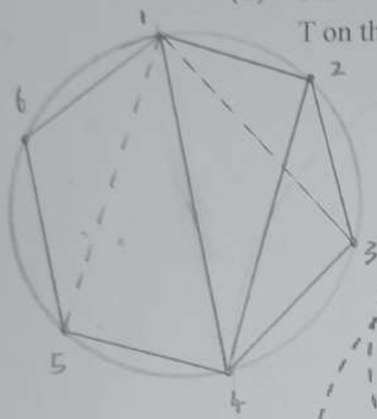
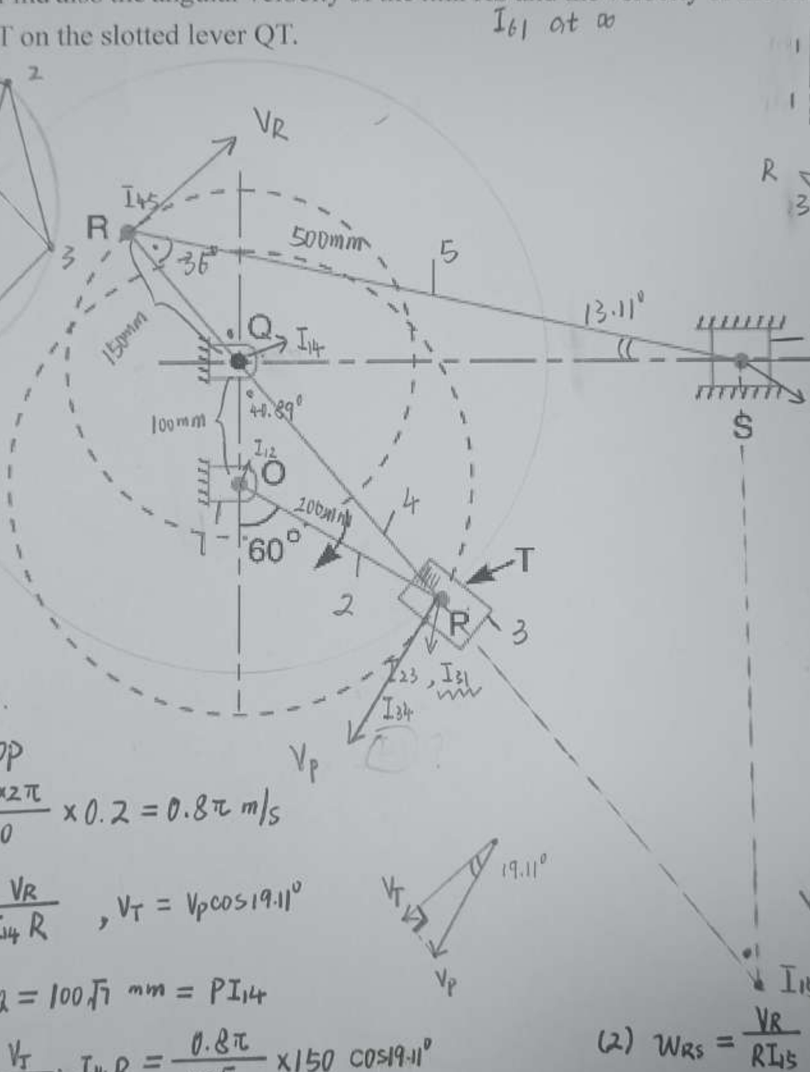
Assignment 2

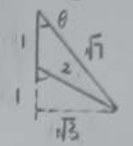
The figure below shows the structure of Whitworth quick return mechanism used in reciprocating machine tools. The various dimensions of the tool are as follows :
OQ = 100 mm ; OP = 200 mm, RQ =150 mm and RS = 500 mm. The crank OP makes an angle of 60° with the vertical.

(1) Determine the velocity of the slider S (cutting tool) when the crank rotates at 120 rpm. clockwise.

(2) Find also the angular velocity of the link RS and the velocity of the sliding block T on the slotted lever QT.

