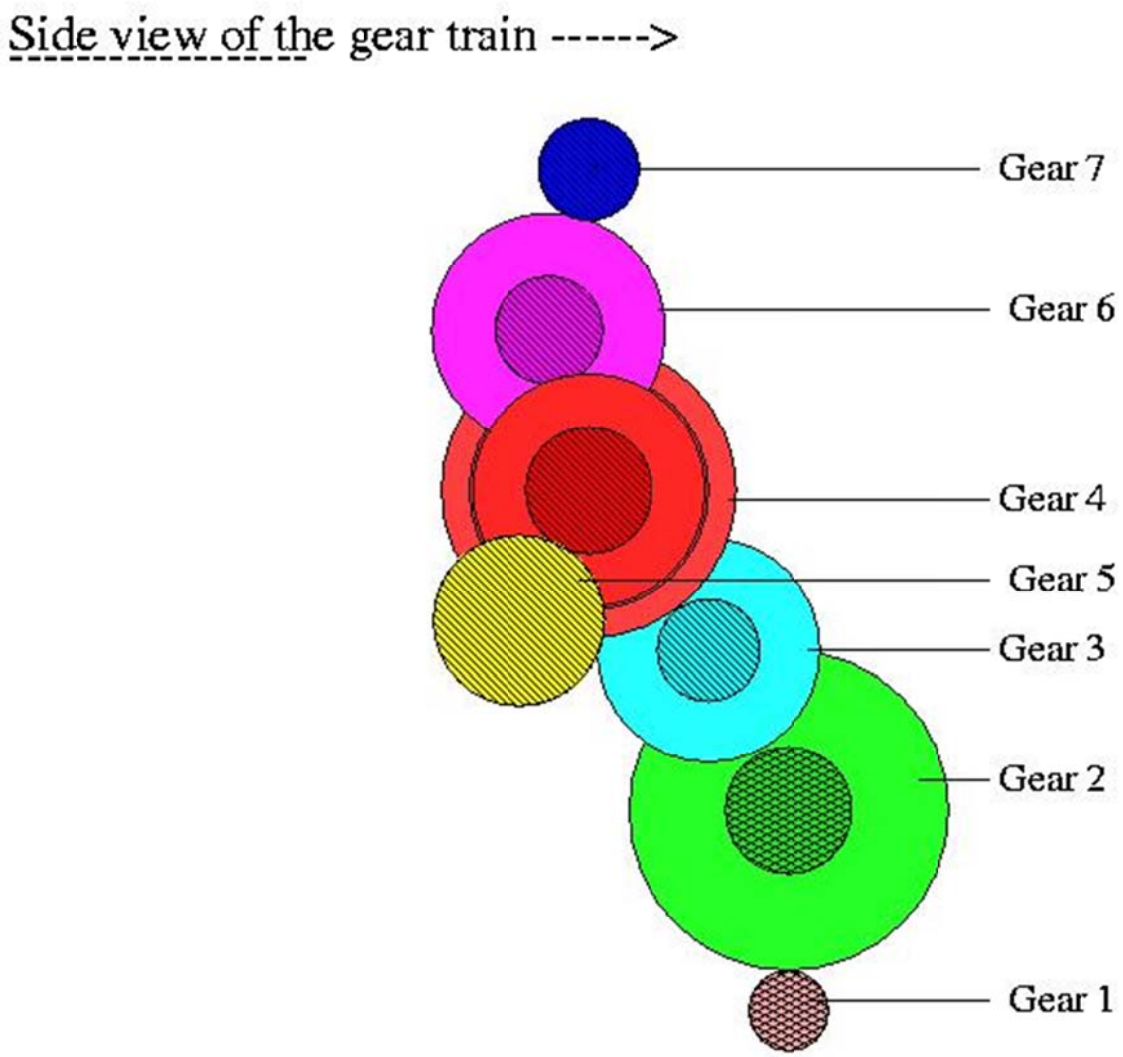
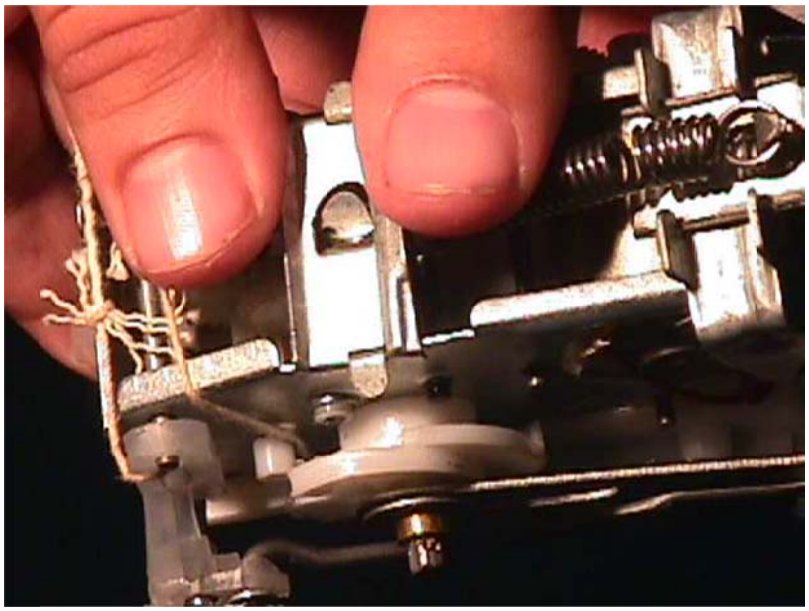


