Nail Coil Gun

Project Proposal Fall 2012

Seth Hartman & Andria Young

TA: Ryan May

Introduction

Traditional nail guns use compressed air, explosive gases or charge, or an electric motor. The disadvantage of the pneumatic nail gun is the hose and extra equipment, like a pump, that has to be on site at all times. The explosive gas nail guns get rid of the need of the hose, but must be regularly cleaned, and require a battery. The electric nail gun solves the problem of having to clean the gun, but is generally heavy due to the motor.

Our solution to these problems is the coil nail gun. The nail is shot out of the gun by a series of electromagnetic coils, all being powered by batteries. It solves many of the problems listed above, filling a void in the nail gun market. Our goal is to build a nail gun that is safe, enjoyable, and easy to use.

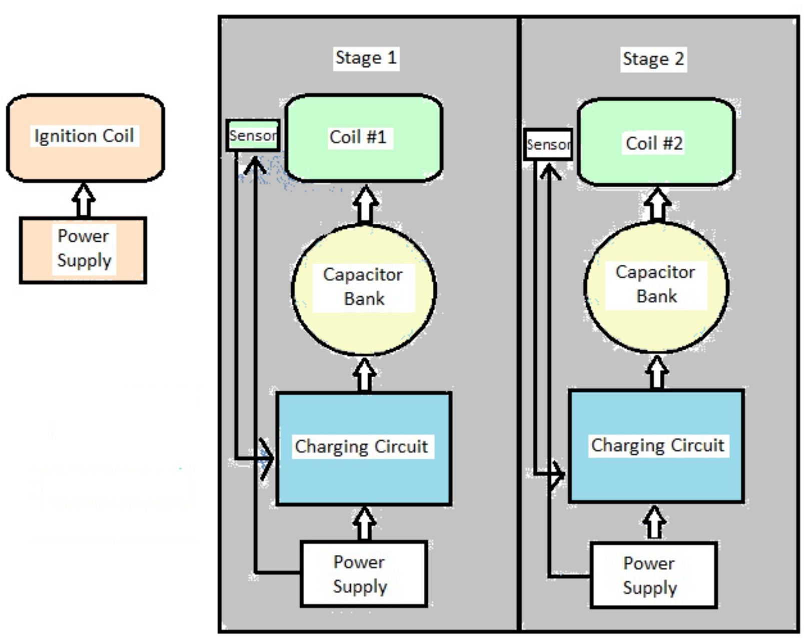
Objectives

Benefits

- No moving parts, which increases the life of the gun
- No hose or extra equipment besides the batteries making it conveniently handheld
- No cleaning or maintenance required, making this gun easy to use.

Features

- Reliable
- Easy to use
- Infrared LED switches to trigger coils, for simpler cheaper circuits



Block Descriptions

Ignition Coil w/Power supply – This first coil is used as a sort of trigger for the nail gun, and is used to launch the nail into the first stage. Its importance lies in the fact that it keeps us from having any mechanical parts which could lower the life expectancy of the gun and cause mechanical problems.

The Charging Circuit – This circuit will be modeled after the flash circuit used for cameras. The idea is to step up the voltage using a DC-DC converter, for example a flyback converter, in order charge up the capacitor which is at a higher voltage than the batteries.

Capacitor Bank – This is the energy storage for the coils. The batteries are used to charge up the capacitors in order to be discharged into the coils. The amount of energy to be stored in each of the capacitor banks will be equal for stage 1 and stage 2.

Stages – There will be a separate circuit for each coil in order to isolate each section. This allows for faster charging times between each shot, and also makes it simple to assemble and disassemble. The possibility for adding more stages also becomes easier because each stage is independent of the other.

Coil and sensor – Although the coil and sensor seem straightforward, the placement of the sensor with respect to the coil, and the two coils with respect to each other is the difference between a working coil gun and a bunch of parts. The two coils are the main component of the gun, and are what supplies the magnetic field to pull/push the nail through the barrel. They mustn't be placed to close otherwise some of the field will be lost in the other coil, and may cause interference when the coils are trying to fire. The sensors must be place at just the right position so that they don't turn on the coil to early or too late. Their purpose is to throw the switch, allowing the capacitors to discharge into the coils.