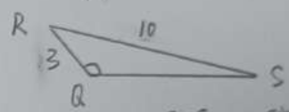






$\cos\theta = \frac{2}{\sqrt{7}}$

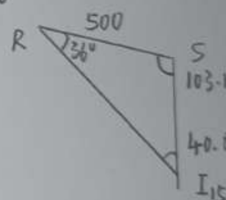
$\theta = 40.89°$



$$\frac{\sin S}{3} = \frac{\sin(90°+40.89°)}{10}$$

$\sin\angle S = \frac{3}{10}\cos 40.89°$

$\angle S = 13.11°$



$$\frac{500}{\sin 40.89°} = \frac{I_{15}S}{\sin 36°} = \frac{RI_{15}}{\sin 103.11°}$$

I_{12}, I_{24}, I_{14}

?

采用瞬心法.

解：(1) $V_P = \omega \cdot OP$

$$= \frac{120\times 2\pi}{60}\times 0.2 = 0.8\pi \ m/s$$

$$\frac{V_T}{I_{14}P} = \frac{V_R}{I_{14}R} \quad , V_T = V_P\cos 19.11°$$

ΔQOP 中, $PQ = 100\sqrt{7}$ mm $= PI_{14}$

$$\Rightarrow V_R = \frac{V_T}{I_{14}P}\cdot I_{14}R = \frac{0.8\pi}{100\sqrt{7}}\times 150\cos 19.11°$$

$$= \frac{1.2\pi}{\sqrt{7}}\cos 19.11° \ m/s$$

$$\frac{V_R}{RI_{15}} = \frac{V_S}{SI_{15}}$$

$$\Rightarrow V_S = \frac{SI_{15}}{RI_{15}}\cdot V_R = \frac{\sin 36°}{\sin 103.11°}\times\frac{1.2\pi}{\sqrt{7}}\cos 19.11° = 0.8126 \ m/s \ \boxed{ANS}$$

(2) $$\omega_{RS} = \frac{V_R}{RI_{15}} = V_R\cdot\frac{\sin 40.89°}{0.5}\cdot\frac{1}{\sin 103.11°}$$

$$= 1.810 \ rad/s \quad \boxed{ANS}$$

$$V_{TP} = V_P\sin 19.11° = 0.8228 \ m/s$$

$$V_T = V_P\cos 19.11° = 2.375 \ m/s \quad \boxed{ANS}$$

12012127 邹佳驹

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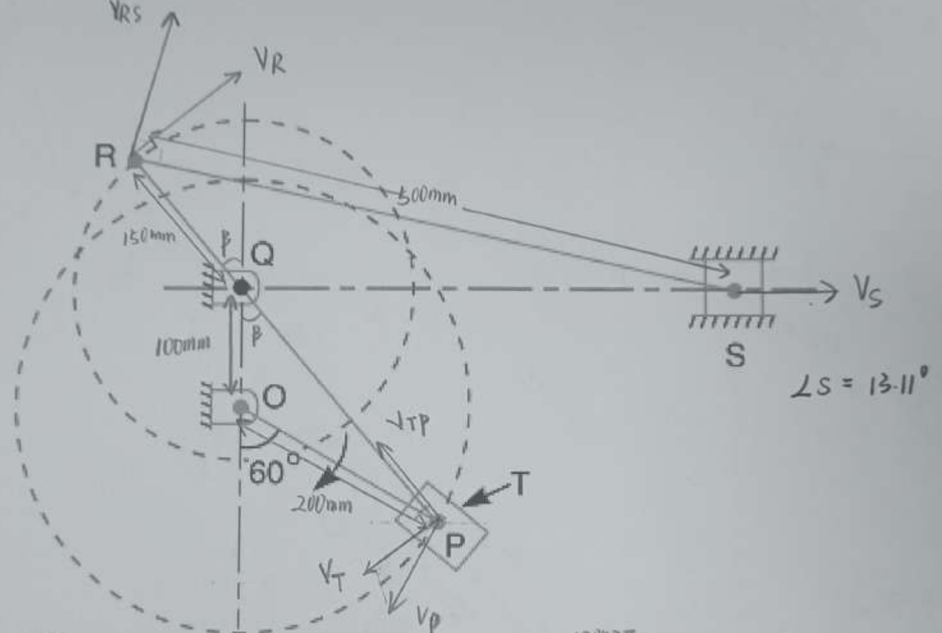
The figure below shows the structure of Whitworth quick return mechanism used in reciprocating machine tools. The various dimensions of the tool are as follows :
OQ = 100 mm ; OP = 200 mm, RQ =150 mm and RS = 500 mm. The crank OP makes an angle of 60° with the vertical.