Figure 1(b): SIDE VIEW OF THE GEAR TRAIN

BACK

The disc :-

The pictorial view of the disc is shown in Picture B.



PICTURE B

The input to the disc comes from Gear 5 which in turn is driven by Gear 4. The cam rotates in the clockwise direction as seen from side A. The disc is attached to a special type of cam as shown in the figure 2. The cam has two distinguishable zone.

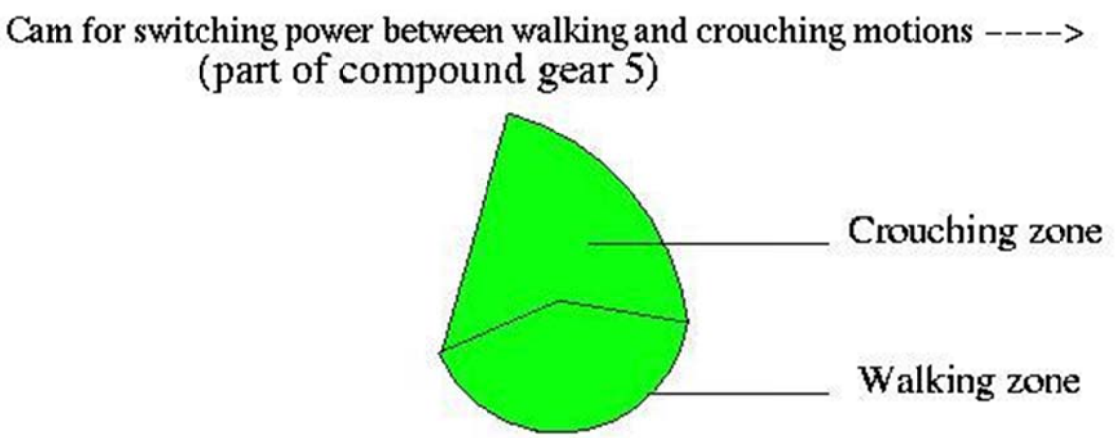


Figure 2: THE CAM SHOWING WALKING AND CROUCHING ZONE

- **Walking zone : The cam rotates in the clockwise direction. A slider is attached to the cam. In this zone the radius of the cam remains constant. And so the slider remains where it is. This is how crouching is avoided during walking.**
- **Crouching zone : In this zone the radius of the cam keeps on increasing. Therefore the cam pushes the slider in the forward direction. The rear part of the slider is attached to the midpoint of the rear legs.Since the upper part of the rear leg is stationary, so the lower part of the rear leg moves in the forward direction due to slider movement and the dog crouches.**

BACK

Walking Mechanism :-

The Gear position during walking is as shown in figure 3.

