ME2300 Project Report on Manufacturing of a Geneva Wheel

ME22B088[1], ME22B086[2], ME22B092[3], and ME22B143[4]

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0.1 Introduction

This report outlines the selection of raw material, manufacturing processes, and processing sequence for fabricating a Geneva wheel in mild steel with a production target of 100 pieces per day.

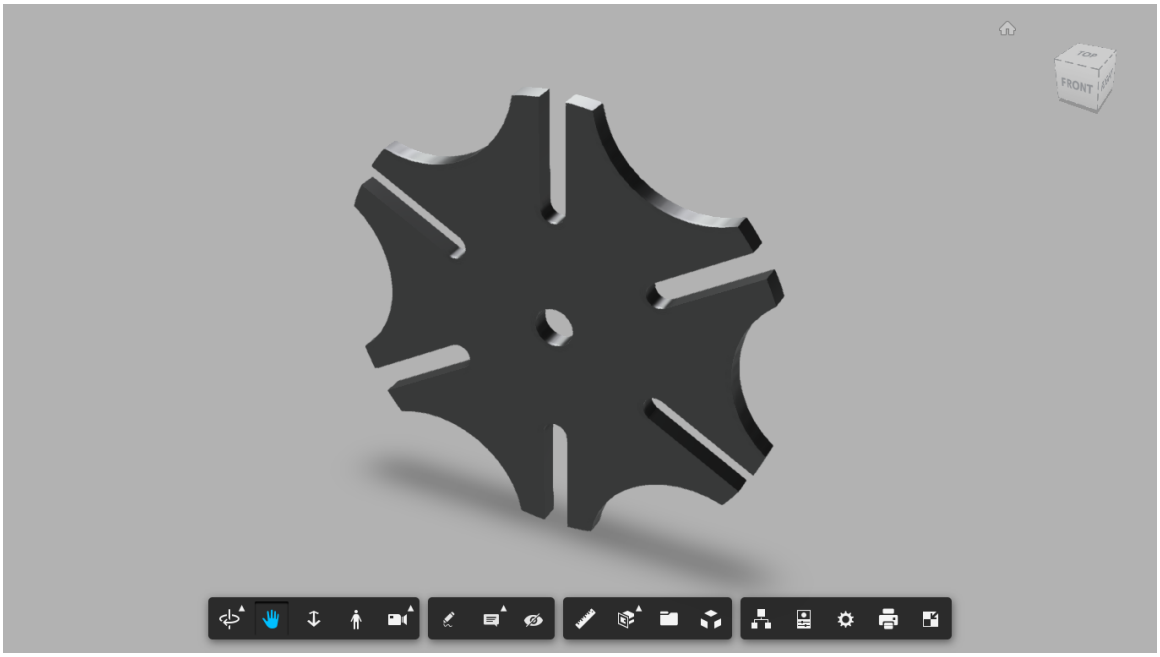

Figure 1: A render of the required product using Fusion 360

0.2 Material Selection

- Mild steel plate with a thickness appropriate for the desired Geneva wheel strength and application requirements;
- Cutting and machining tools suitable for mild steel (e.g., lathe, milling machine, drill press, cutting blades);
- Welding materials (optional, if joining multiple pieces is necessary);
- Finishing tools (e.g., sandpaper, deburring tool);

0.3 Raw Material Shape and Dimensions

To ensure that we have enough material for machining and finishing the Geneva wheel with the specified dimensions, the metal plate dimensions should be chosen to accommodate the largest diameter and thickness required. Here's a breakdown of how we determined the appropriate dimensions for the metal plate:

Dimensions of the Geneva Wheel:

- Outer Diameter: 230 mm;
- Thickness: Not specified, but let's assume it to be 10 mm;
- Clamping and machining tolerances: 10 mm on each side should be sufficient;

Calculations for Plate Dimensions:

- Diameter of the plate: 230mm+10mm (extra for machining on each side) = 240mm;
- Thickness of the plate: Assumed 10 mm as a typical value;

Recommended Plate Dimensions:

- Diameter: 240 mm;
- Thickness: 10 mm;

0.4 Product Shape and Dimensions

- Outer Diameter: ϕ 230 mm;
- Number of Slots: 6;
- Radius of Slots: ρ 51;
- Distance between Slots: 140 mm (centre to center);
- Thickness of Slots: 13 mm;
- Fillet Radius: R115 mm;
- Central Hole Diameter: ϕ20mm (not specified but typically matching the drive pin diameter);

