DEPARTMENT OF MECHANICAL ENGINEERING

TEAM Autohammer
Low Profile Nail Gun

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Motivation, Goal, Impact

Motivation

Traditional nail guns are “responsible for an estimated 37,000 emergency room visits each year” (OSHA Nail Gun Safety, n.d.). The leading cause for injuries is “awkward position nailing” which includes “nailing in tight quarters.”

Goal

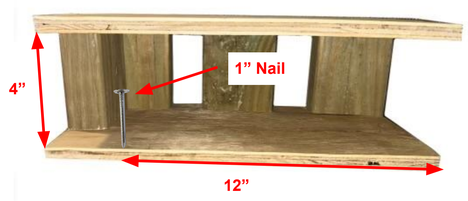
Design and fabricate a nail gun capable of driving nails perpendicular to the insertion surface in a cavity that is 4” tall and 12” long.

Impact

Improve efficiency, safety, and accessibility for carpenters and roofers. Lead to a higher quality work and reduce the risk of user fatigue and injury.

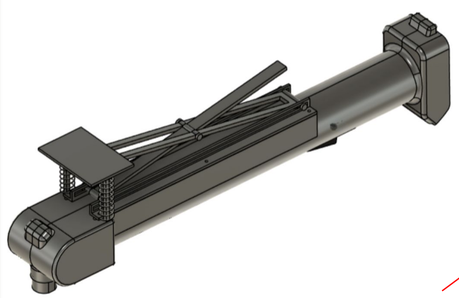
Requirements

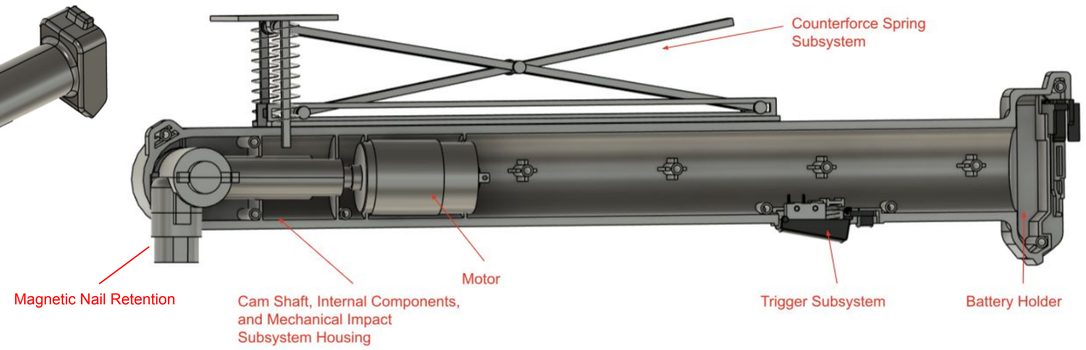
- Function in a cavity that is as small as 4” in height
- Function in a cavity that is 12” or longer
- Drive nails perpendicular to surface
- Compatible with 1” nails
- Insert nails under 6 seconds
- Drive nails into wood
- Low recoil
- Ergonomic grip
- Run only when the user intends to fire



Final Design

Cam-Driven Impact System	Counterforce Spring System	Magnetic Nail Retention	Low Profile Ergonomic Housing	Battery-Powered System
• Convert motor rotation to linear hammer impact on nails • 20V motor, bevel and crown gears, camshaft, cam, hammer head, conical spring, and ball bearing	• Stabilize the tool • Exert force on opposing surface to drive downward nailing • Prevent excessive user strain at an extended reach • User compresses the lever arm to load the spring system	• Retain 1” nail in a magnetic chamber during application	• Compact design for 4” x 12” cavities • Trigger is positioned at rear • Rubber textured grip • Two piece injection molded casing which is disassemblable	• Rechargeable 20V lithium ion battery • Trigger switch to control power to motor





Design Calculations & Decisions

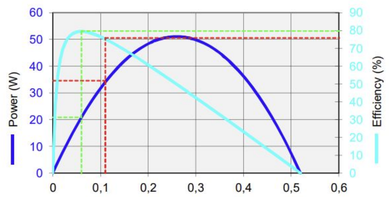
Motor Required Power Caculations	Design Decisions

• Weighted drop test
  ○ Force to drive a nail in wood (39.5 - 75.7 J)
• Power (required energy and nail drive time)
  ○ Minimum motor power (>33.9 W)
	Selected Crouzet 89850008 Motor
	• Power Output: 35 W
	• Speed: 3000 RPM
	• Torque: 110 mN-m.