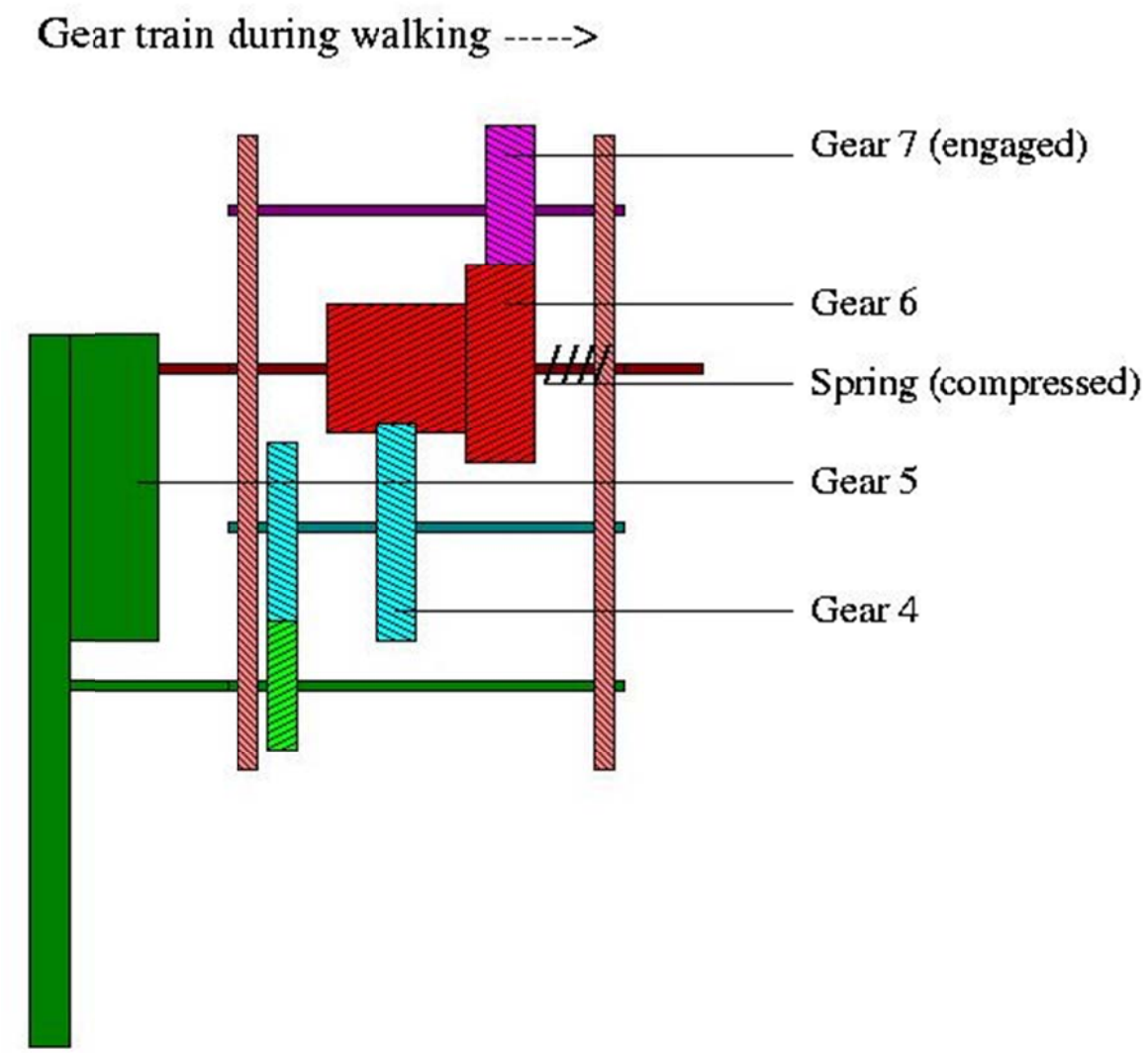


Figure 3: GEAR POSITION DURING WALKING

The disc has a peculiar shape such that during walking it pushes the shaft inwards and hence it compresses the spring loaded shaft driven by Gear 6 and thus Gear 6 engages with Gear 7 which in turn drives the crank of the walking mechanism. The crank is rotating in the anticlockwise direction. The walking mechanism is a 5-link mechanism (shown in fig. 4) between the front and the rear legs (shown as shaded) where the input motion from link 7 (integral with gear 7) is first transferred to the front legs which in this case is the link 8 and then to link 11 on which the rear legs are attached via coupler(link 9). Both the link 8 & link 11 (front and rear legs) are executing to and fro motion.

