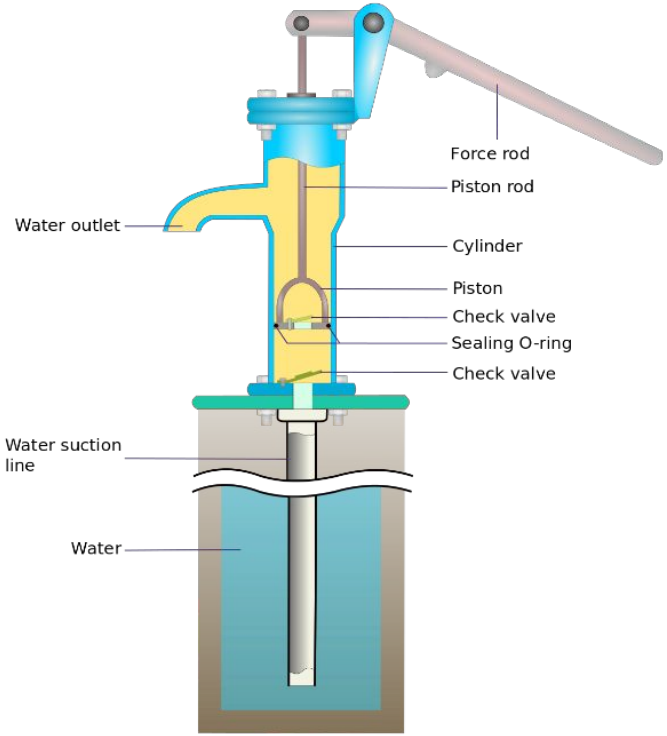


KOM - Mini Project

Basic Water Pump

Mechanism:

When the handle is pushed downwards, the piston moves vertically upwards. During this cycle , the piston valve closes and the foot valve closes. This forms a vacuum below the piston valve. Then water is drawn upwards to fill the vacuum . Now the handle is pulled upwards. During this cycle, the piston valve opens and the water is drawn above the piston. Simultaneously the foot valve closes and prevents water from returning back to the well. In the next cycle, the piston displaces the water through the outlet as shown.

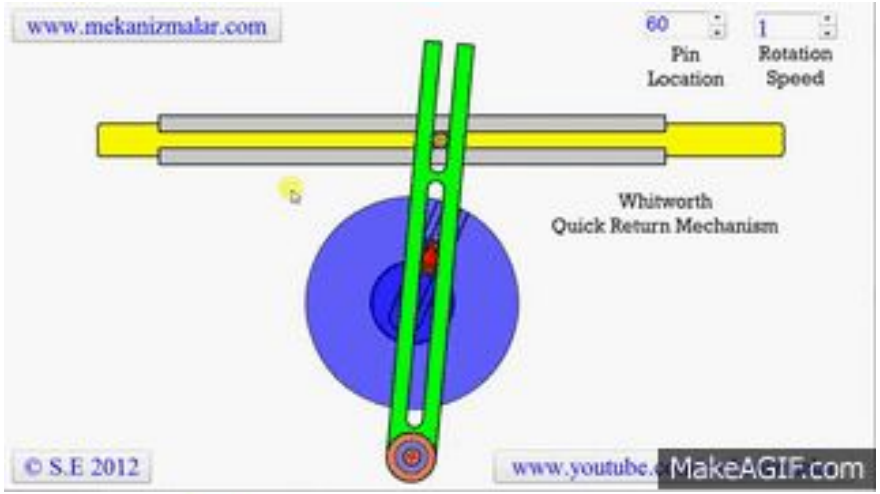
Except the force this time will be produced by the cattle or the rotational inertia concept.

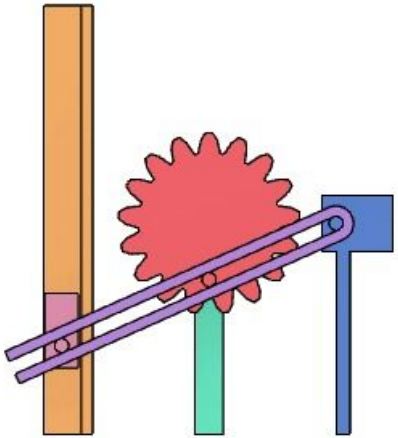
Velocity Multiplier

To convert the torque to speed . Thus, the speed or torque multiplier system will divide the output gear's speed by a factor of Gear ratio.

