

Fabrication and Testing of Supersonic of Press-Vac Canon

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Abstract:

The supersonic Press-Vac cannon is an impression of combining spud gun (Pneumatic technology) and vacuum cannon such that with a press of button a projectile is forced to travel at speeds greater than that of sound by the expansion of compressed air into a vacuum barrel through a convergent-divergent (De-laval) nozzle. This technology can be an advantage in the use of Military Purpose, Space launch systems, Submarines, Riot gun.

Key words: spud gun, vacuum cannon, compressed air, vacuum barrel, CD nozzle.

I. INTRODUCTION

The Supersonic Press-Vac Cannon is an impression of combining the Spud gun technology and Vacuum cannon technology. At the touch of a button, an expansion of compressed air hurls a projectile hundreds of feet at close to 360 meters/sec (805.29 mi/hr). This technology can be an advantage in the use of Military Purpose and Space launch systems.

The Ping-Pong Vacuum Cannon or Vacuum bazooka has been a popular and compelling tool for demonstrating acceleration and the power of pressure differentials in air. It has even proven to be a challenging problem for computational fluid dynamics since it encompasses a range of aerodynamic phenomena that are particularly difficult to model. However, the ball emerging from the barrel is necessarily traveling at subsonic speed. A simple modification to the basic design allows the device to launch the ball supersonically.

II. COMPONENTS USED FOR CONSTRUCTION OF THE CANNON

There are roughly eight components used to make the supersonic press-vac cannon. Those are list out below.

- Pressure chamber
- Compressor
- Pressure gauge
- Solenoid Valve
- Supersonic convergent divergent nozzle
- Barrel
- Vacuum pump
- Vacuum gauge
- Ping pong ball

TABLE I: SPECIFICATION

COMPONENTS	MATERIAL & DIMENSIONS
PRESSURE CHAMBER	3" Schedule 80 pvc of 1m
SOLENOID VALVE	1.5" Solenoid valve (Electrically Actuated)
C-D NOZZLE	Inlet Diameter : 1.8 inch , Outlet Diameter : 2 inch Bored out of a 5" Polypropylic Solid Block
VACUUM PUMP	22 inhg Vacuum and 15L Displacement
BARREL	2" Acrylic pipe of 2m
PRESSURE GAUGE	¼ BSP analog Pressure Gauge
VACUUM GAUGE	¼ BSP analog Vacuum Gauge

III. CONSTRUCTION OF CANNON

The two most significant modifications to the standard ping pong gun are the addition of a pressure plenum and a convergent divergent (de Laval) nozzle between the pressure chamber and the barrel.



Fig 1. Pressure Chamber

The pressure chamber is comprised of 3 inch (7.62cm) diameter schedule 40 gray PVC. It is 36 inches (91.4cm) long and is able to withstand pressures up to 120psi (827kPa). One end is sealed through the use of a schedule 40 PVC cap. The other end is connected to one end of the Solenoid Valve (Electrically actuated). This Solenoid valve is placed around the free end of the pressure chamber and threaded into the pressure side of the nozzle. Depending on the desired pressure, the Solenoid valve is electrically actuated by a 12 volt Battery



Fig 2 .Solenoid Valve

Note that the pressure gauge we used was simply threaded into the pressure chamber. Thus, it read pressure referenced to atmospheric pressure. The actual pressure differential was one atmosphere higher than that displayed on the gauge.



Fig 3. Vacuum Gauge

It is important that the pressure chamber be able to withstand pressures much higher than those expected during use. The compressed air in the plenum contains significant energy that could be released uncontrolled if the plenum failed structurally.



Fig 4. Supersonic Press-Vac setup

The nozzle was machined from a 5 inch (12.7cm) diameter by 12.125 inch (30.8cm) long piece of solid Polypropylene. Instead of machining threads into the end of the nozzle, a sch80 PVC coupler was cut down and glued into the end. The breach end of the nozzle is oversized for the nominal outer barrel diameter. In order to ensure that the barrel could be easily removed, we chose to oversize the breach end of the nozzle. In this manner, two bushings are placed around the barrel to ensure a snug fit, and to aid in removal. Also, to ensure that both the nozzle and barrel were properly sealed and able to hold a vacuum, 'Sticky Tack' was used around the interface between the nozzle and barrel. Dimensions of the nozzle are shown in the diagram.

The barrel is comprised of 1.96 inch (50mm) outer diameter and of 1.723 inch (44mm) x 78, 74 inch (200cm) long, clear Acrylic tube. The overall dimensions of the device are shown in diagram

The barrel is simply press fit into the nozzle as shown in diagram. After assembly, a bead of a flexible polymer ('Sticky Tack') is pressed into the junction of the barrel and the nozzle.

IV. RESULT

The velocity of the Press-Vac Cannon is theoretically measured as between 1.2 Mach and 1.8 mach. A ballistic Pendulum is

to be designed to measure the experimental velocity of the ball.

V. CONCLUSION

By adding a pressure chamber and a convergent divergent nozzle, a standard Ping Pong gun has been shown to launch the ball supersonically. Further study is needed to use Varying the nozzle geometry may have a major effect on launch velocity. Finally, it is important that the device be used only in a controlled environment. The increase in velocity greatly increases the kinetic energy of the ball, so care must be taken to ensure that the ball is captured after launch. Additionally, it is very important to keep all observers behind the muzzle and safe from any bounces or ricochet.

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