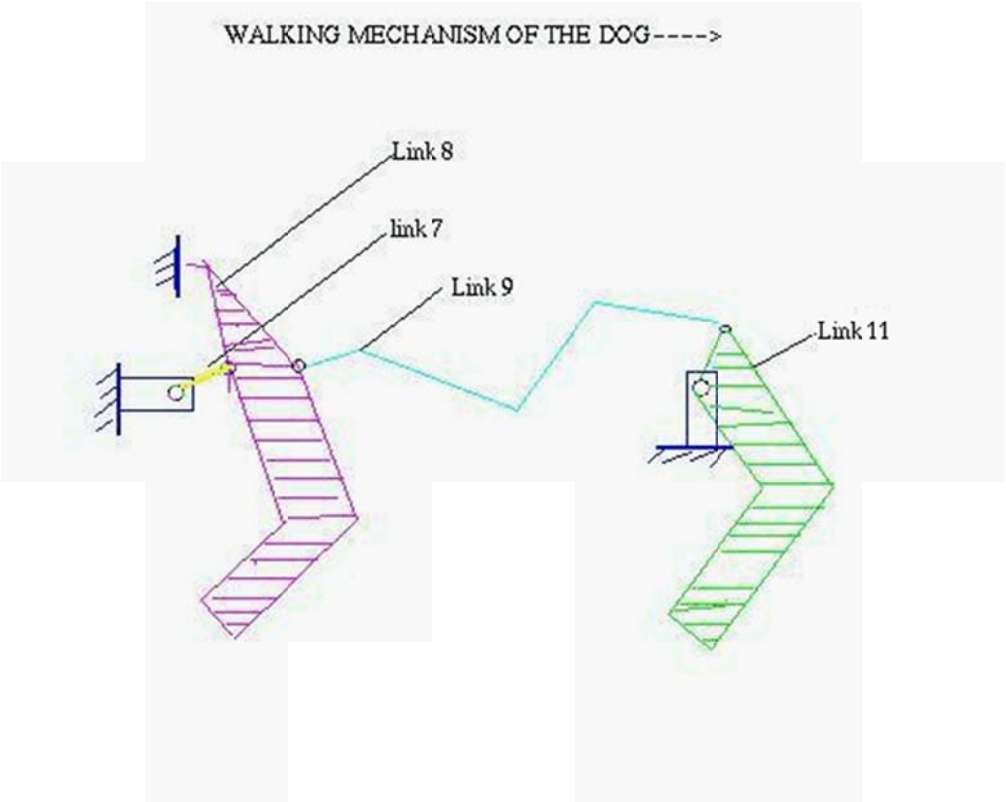


Figure 4:THE WALKING MECHANISM

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Crouching Mechanism :-

The overall mechanism of the system during walking, crouching and somersaulting is shown in the figure 5.