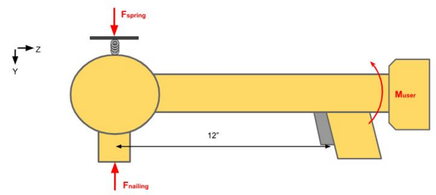
Spring Mechanism Calculations	Design Decisions

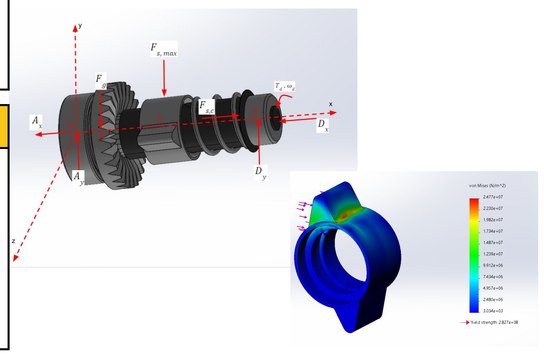
• User force input test (auto hammer on scale)
  ○ Determined input force to drive 1” nail (51.2 lbf)
• Spring constant (force and compression distance)
  ○ Determined spring constant (51.2 lbf/in)
	Designed the spring mechanism to support two springs
	• 25.6 lbf/in constants
	• Uncompressed length: 2”
	• Compressed length: 0.5”

Cam Mechanism Calculations	Design Decisions
• Calculated bearing reactions (distance and forces) ○ Found correct proportions between all mechanisms in cam assembly • Ran FEA for cam with required maximum force of 344 N	Designed smaller cam • Allows for height of tool to be less than 4” • Doesn’t fail under load

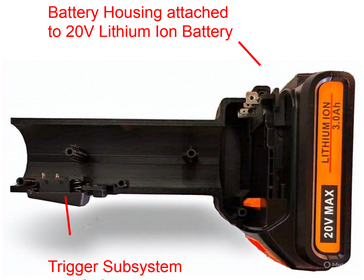


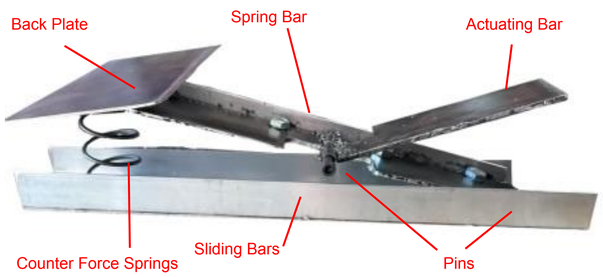
“Dcmind Brush Motor Data Sheet 89850008” cdn.crouzet-motors.com





Prototype & Test Results





Test Results + Test Plan

Test Results:
- Cam and bevel shaft rotate within inner housing
- Battery attaches to tool
- Trigger successfully controls power to motor
- Height profile fits in designated 4” cavity
- Chamber compatible with 1” nails
- Magnetic Chamber fails to magnetize nail

Test Plan:
- Force output of Counter-force spring mechanism
- Ability to drive nail into wood, and drive time
- Torque of recoil on user
- Evaluate ergonomic performance of handle and spring lever
- Measure noise and vibration levels during operation
- Conduct thermal testing of motor and internal components

Future Work

- Full system integration testing in real-world applications
- Long term durability and performance testing of mechanical components, spring mechanism, and battery life
- Redimension magnetic chamber to allow for stronger retention
- Redesign outer casing and actuating bar to better integrate ergonomic grips