Detailed Calculations:

- Slot Angles:360°/6=60°;
- Half Slot Angle: 60°/2=30°;
- Slot Center to Center Distance: 140 mm;
- Slot Radius: 51 mm;
- Fillet Radius: 115 mm at the intersection of slots;

0.5 Manufacturing Process

There are several methods to manufacture a Geneva wheel in mild steel. The most suitable approach depends on the complexity of the design, production volume, and available resources. Here is the best method for the given use case:

Machining from Solid Plate

1 **Prepare the blank**:
   - Material: Obtain a mild steel plate with the required dimensions, which must be 10mm thick and greater than a circle 240mm in diameter.
   - Marking: Mark a circle of diameter 240 mm on the plate to ensure that we have enough material for machining.

2 **Rough cutting**: Use a bandsaw, waterjet cutter, or similar equipment to roughly cut out the Geneva wheel with the marked diameter of 240 mm from the plate.

3 **Machining**:
   - Secure the Blank: Use a lathe or milling machine to secure the blank.
   - Outer Periphery: Machine the outer diameter (ϕ240 mm) to ensure accuracy.
   - Slots: Machine the slots with a radius of R51 mm, spaced 140 mm apart (center to center) and with a thickness of 13 mm.
   - Fillet: Add the fillet radius of R115 mm at the slot intersections to ensure smooth transitions.

4 **Drilling**: Drill the central hole for shaft mounting, matching the required diameter (not specified, but assume ϕ20mm. Ensure the hole is concentric with the outer diameter.

5 **Deburring and finishing**: Remove burrs and sharp edges using files, sandpaper, or deburring tools. Ensure all machined surfaces have the required surface finish and dimensional accuracy.

0.6 Quality Control

- Dimension verification: Measure critical dimensions of the Geneva wheel (e.g., overall diameter, slot width/depth, shaft hole diameter) using calipers or micrometers to ensure they meet design specifications.
- Visual inspection: Inspect the Geneva wheel for any defects such as cracks, scratches, or uneven surfaces.
- Functionality testing (optional): If possible, perform a test run of the Geneva wheel mechanism to ensure smooth operation and proper indexing.

0.7 Conclusion

Manufacturing a Geneva wheel in mild steel requires careful planning, selection of appropriate manufacturing methods, and quality control procedures. Following the outlined steps and considering the specific design requirements will ensure the production of a functional and reliable Geneva wheel.
Machining a Geneva wheel from a solid plate is a good choice for this scenario considering the moderate complexity of the design, low production volume of just 100 pieces per day, and widespread availability of machining tools. The steps are sequenced for optimal efficiency and precision.
Starting with a marked plate ensures enough material and defines the final size. Rough cutting removes excess material quickly. Then, machining creates accurate features in a specific order: outer diameter first, then slots and fillets relative to the diameter, and finally the central hole concentric with the outer diameter. Deburring and finishing are the final touches for a smooth, functional Geneva wheel.

Machining from a solid plate, as described previously, would not be an economical choice for producing 10,000 Geneva wheels per month due to several reasons:

- Machining is a slow process, making it unsuitable for high production volumes, which would require a significant number of machines and machining hours.
- Rough cutting from a solid plate wastes a considerable amount of material. This becomes significant when producing a high volume of parts, impacting overall cost.
- Machining requires skilled labor to program and operate the machines. Setting up each part for machining is also time-consuming. For mass production, this translates to high labor costs per unit.
- Therefore, for high-volume production of Geneva wheels, alternative manufacturing processes are more suitable. Here are some better options:
  - Stamping is a fast and cost-effective method for creating identical metal parts from sheet metal. A stamping tool can produce a Geneva wheel in a single press stroke, significantly reducing production time per unit.
  - Die casting is ideal for complex shapes like Geneva wheels and offers good production rates. Molten metal is injected into a reusable mold, allowing for quick production of large quantities.
  - While not ideal for the reasons mentioned earlier, automating CNC machining can improve efficiency for high volume compared to manual machining. A program can control the machine, reducing setup time per unit. This can be a good option if the Geneva wheel has complex features that are difficult to achieve with stamping or die casting.

0.8 Additional Considerations

- For high-precision applications, we may consider post-machining processes like grinding for improved surface finish and dimensional accuracy.
- Depending on the application, surface treatments like painting or powder coating may be applied for corrosion resistance or aesthetic purposes.
- Safety precautions should be followed during all manufacturing processes, including wearing appropriate personal protective equipment.