# Introduction to hardware design HA(1) (20 points)

**To design an automatic tilter (turner) for metal workpieces.**

Type of workpieces:  sheet metal

Material: Spring Steel

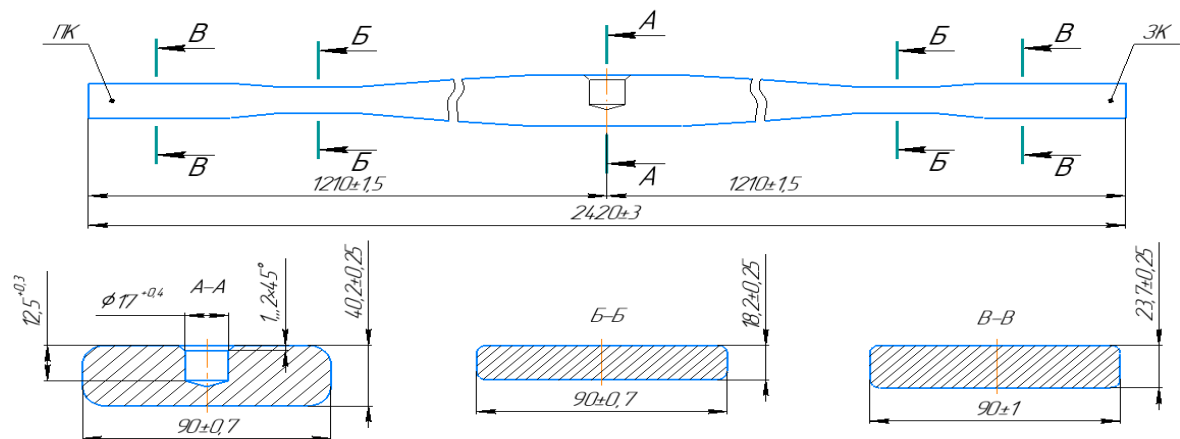Sheet width:  44 – 120 mm

Sheet thickness:  6 – 65 mm

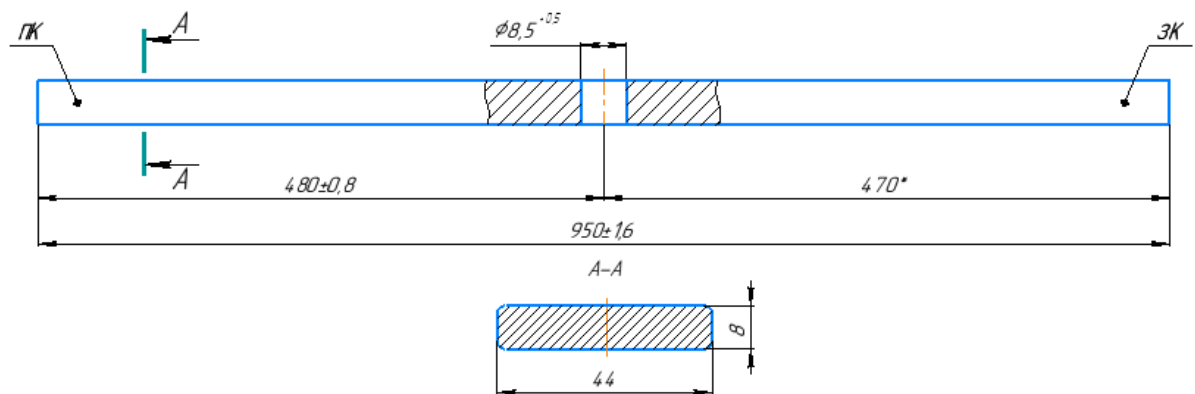Sheet length:  900 – 2500 mm

Workpiece weight:  2 – 50 kg

*Examples of blanks are given below.*

*Billet #1*



Workpiece weight 47 kg

*Billet #2*



The workpiece is 2.6 kg.

**Requirements:**

- The manipulator should automatically turn the workpieces 180 degrees along the long side.
- The time of the reversal cycle is the lowest possible (approximately no more than 2... 3sec)

Initial location of the workpiece cross-section



 Required cross-sectional location of the workpiece.



A robot with a magnetic gripper shall place the workpiece and pick it up again after the flipping process.

## Task:

1. Design a Grashof 4-bar mechanism that shall flip the workpiece to 180 degrees.
2. Design a 6-bar mechanism to execute the task with continuous motion by the crank link.
3. Design a 4-bar or a 6-bar mechanism with a quick return.
4. Redesign your 6-bar mechanism to use a pneumatic actuator.
    a. The pneumatic actuator has a travelling length of 160mm.
    b. The pneumatic cylinder has a retracted length of 325mm.

Hints:

- To keep the accuracy of the piece's location, it is better to design the motion on two stages.
- You will probably need **two** synchronized mechanisms.

## Your submission:

- Submit a schematic of your design process.
- A short description of your reasoning behind the proposed design.
- Any animation of the motion (Geogebra is fine). Here's a [tutorial](#).