Rapid Solidification Machine

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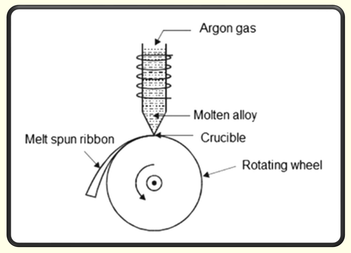
Overview

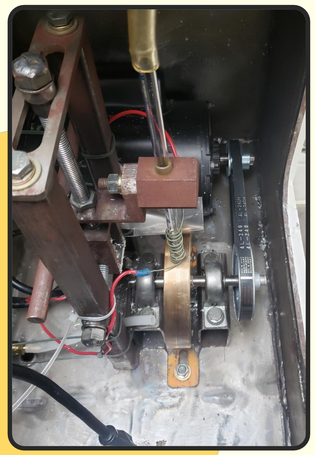
Rapid Solidification: is a process that applies extreme temperature gradients to a material, forcing it to quickly transition from a liquid to a solid phase, forming a new microstructure.

Types of Rapid Solidification:
- Melt Spinning
- Droplet Cooling onto a cold surface
- Surface Melting using lasers



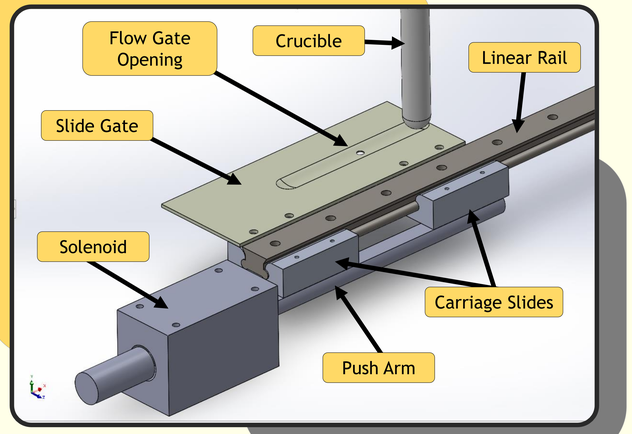
Objective

To refurbish and retrofit a pre-existing machine to be able to process aluminum samples as well as upgrade controls to a digital system.

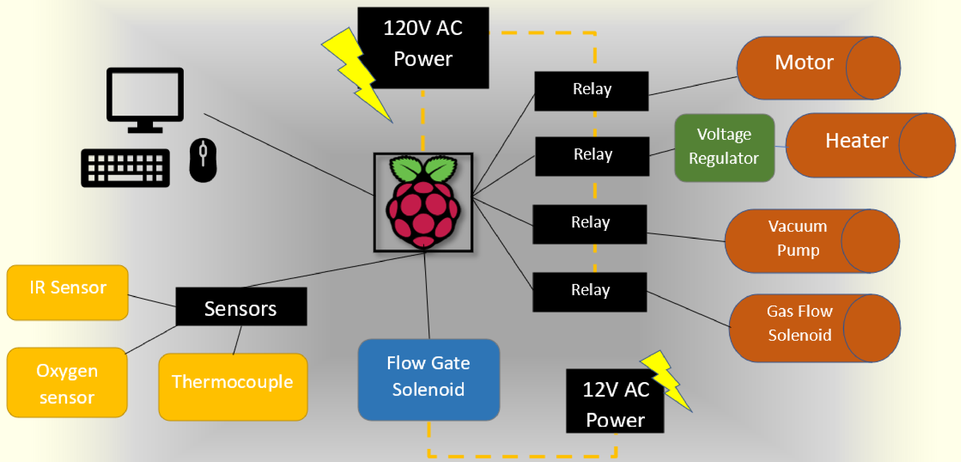


Flow Gate Actuation

WHY: It was determined that some of the samples appeared chunky. It is believed that the chunky texture was due to pieces of the sample material not being fully melted before falling out of the melt chamber. This design addresses the concern that the melted sample was non-homogenous by introducing a flow gate at the opening of the crucible. The flow gate prevents the partially melted sample from prematurely dropping out of the melt crucible before reaching desired melt temperature.



Automation



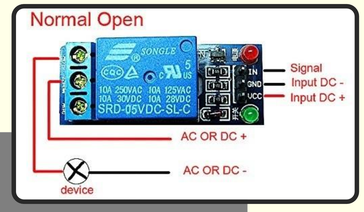
A Raspberry Pi 4 was used to control eight different components to automate sample processing. The program was developed using Raspbian OS and Python.

Process

1.) Relay A activates and powers the vacuum pump.

2.) Oxygen sensor detects a preset % O2 and shuts off the vacuum pump.

3.) Relay B activates and powers the voltage regulator, which controls power to the resistance heater.

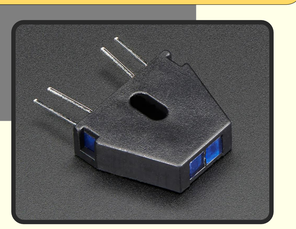


4.) Resistance heater increases the sample's temperature.

5.) Thermocouple detects a preset melt temperature.

6.) Relay C activates and powers the motor, driving a belt which spins the copper wheel.

7.) IR sensor takes an RPM measurement for the trial.



8.) Relay D activates, opening the gas flow solenoid which pressurizes the feed line to the crucible.

9.) The flow gate solenoid is activated, pushing the hole in the slide gate underneath the crucible.

10.) Melted sample material is deposited onto the copper wheel, cools, and is transferred to the holding bin.

11.) All relays and components are turned off by the pi program.