Hybrid micro motor ("D") Testing August 1994

Paper Fuel with N2O

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Dave Oback requested earlier this year that I help him with a new idea: to use existing N2O cartridges to create a tiny hybrid motor using spent Estes motors as both motor and fuel. He had fired a test with a system made from a micro torch unit. It used an Estes C-6 case but with a wooden dowel as the grain. It operated as a proof of concept. I thought it was an idea with merit and after executing a patent disclosure for him, we undertook a joint development program. I first remachined a tire inflator which was made for CO2 capsules to use the slightly different N2O cartridges. The injector was a standard inflator needle for inflating basketballs. Dave then epoxied this injector into various fuel/motor assemblies using everything from cardboard to bundles of dried pine needles as fuel. Dave has hours of video of his patient experiments in first attempting to ignite these motors.

In the meantime, I tried to get the cartridge manufacturers to repackage the N2O in the threaded cartridges available for CO2. They were completely non-interested; an attitude I frequently observed for N2O suppliers when confronted with a novel idea- I think they must believe that each idea is a new dispensing technique for N2O inhalers!

Lacking a threaded sealing method, I decided to use a thermitic charge to burn through the diaphragm seal on the cartridge; this would also serve as an ignitor for the fuel grain. This method did not seem to be fruitful, although Terry McEhleran has reported success with CO2 capsules.

The next method involved a more standard approach in opening the capsule, a puncturing needle. Incorporating that in a miniature motor looked difficult. It was done, though, and was somewhat successful. Close to 40% of the test articles functioned. Ignition continued to be a problem as well as getting reproducible performance with the spring driven mass carrying the piercing needle. This rode in a cardboard tube bore and the fit was very critical to performance. The fuel grains were cardboard tubes 3 3/8" long, .370" OD and .260" ID. They weighed 1.45 grams with a density of .029 lb/.cubic inch. The motor tube was .380 ID x .55 OD and were also cardboard. An extension of this same tubing formed the "barrel" for the spring driven needle. The N2O cartridge was epoxied into the end of this barrel via a metal adaptor ring which centered it and provided the fit. This bond could not be broken with a force equal to that produced by twice the expected motor pressure. (150 psi, resulting in resistance to 35 pounds force.) The Tin-Lead mass of the piston was cast into a mold which contained a positioned needle. The piston had a key slot for the beaded end of a polyethylene tie wrap. This tie wrap would fail at a tension of 22 pounds, so was just marginal as a spring compressor. It would fail instantly, of course, when heated with the ignitor. The beaded tie wrap passed through the spring, through a short section of fuel grain tubing used

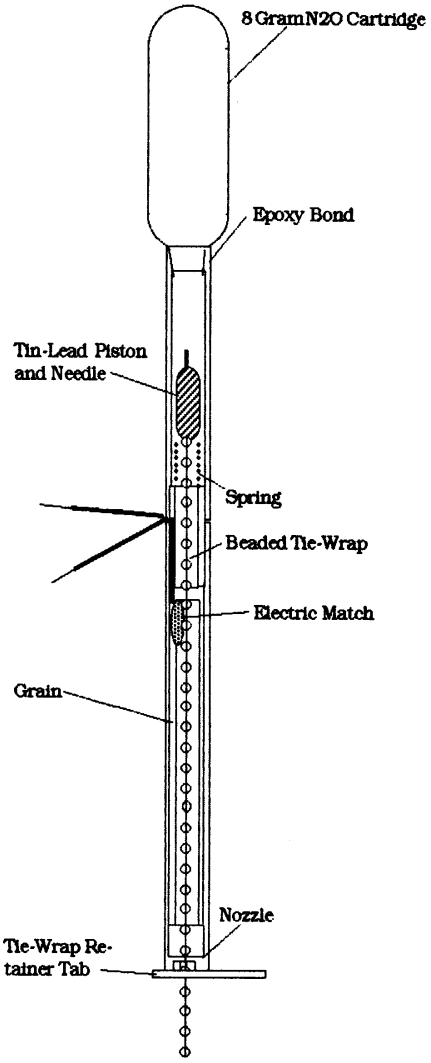
as a connector and spring stop, through the fuel grain and motor and exited the nozzle. The Keyslot tab was used to secure the tie-wrap after it was pulled to compress the spring. It was then held in this condition until an electric match was fired at the head end of the tiny motor. This would produce enough heat to weaken the tie wrap, which would then release the piston which would fly forward and pierce the cartridge seal with a .016 inch diameter hole, thus starting the motor.

These motors would burn for about 1 second producing about 1.5 pounds of thrust. They consumed about .4 grams of fuel and 6 grams of N2O as liquid. The yielded specific impulse was about 100 seconds, even though the operating pressure would be 120 psi, assuming a thrust coefficient of 1.0. (no expansion section) resulting in a theoretical specific impulse of about 130 seconds, even with a non-expanded nozzle. The combustion efficiency, therefore, is extremely low.

Afternote, January 2, 1998

I decided not to go farther with r/d on this concept based on the high failure rate of the test articles. Dave did not exercise his options on his patent disclosure so it passes into public domain.

This concept is probably workable with Terry's thermitic concept; someday, somewhere that may get investigated...



Oback-Colburn D-9 Micro-Hybrid in a Ready-To-Fire Condition