

D Carriage Design (ALS)

The air carriage system is composed of a CO₂ gas supply system, pucks, and carriage.

D.1 Gas Supply

A tank containing liquid CO₂ supplies the gas for the carriage. The tank is mounted in a vertical position with the outlet at the top. This ensures a desirable configuration for steady gas flow. During operation, the tank must sit in a warm water bath to keep the tank temperature from dropping too quickly. If the temperature drops too low and too quickly, dry ice chunks will form inside the tank, and not only will some of the gas be unavailable for use, but the flow path could be restricted and the supply pressure could drop. A bath of hot tap water is sufficient to keep this from happening.

The high-pressure outlet of the tank (860 psi) connects, via a bottomline hose, to a reducing pressure regulator. The chosen Tescom regulators are capable of reducing up to 3500 psi to a range of 0-100 psi. The EMFFORCE system operates between 12-35 psi. A gauge allows the operator to manually set the desired operating pressure depending on the floor surface. The low-pressure discharge from the regulator is split via a manifold into three flexible tubes routed to the pucks.

D.2 Pucks and Carriage

The pucks selected for use on the carriage are 100 mm in diameter and have a single outlet aperture. They are equally spaced (120° apart) around the base ring underneath the vehicle. This configuration allows the pucks to maintain co-planarity with relative ease, while the ring adapts the three-armed tripod of the puck configuration with the four-“armed” cross configuration at the base of the magnet containment rings. Figure D.2-A shows the base ring with the pucks attached.



Figure D.2-A: Base ring with pucks attached

Also, the pucks are not rigidly attached to the rest of the carriage; rather, they are attached by screws with finger springs placed between the puck and the ring to allow them some play. This also ensures their ability to remain coplanar in the event of slight imbalance and force shifts. The main carriage base, to which the pucks are attached, is a rigid structure, rigidly attached to the rings of the magnet containment rings. Figure D.2-B shows a closer view of the puck-base interface.



Figure D.2-B: Close-up view of puck attached to base ring

At the time of this publication, the air carriage is able to supply approximately seven and a half minutes of float time. It may be desirable to increase this time for longer tests. To do this with the current setup, a larger CO₂ tank is required. Twenty-ounce capacity tanks are available through paintball suppliers. Alternatively, some research on lubrication theory and gas bearing behavior has been conducted by Jeannette Garza (Course 2, 2003). This research may be consulted to refine the arrangement of the air carriage.

Unfortunately, the use of the gaseous nitrogen from the cryogenic system boil-off was ruled infeasible by the structures team under the constraints of schedule and manpower. In future iterations of the project, the structures team would like to see this option reopened and explored.

Table D.2-A shows a list of specific parts and quantities required to assemble one carriage. The components in the table are referenced by letter to their location in Figures D.2-B, D.2-C and D.2-D.

Table D.2-A: Air Carriage Parts List

	Qty.	Part Description	Vendor	Vendor P/N
A	1	16 oz. Capacity rechargeable CO ₂ tank		
B	1	Standard paintball bottomline kit	www.paintballarmory.com	42041
C	1	Reducing coupling (1/8"NPT x 1/4"NPT brass)	McMaster-Carr	9171K72
D	1	Nipple (1/4"NPT brass)	McMaster-Carr	9171K214
E	1	Tescom regulator	Northeast Engineering	04-1C3ANN
F	1	Pressure gauge (0-100 psi)	McMaster-Carr	4089K24
G	1	Instant tube fitting adapter (1/4"NPT x 1/8"OD tube)	McMaster-Carr	5779K243
H	6	Instant tube fitting adapter (1/8"NPT x 1/8"OD tube)	McMaster-Carr	5779K102
J	1	6-port manifold (2-1/4"NPT, 4-1/8"NPT)	McMaster-Carr	5469K151
K	1	Hex plug (1/4" NPT brass)	McMaster-Carr	9171K47
L	1	Hex plug (1/8" NPT brass)	McMaster-Carr	9171K46
M	3	100mm dia. Aluminum pucks	Self-manufactured	
N	6 ft	General purpose PVC tubing, 1/8"OD	McMaster-Carr	5233K51
O	3	Finger springs	McMaster-Carr	9717K55
P	6	6-32 x 1/2" screws	McMaster-Carr	90604A148