As Speed input/Speed Output =Gear ratio

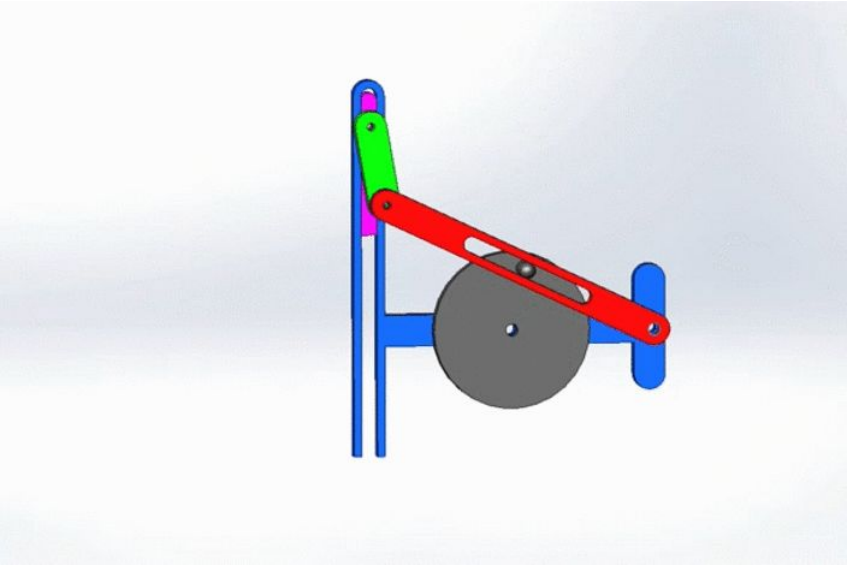
But as can be seen in the diagram, the gear ratio will be less than one (g.r.= no. of output gear teeth to input gear teeth). Thus, we will get the desired velocity.





This is the crank and slotted link type of the Quick return Mechanism.

Basically, we convert the vertical rotary motion into a translational one.



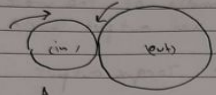
Why Quick Return

It transmits the motion to the Lever EAD through the slider . As a result the lever EAD starts rotating about the point A. As shown in the figure the forward stroke of the ram is slower and return stroke is faster (Angle theta is greater than angle beta). Hence this mechanism is called the quick return mechanism. In this case, a faster return saves time on the forward stroke and thus leads to efficient water drawing.

Ratio of Time of Cutting Stroke to Time of Return Stroke is equal to beta/alpha.

Calculations

Considering a Simple Gear Train,



(in) $t_A = x$
(out) $t_B = y$.

t = teeth
N = rotational speed (RPM)
T = Torque (Nm)

$$\text{Gear Ratio} = \frac{t_{out}}{t_{in}} = \frac{N_{in}}{N_{out}} = \frac{T_{out}}{T_{in}} \rightarrow \text{for ideal efficiency.}$$

$$P = \frac{2\pi N T}{60} \quad \text{And} \quad \mu = \frac{P_{out}}{P_i}$$

Now, we know the cattle could produce a Force of say F_B. Multiplied by the Moment arm, say (l_{AB}), we get the torque input.

$$T_{in} = F_A \times l_A$$

$$\text{Gear Ratio} = \frac{t_{out}}{t_{in}} = \frac{t_B}{t_A} = \frac{y}{x}$$

For Ideal Torque output

$$(T_B)_{ideal} = T_{in} \times \text{Gear Ratio} = F_A \times l_A \times \left(\frac{y}{x}\right)$$

But Since we'll be using bevel gears, we take efficiency into consideration.

$$\therefore (T_B)_{ACTUAL} = \mu (T_B)_{ideal} = \mu \times F_A \times l_A \times \frac{y}{x}$$