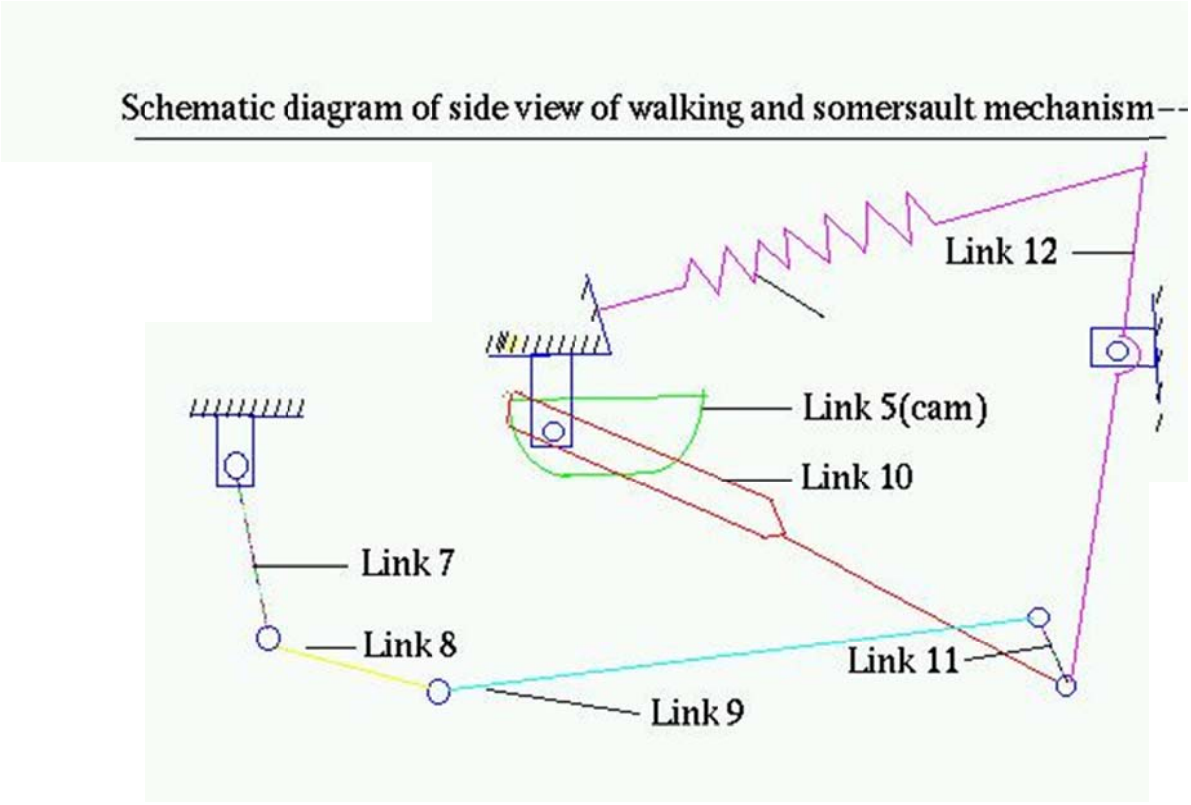
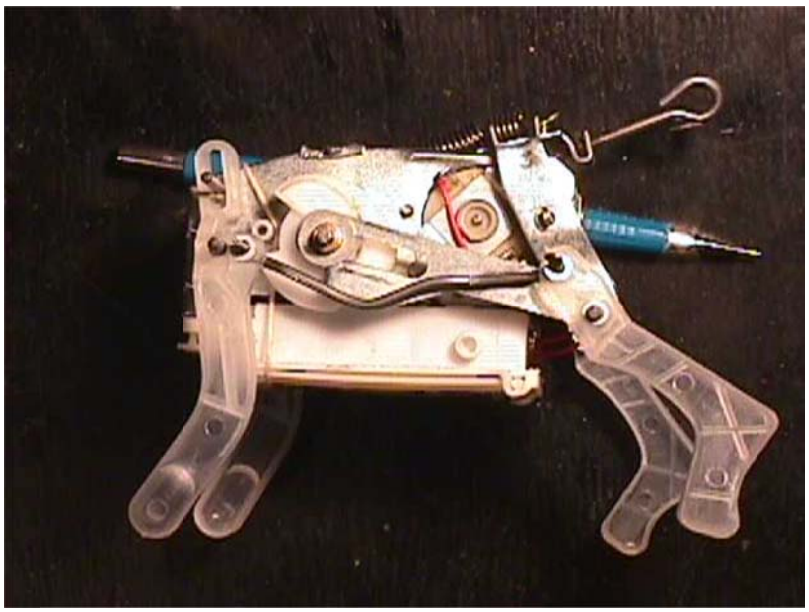


Figure 5: WALKING AND SOMERSAULTING MECHANISM

The picture showing the slider-cam mechanism is shown in Picture C.



PICTURE C

During walking the cam is rotating in the walking zone. In this zone the radius of the cam is constant. So the slider(link 10) remains stationary. The Gear position during

crouching and somersaulting is shown in the figure 6. During crouching the disc releases Gear 6. Due to spring Gear 6 comes back to normal position and thus it disengages with Gear 7. Since Gear 7 was driving the crank(link 7) of the walking mechanism, so the Dog stops walking.

