Grim Reaper Broadheads

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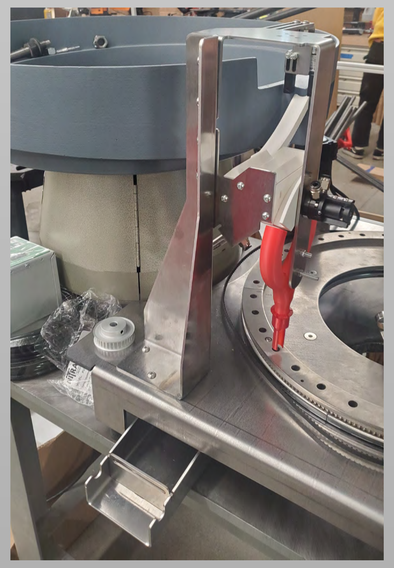
PROBLEM STATEMENT

Grim Reaper Broadheads is a local manufacturer of hunting broadheads. Grim Reaper Broad\heads has noticed that their broadheads are prone to loosening from the vibration of being fired. We are attempting to implement an automated polymer application process to fix this issue.

ALIGNMENT



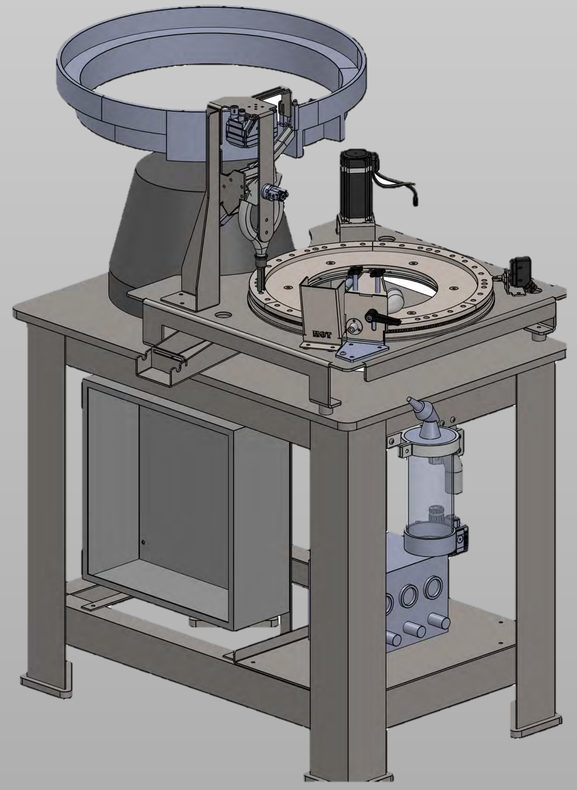
Loose broadheads exit the vibratory bowl in a single file line. One at a time, broadheads enter a flipper mechanism. Here, a vision system determines if the broadheads need to be dropped into the left or right chute. This mechanism is controlled pneumatically. Below is a test performed to show accuracy of the chute measured off center from the conveyor holes with different broadhead types.

Drop Accuracy Test				
Model #	Distance (cm)			
	0.5	0	-0.25	-0.5
1	0%	100%	100%	100%
2	0%	90%	100%	87%
3	0%	85%	93%	87%
4	0%	55%	100%	73%

SPRAY SYSTEM

A powder coating injector and fluidizing hopper were repurposed to apply nylon powder to the threads. When the threads have been heated to the appropriate temperature, the powder is fired in single bursts and then melts on contact. A pneumatic vacuum has also been fitted to collect excess powder.

OVERVIEW



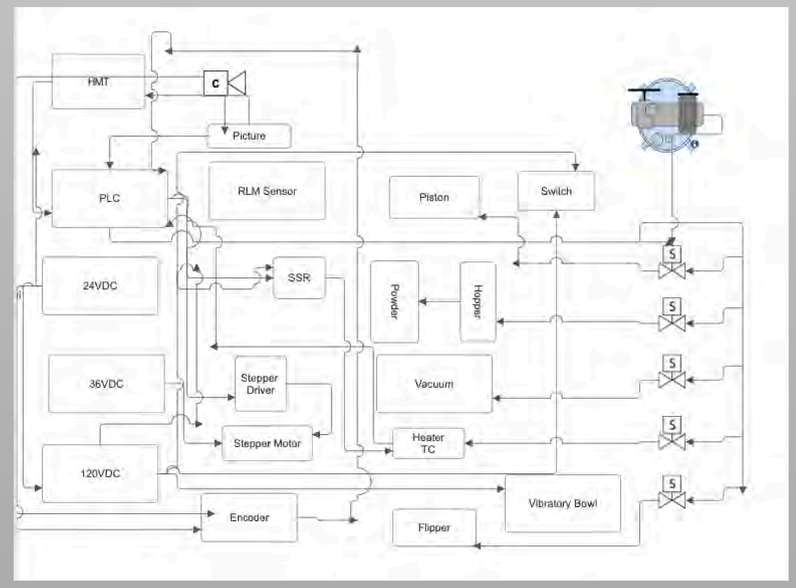
The assembly line consists of an alignment system with a vibratory bowl and a flipping mechanism. The broadheads then drop into a conveyor where they are transported to a heating chamber and a spraying chamber until they drop into a hole that sends them to a metal box and then into a bucket. The system is controlled by a programmable logical controller for autonomous movement. An example of the final product is shown below.

HEATER

The following equations were used in order to conduct heat transfer convection analysis, we were able to determine the air temperature required to heat the broadheads to 280℃. This yielded an air temperature of 700 ℃, Hence it was possible to get the heating time to around 3 seconds for stainless steel and about 2 seconds for aluminum.

$$F_0 = \frac{\alpha k}{Lc^2} \qquad h = \frac{N_u k}{L} \qquad B_i = \frac{R_{cond}}{R_{conv}} = \frac{hL}{k} \qquad \frac{T_2 - T_\infty}{T_1 - T_\infty} = e^{-B_i F_0}$$

P&ID DIAGRAM



This diagram is a P&ID diagram, which illustrates the placement of all the mechanical and electrical components within the system and how they connect to each other.

CONCLUSION

The automated process for applying a nylon polymer coating to Grim Reaper Broadheads has reached a critical stage, with all system components integrated and PLC wiring completed. Individual tests on the vibratory bowl, flipper mechanism, conveyor and spraying system, have been successful, though challenges such as temperature control during spraying, precise alignment for drop accuracy, and system synchronization remain. The next key step is debugging and fine-tuning the complete manufacturing workflow to ensure seamless communication between systems under PLC control. Emphasis should be placed on validating the vision system across designs, optimizing alignment, and addressing system-wide synchronization for efficient operation.