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Date

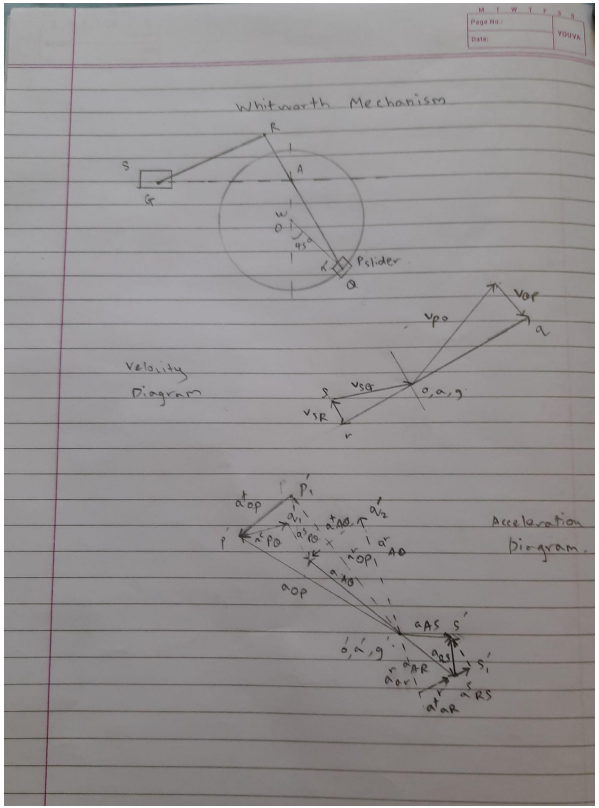
Now we want to get the Torque required to lift the handle of the water pump. Thus, the net output should be

Force × Length of Handle = Torque output

$$\therefore T_{out} = (Mg)_{Pump} \times l_B$$

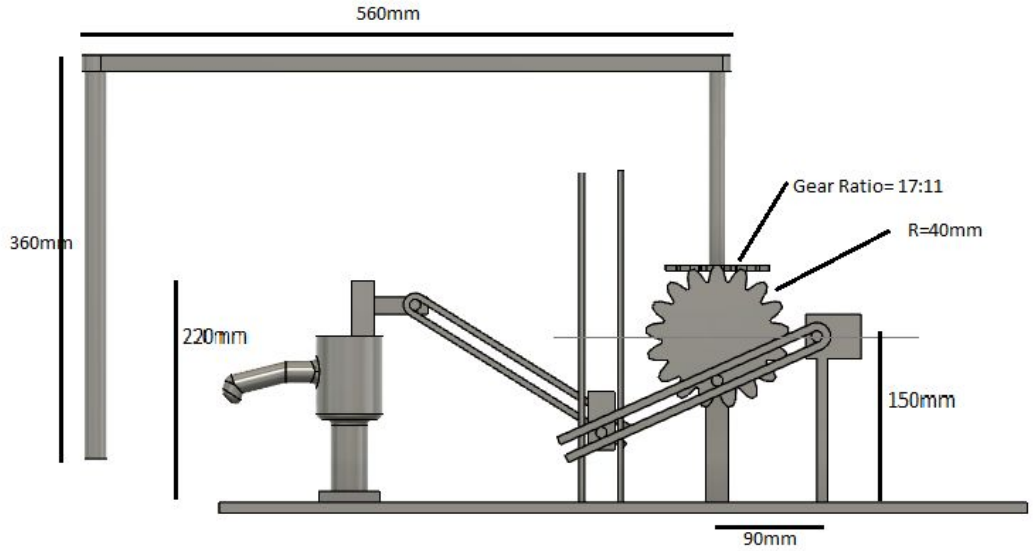
$$\text{Thus, } (Mg)_{pump} \times l_B = \mu \times F_A \times l_A \times \left(\frac{y}{x}\right)$$

Using necessary calculations, we will do the necessary torque to speed conversation.