Gear train during crouching and somersaulting --->

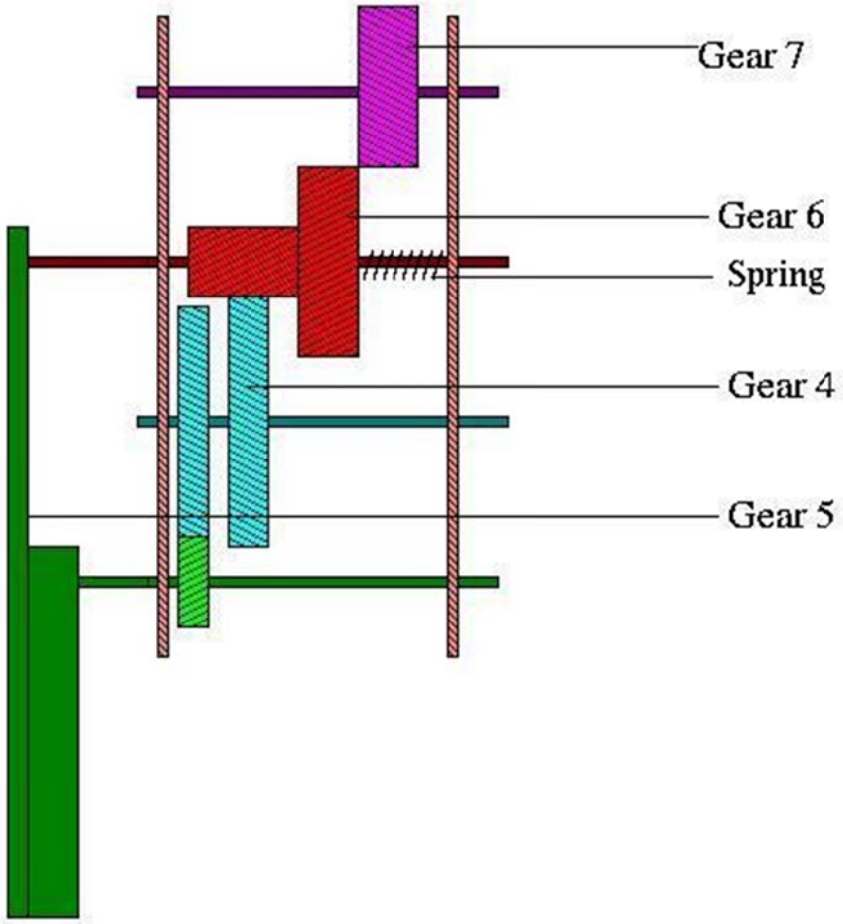


Figure 6:GEAR TRAIN DURING CROUCHING AND SOMERSAULTING

The crouching mechanism is driven by Gear 5 which is the input to the disc. The cam is operating in crouching zone. Now in crouching the radius of the disc is increasing. Since the disc is rotating in the clockwise direction. So it pulls the slider in the forward direction. As the slider goes in the forward direction and the upper end of the rear legs are stationary, so the rear legs go in the forward direction and therefore they crouch upto the Somersault point.

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Somersaulting :-

The force diagram during somersaulting is as shown in figure 6.