Requirements and Verification

Requirements:

1. The ignition coil should move the nail into the first stage. The power supply should provide 12VDC.
2. The charging circuit in each stage should charge the capacitors with ~40J to move the nail with the speed necessary for the nail to go through pine wood.
3. The capacitor bank should be ~40J of energy for each stage. Then the capacitor bank should discharge the energy into the coil.
4. The first stage should push the nail into the second stage. The nail should be ejected out of the gun after the second stage.
5. The coil should provide the magnetic field that will push the nail forward. The infrared sensor should switch on the charge circuit after sensing the nail.

Verification:

1. To test the ignition coil a nail would be set into the coil and the power supply will be turned on. The nail should move forward.
2. For the charging circuit it would be powered with 12VDC from a function generator. We would connect the output to the oscilloscope to see how much energy the circuit provides.
3. For the capacitor bank we would connect the oscilloscope in parallel with the 2200 uF capacitor to see how long it takes to charge. To test the discharge of the
4. To test either stage the nail would be pushed past the first sensor. The coil should eject the nail at a speed fast enough to penetrate pine wood.
5. We can measure the resistance with a multi-meter and calculate the inductance of each coil. To test the sensor we would connect it to the oscilloscope to see how fast it responds.

Tolerance Analysis:

The limiting factor of the design is the capacitor bank. The capacitor bank must hold enough energy to send the nail out of the gun at a speed that is fast enough to penetrate wood. The capacitor bank should be able tolerate high voltages and should discharge fast enough to get the nail to the next stage. We will test the tolerance of the capacitor bank before connecting it to the charge circuit. The goal is for the capacitor bank to be able to store ~40J in each stage.

Cost and Schedule

Labor:

Team Member	**Hourly Wage**	**Total Hours***	**Total Cost**	**Total × 2.5**
Andria Young	$35	180	$6300	$15750
Seth Hartman	$35	180	$6300	$15750
			Total	$31500

*Total hours include 12 weeks of work at 15 hours/week.

Parts:

Parts	Cost	Multiplier	Total
Inductor Coil	$4	3	$12
Infrared Sensor	$1.00	2	$2.00
2200uF @ 200V Capacitor	$6.17	2	$12.34
DC Transformer	$6.00	4	$24.00
8 Batteries	$10.00	1	$10.00
Microswitch	$4.00	3	$12.00
Transistor	$3.00	2	$6.00
Clear Acrylic Tube	$9.00	1	$9.00
		Total	$87.34

Total Cost = Parts + Labor = $87.34 + $31,500 = $31,587.34

Schedule:

Date	Project	Student
9/16	Proposal	Seth Hartman
9/16	Proposal	Andria Young
9/23	Design Charging Circuit	Seth Hartman
9/23	Simulate Charging Circuit	Andria Young
9/30	Design Review	Seth Hartman
9/30	Design Review	Andria Young
10/7	Capacitor Bank	Seth Hartman
10/7	Buy Components	Andria Young
10/14	Test Switch Tolerances	Seth Hartman
10/14	Test Inductor Tolerances	Andria Young
10/21	Test Switch with charging Circuit	Seth Hartman
10/21	Test output of charging circuit	Andria Young
10/28	Test Charging circuit with capacitor bank	Seth Hartman
10/28	Test ignition coil	Andria Young
11/4	Mock-Up Demo	Seth Hartman
11/4	Mock-Up Demo	Andria Young
11/11	Test stats of stage 1	Seth Hartman
11/11	Work on presentation	Andria Young
11/18	Test stage 2	Seth Hartman
11/18	Properly space all stages for timing	Andria Young
11/25	Final Assembly	Seth Hartman
11/25	Final Assembly	Andria Young
12/2	Demo	Seth Hartman
12/2	Demo	Andria Young