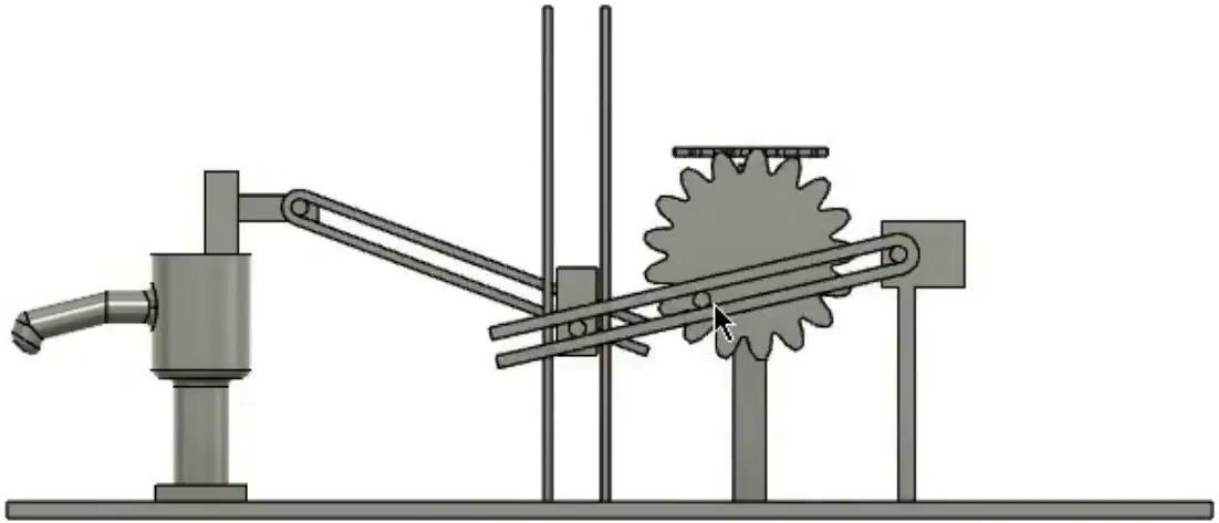
Velocity and Acceleration Diagram for a Simple Whitworth Mechanism

Model Dimensions

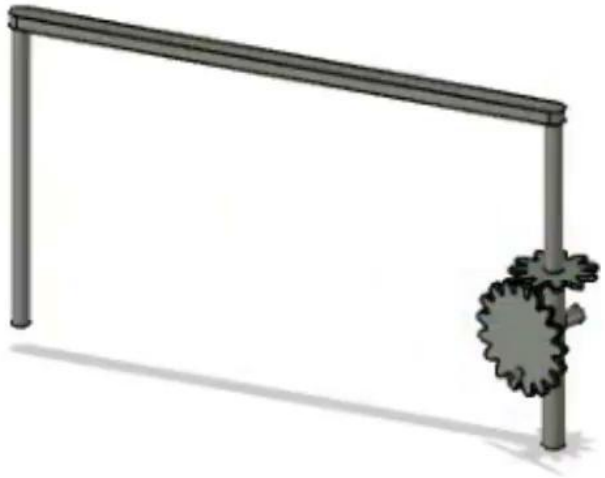


Model Simulations

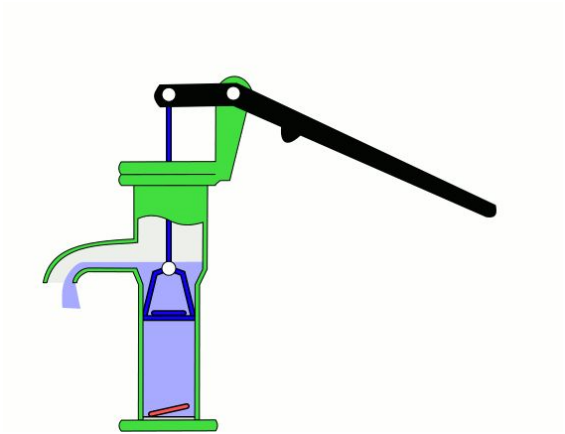
Full Model:



Gear Model:



Cattle Feed (Input)



Pump Motion (output)