Provisional Patent Application for Autoloading Pneumatic Cannon

(draft copy – 11 Jan 2001)

Background of the Invention

Pneumatic cannons are used to launch a variety of objects including, but not limited to, t-shirts, balls, produce, and explosives to precipitate avalanches. Many past applications have not required a high rate of fire; as a result many pneumatic cannons on the market must be manually loaded prior to each firing. Manual loading can reduce the utility of the cannon in certain applications. At a sporting event, for example, there might be limited time during a timeout or between innings for launching t-shirts.

Although products have been introduced to increase the rate of fire (notably, a Gatling-style cannon[1] sold by a company called "FX in Motion"), none use a traditional autoloading action with a magazine of shells, sliding bolt, and ejection mechanism. At the cost of significant added complexity, these components allow faster reloading and a more compact, gas-efficient design.

Design Details

Referring to the Figures, the cannon's primary features are shown generally in Figure 1. Dump Valve 1 is a fast-opening, high-flow, "quick exhaust" style valve actuated by an electric solenoid. It is the primary means of pressure modulation and, when closed, the only barrier between the air supply's regulators and the projectile.

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[1] http://fxinmotion.com/gatlinggun.html

Magazine 2 provides the store of unfired shells, which are stacked vertically and oriented parallel to the cannon's bore. Below the bottom shell is a sliding platform that applies upward pressure on the stack of shells, so that the stack translates upward as shell are removed. The sliding platform itself is pulled upward by two elastic cords that attach to both sides of the platform.

Barrel 3 provides a means of exit for the projectile. The barrel is airtight and allows pressure to propel the projectile forward along the entirety of the barrel. Depending on the projectile, the inner surface of the barrel might be smooth or rifled. In Figure 1, the barrel is shown with a muzzle brake, which serves to mitigate recoil and barrel rise, suppress sound, and enhance aesthetics. A barrel may be made of metal, plastic, composite, or any combination thereof that is safe for the cannon's operating pressure.

Ejection Housing 4 allows a shell to be ejected from the cannon after the projectile has been fired. The shell travels forward along the inside of Ejection Housing 4, which directs it first upward, the laterally toward an exit port, and finally out of the cannon.

Bolt Spring Housing 5 contains a tension spring, oriented along the "spine" of the cannon. The spring is attached to the rear of the cannon and to the sliding bolt, and drags the bolt rearward after firing. Air pressure moves the bolt forward, against the force of the spring, prior to firing and during the autoloading phase of the firing cycle.

The cannon's interior features are shown in Figure 2, where the body of the cannon has been made transparent. Bolt 7 plays a role in the cannon similar to what the bolt of a traditional autoloading firearm, in that it peels unfired shells from the top of the magazine and positions them at the rear of Barrel 3 (the posterior end of the red tube in Figure 2)

In a traditional firearm, however, the pressure that propels the projectile forward is created inside the shell when an explosive is ignited. No explosives are used in the cannon, and the projectile is propelled purely by air pressure released when the Dump Valve 1 is opened. Since the shell is at the top of the magazine when Dump Valve 1 is opened, and not in position to be fired, Bolt 7 has the added function of containing the pressure until it, and the shell to be fired have traveled far enough forward.

Bolt 7 has an o-ring that seals against and slides along the interior of Cannon Body 6 (visible in Figure 1 and transparent in Figure 2). Because air must pass through Bolt 7, it is hollow longitudinally. As noted earlier, however, Bolt 7 must not pass air until it has traveled sufficiently far forward, and Plunger 8 (visible in Figure 2) plugs the hole in Bolt 7 until it has traveled far enough forward to uncover the end of Plunger 8, which is pressed rearward slightly by the air pressure to seal its internal gas escape ports. At that point, the Shell 9 (the shell being fired, checkered black and yellow in Figure 2 and visible under the anterior end of Bolt 7) has just been pushed to the end of Barrel 3, and air rushes through Bolt 7 and forces the projectile out of Shell 9 and down Barrel 3.

Also visible in Figure 2 are the basic components of the ejection system. This, too, works differently than in a traditional autoloading firearm, where a shell is expelled as part of its own firing cycle. In the cannon, the empty shell is expelled as during the next shell's firing cycle. Referring to Figure 2, Shell 9 is positioned under the front end of Bolt 7. After Dump Valve 1 opens, air pressure forces Bolt 7 and Shell 9 forward. Eventually they encounter Flipper 10 (best seen in the cutaway view of Figure 3), which is hinged at its lower end and kept oriented upward by Flipper Spring 11 (Figure 3), and force it downward against Flipper Spring 11 until it lies parallel to Barrel 3. Flipper Spring 11 is contained within Flipper Spring Housing 12, which is mounted to the underside of Cannon Body 6.

After firing, the air pressure has dropped to a level where Bolt 7 can be pulled rearward by Bolt Spring 13 (hidden within Bolt Spring Housing 5). Simultaneously, Plunger 8 is again moved slightly forward to uncover gas escape ports that allow Bolt 7 to force the remaining gas out the rear of the cannon. Although Bolt 7 moves rearward, Shell 9 is caught by Ratchet 14 (visible in Figure 2 with Ratchet Spring 15 and Ratchet Spring Housing 16. Ratchet 14 protrudes into the forward pathway of Shell 9, was forced down by as Shell 9 traveled forward, and sprung up again once Shell 9 passed completely over it.

After firing, Bolt 7 is dragged rearward and Shell 9 is kept in place by Ratchet 9. Once Bolt 7 has retreated far enough, Flipper 10 is able to spring upward (best seen in Figure 3) and rotate the shell upward in preparation for its ejection, where it remains until the next shell is fired.

Shell 17 (the shell directly below Shell 9 in Magazine 2, best seen in Figure 3) is pushed upward once Bolt 7 has retreated far enough to permit it. Because When the cannon is fired again, Bolt 7 moves Shell 17 forward. Because Shell 17 is not geometrically suitable for pushing out the already-fired Shell 9, however, Magnet Arm 18 (along with its unnumbered, contralateral counterpart, both seen in Figure 4) is used.

The magnet arms are mounted on opposite sides of the anterior end of Bolt 7. They are able to pivot slightly toward the center of the bore (from parallel to it), as seen in Figure 4, enough to catch the empty shell and push it along Flipper 10 into Ejection Housing 4. The pivoting is brought about by magnetic repulsion between permanent magnets mounted in the magnet arms and magnets mounted in the exterior magnet housings. Magnet Housing 19 (and its unnumbered, contralateral counterpart) is mounted to the side of Cannon Body 6 also contains permanent magnets, such that they exert a repulsive force on the magnets of Magnet Arm 18 and pushed them inward. In that position, the magnet arms catch Shell 9 and force it along Flipper 10 into Ejection Housing 4 (seen again in Figure 3), where it falls out of the side. Because the magnet arms are hinged, they are able to tuck into tracks as Bolt 7 travels rearward and slide freely past the fired shell, which is held forward by Ratchet 14. Figure 5 more closely overviews this section of the gun.

With that the primary firing features of the cannon have been overviewed. More complicated analysis needs to be conducted to properly size the components to bear their expected loads and wear, with an included safety factor. The novel portion of the cannon is the mechanism for loading, orienting, firing, and ejecting shells and their contained projectiles, which allows for a wide variety of small items to be deployed at great velocities and short intervals.