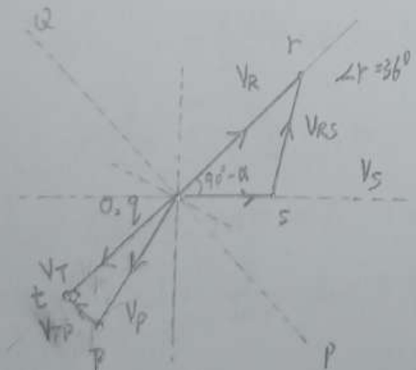
(1) Determine the velocity of the slider S (cutting tool) when the crank rotates at 120 rpm. clockwise. $w = \frac{120\times 2\pi}{60} = 4\pi\ rad/s$

(2) Find also the angular velocity of the link RS and the velocity of the sliding block T on the slotted lever QT.



$\angle S = 13.11°$

解：采用相对运动图解法



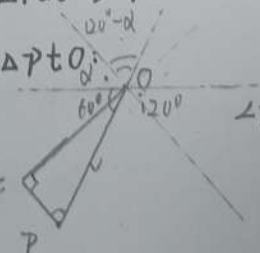
V_{TP}沿PQ方向

(1) $V_P = OP \cdot W_{OP} = 0.2\times\frac{120\times 2\pi}{60} = 0.8\pi\ m/s$

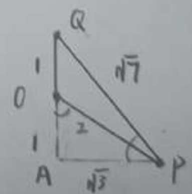
$\left.\begin{aligned} V_R &= RQ\cdot W_{RP} \\ V_T &= QP\cdot W_{RP}\end{aligned}\right\} \Rightarrow \frac{V_R}{V_T} = \frac{RQ}{QP}$

$\Delta PQO \Rightarrow PQ = 100\sqrt{7}\ mm$

Δpto:



$\angle p = 120° - \alpha$



$\angle QPA = \alpha$

$\sin\alpha = \frac{2}{\sqrt{7}}$

$\alpha = \sin^{-1}(\frac{2}{\sqrt{7}}) = 49.11°$

$\angle Q = \beta$

$\sin\beta = \frac{\sqrt{3}}{\sqrt{7}}$

$\beta = \sin^{-1}(\frac{\sqrt{3}}{\sqrt{7}}) = 40.89°$

$ot = V_T = OP\cdot\sin P =$

$\Rightarrow V_R = \frac{RQ}{QP}\cdot OP\cdot\sin P = \frac{RQ}{QP}\cdot V_P\cdot\sin(120° - \alpha) = 1.346\ m/s$

ΔRQS中，$\frac{RS}{\sin(90°+\beta)} = \frac{RQ}{\sin\angle S} \Rightarrow \angle S = \sin^{-1}\left[\frac{RQ}{RS}\sin(90°+\beta)\right] \Rightarrow \angle r = (\frac{\pi}{2} - \angle S - \beta)$

$\frac{V_{RS}}{\sin(90°-\alpha)} = \frac{V_S}{\sin\angle r}$

Δrso中，$\frac{V_S}{\sin\angle r} = \frac{V_R}{\sin(90°-\alpha+\angle r)} \Rightarrow V_S = 0.8123\ m/s$ $\boxed{ANS}$

$\Rightarrow V_{RS} = 0.9046\ m/s$

(2) $W_{RS} = \frac{V_{RS}}{RS} = 1.809\ rad/s$ ，$V_{TP} = V_P\cdot\sin\angle tOP = 0.8228\ m/s$ $\boxed{ANS}$

$V_T = V_P\sin\angle P = 2.375\ m/s$