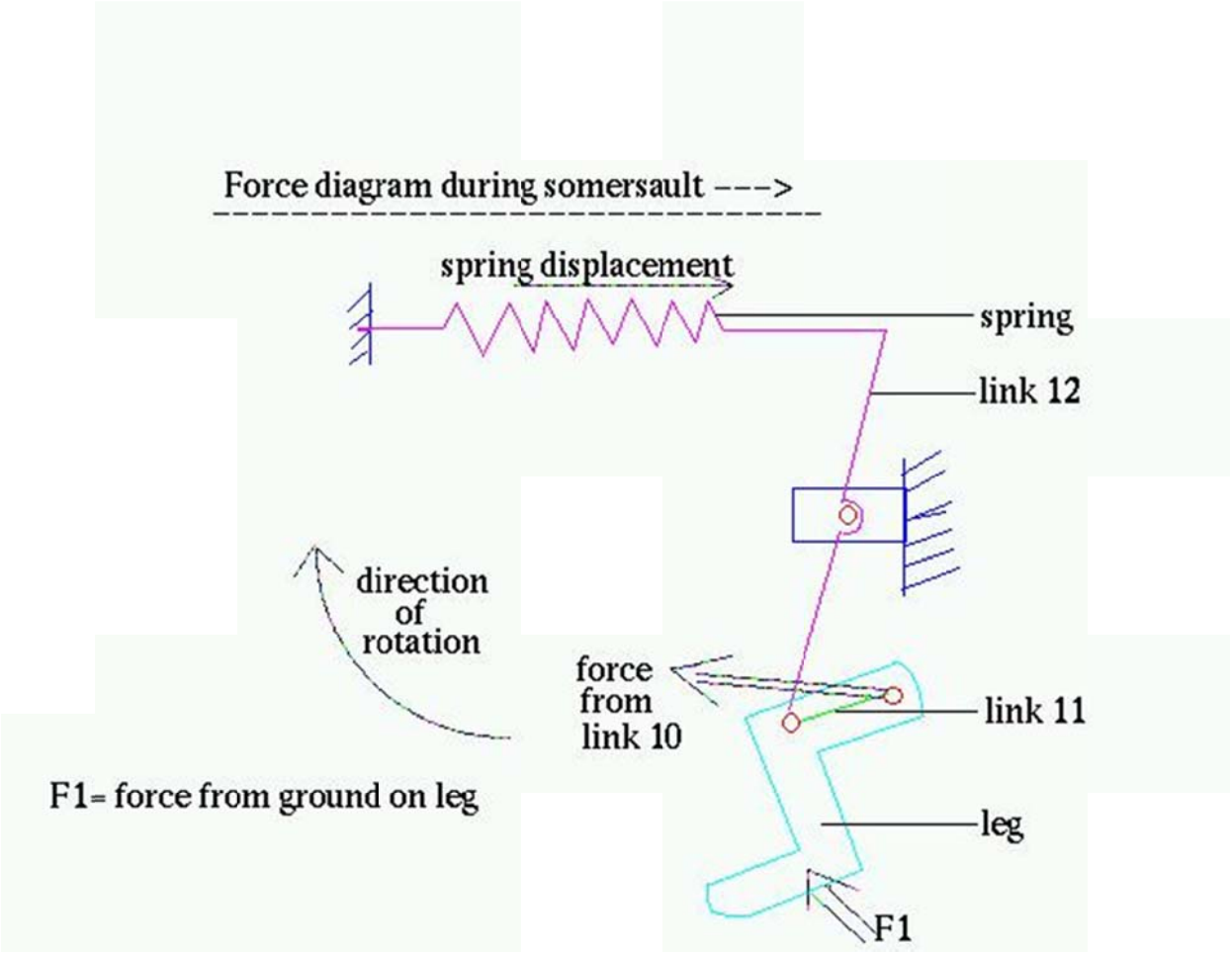

Figure :7FORCE DIAGRAM DURING SOMERSAULT

During crouching the extension spring(See fig. 7) is extended and that's how it creates large elastic forces in the backward direction. Now when the slider reaches the somersault point of the disc, the contact between the disc and the slider breaks. The spring is stretched in the crouching zone due to which there is a large spring force acting in the backward direction. As the contact between the slider and the disc breaks, the supporting force acting against the spring force drops to zero, due to which the rear legs(link 11) try to come back to normal position. So the rear legs exert a huge force on the ground. But since the rear legs are in contact with the ground, the ground also exerts force on the legs. so the whole body of the dog somersaults in the direction shown. The initial tension in the extension spring is adjusted with the help of a screw, so that it can stay upright after somersaulting.

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Special Comments :-

1. **The external covering of the Dog is made of soft, spongy material (particularly at the legs). This is meant for absorbing(damping) the impact shocks due to the landing after the somersault.**
2. **The number of somersaults in the air can be changed by adjusting the initial tension in the extension spring, thereby tinkering with the somersault torque.**
3. **The considerations for using the plastic gears are as follows:-**

- **Load is not too large**
- **Ease of fabrication**
- **Economical in large scale manufacturing**
- **Light weight**

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