

Design Rationale Document

Wire Feeder Assembly for WAAM

1. Rendered Views

Below are key visualizations of the wire feeder assembly.

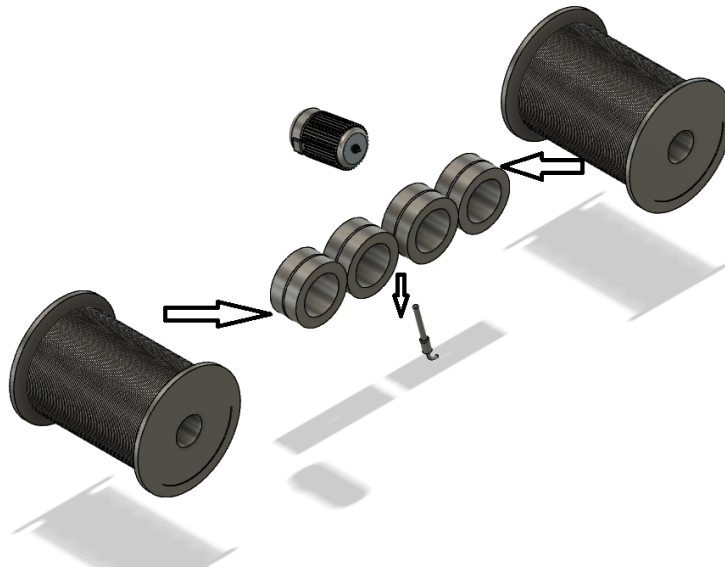
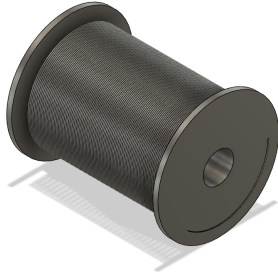
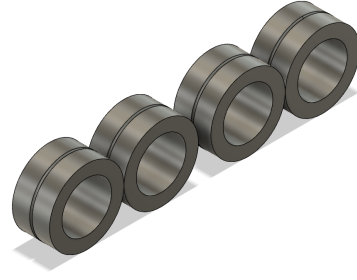


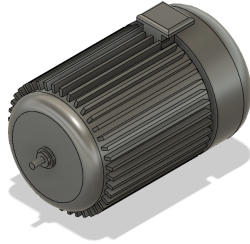
Figure 1: Isometric view of wire feeder assembly



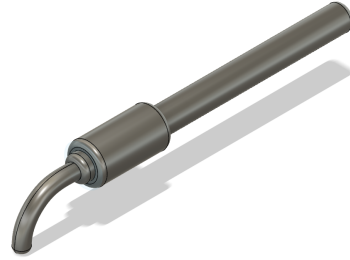
(a) Wire spools



(b) Wire feeder unit



(c) Motor assembly



(d) Wire feeder gun

Figure 2: Key components of the wire feeding system in WAAM

2. Component Overview

The wire feeder is a key subsystem in WAAM, enabling precise, continuous metal feed. A dual-spool setup allows for switching between alloys—ideal for functionally graded or hybrid material deposition.

In my master’s project, I explored alternating FeSi and Al wires to create variable electrical steel properties layer-by-layer. This system supports such advanced, data-driven strategies.

3. Functional Description

- **Frame:** Structural support for all assemblies.
- **Wire Spools:** Dual-spool configuration for multi-material applications.
- **Spool Holders:** Secure and guide spool unwinding.
- **Rollers:** Ensure accurate and consistent wire feed.
- **Guide Tube:** Low-friction passage for smooth delivery to nozzle.
- **Motor:** NEMA 17 stepper motor for controlled feed rate.
- **Feeder Gun:** Dual-input nozzle with sensors for multi-alloy deposition.

4. Material Selection

Part	Material	Rationale
Frame	Aluminum 6061	Lightweight, corrosion-resistant, easy to machine.
Wire Spools	Inconel / Stainless Steel	Suitable for high-temperature alloy compatibility.
Spool Holders	Aluminum 6061	Lightweight and strong.
Rollers	Hardened Steel	Durable and wear-resistant.
Guide Tube	PTFE / Stainless Steel	Provides smooth flow and high thermal resistance.
Motor	NEMA 17 Stepper	Precise 1.8° step resolution, 45 N·cm torque, 12V operation.
Feeder Gun	Dual-input nozzle	Enables controlled, multi-material deposition.

5. Thermal and Environmental Constraints

- Exposure to arc heat necessitates robust shielding.
- Roller and guide components must withstand elevated temperatures.
- Motors require insulation or offset positioning.
- Preheated wires improve flow and reduce residual stress.

6. Motion and System Integration

- Stepper motor drives rollers via geared coupling.
- Wire routed through flexible metallic conduits.
- Feeder can be integrated into robotic or fixed setups.
- Supports automated switching between spools.

7. Advantages and Limitations

Advantages:

- Multi-material printing enabled via dual spools.
- Modular, compact, and easy to maintain.
- Lightweight design for robotic compatibility.

Limitations:

- More complex mechanism and control logic required.
- Sensitive parts need robust thermal protection.