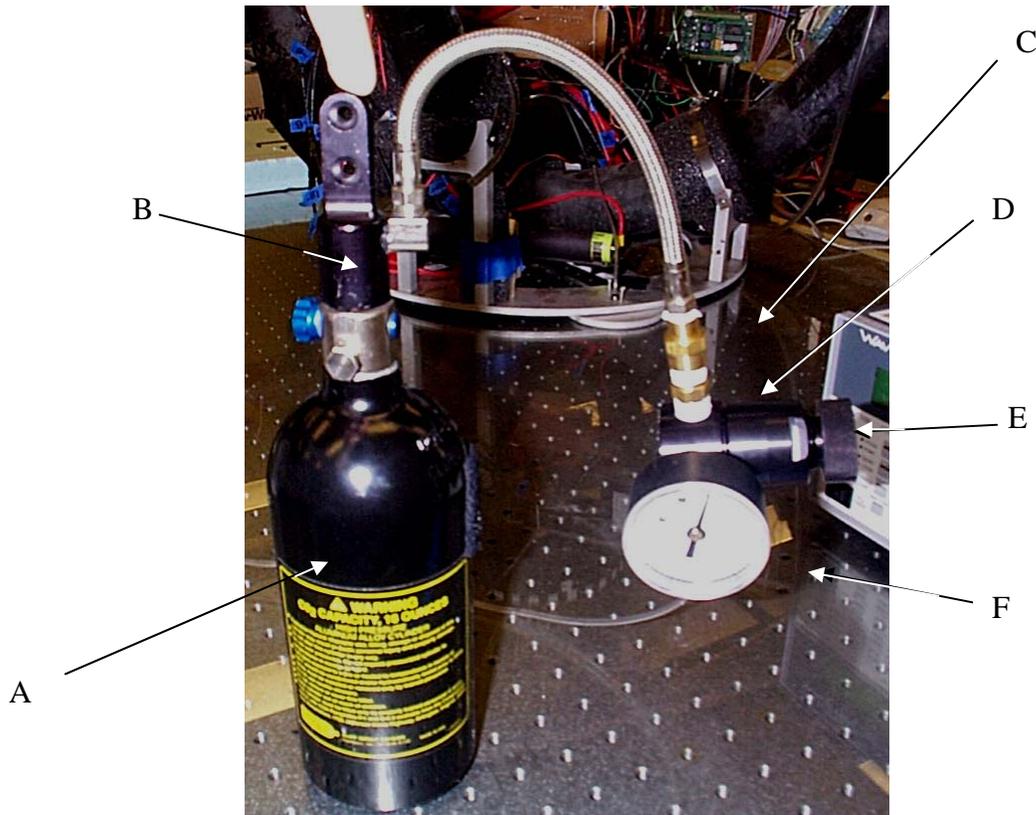


Table D.2-B: Tank, bottomline, and regulator assembly

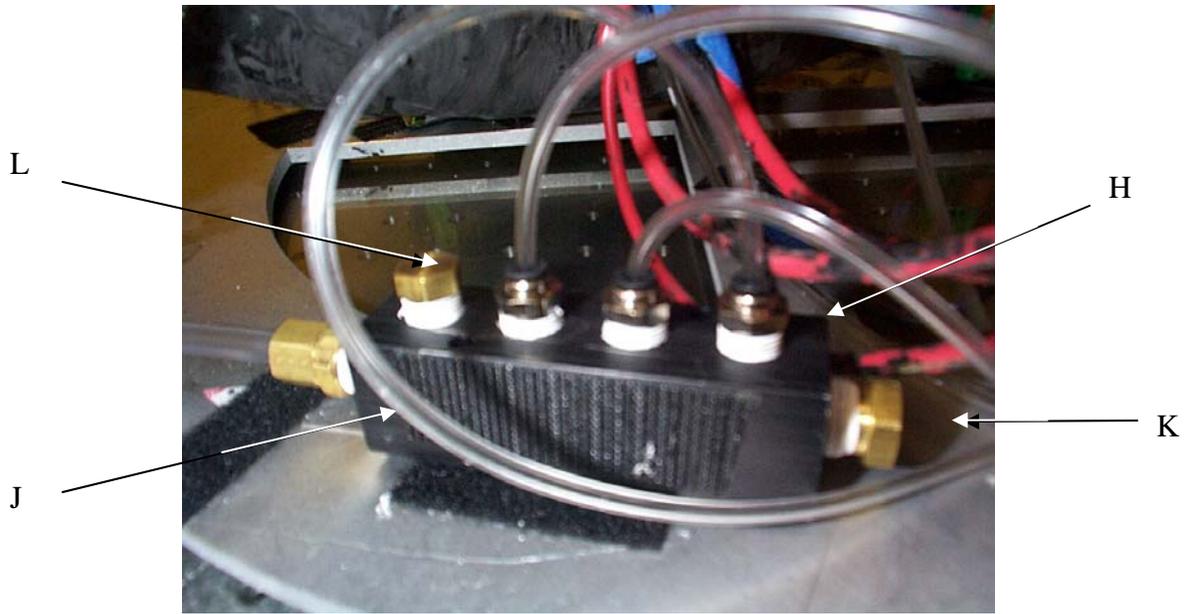


Table D.2-C: Manifold assembly

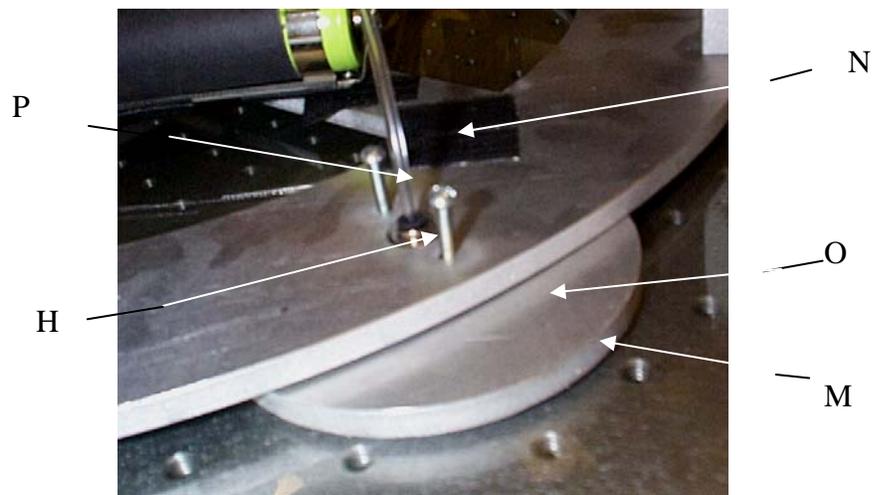


Table D.2-D: Puck assembly