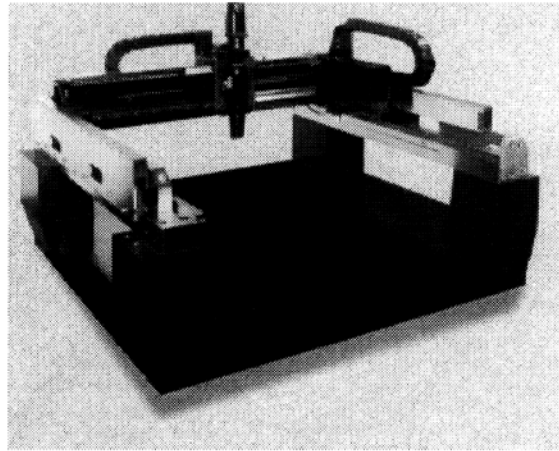
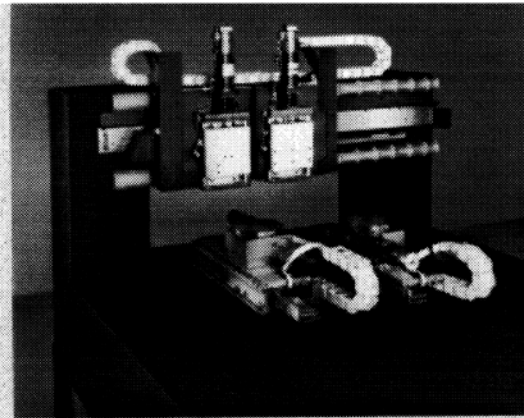


Linear electric motors

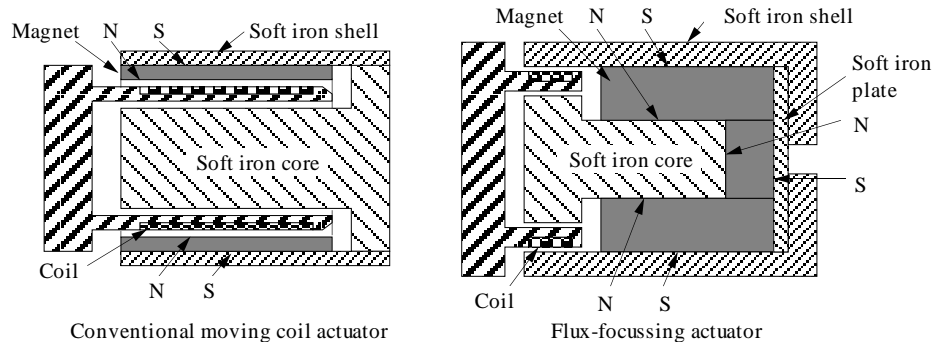


- **Pros**
 - Direct drive minimizes the number of parts
 - Velocity and acceleration not limited by the actuator
 - Very simple installation
 - Very clean operation
- **Cons**
 - Optimal transmission ratio is not achieved
 - High currents, large thermal loads
 - Some motors high attractive forces
 - Much more expensive components (\$10/lb thrust vs. \$2/lb for a ballscrew system)

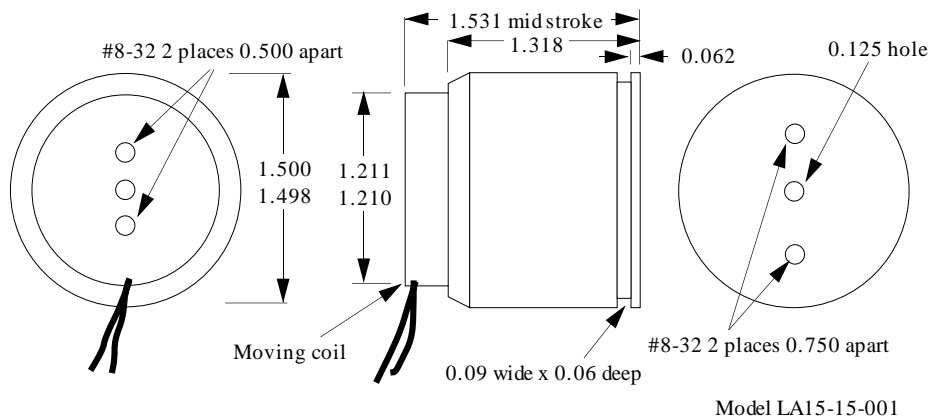
Types	Axial force F_a (rare earth, alnico)	Attractive force
Voice Coils	2, 1	0
Stepping motors	1	5-10x F_a
Brushless DC motors		
Ironless core	2, 1	0
Iron core	2, 1	5-10x F_a

Voice Coils

- **Ideal for short strokes.**
- **No phase switching circuitry required.**
- **Can be used to drive fast tool servos (e.g., for piston turning machines).**

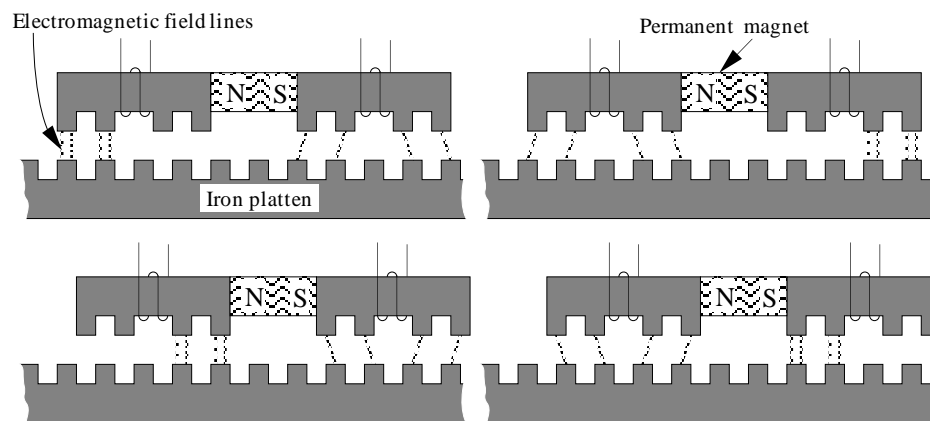


- **Typical configuration of a moving coil actuator.** (Courtesy of BEI Motion Systems Company, Magnetics Division).

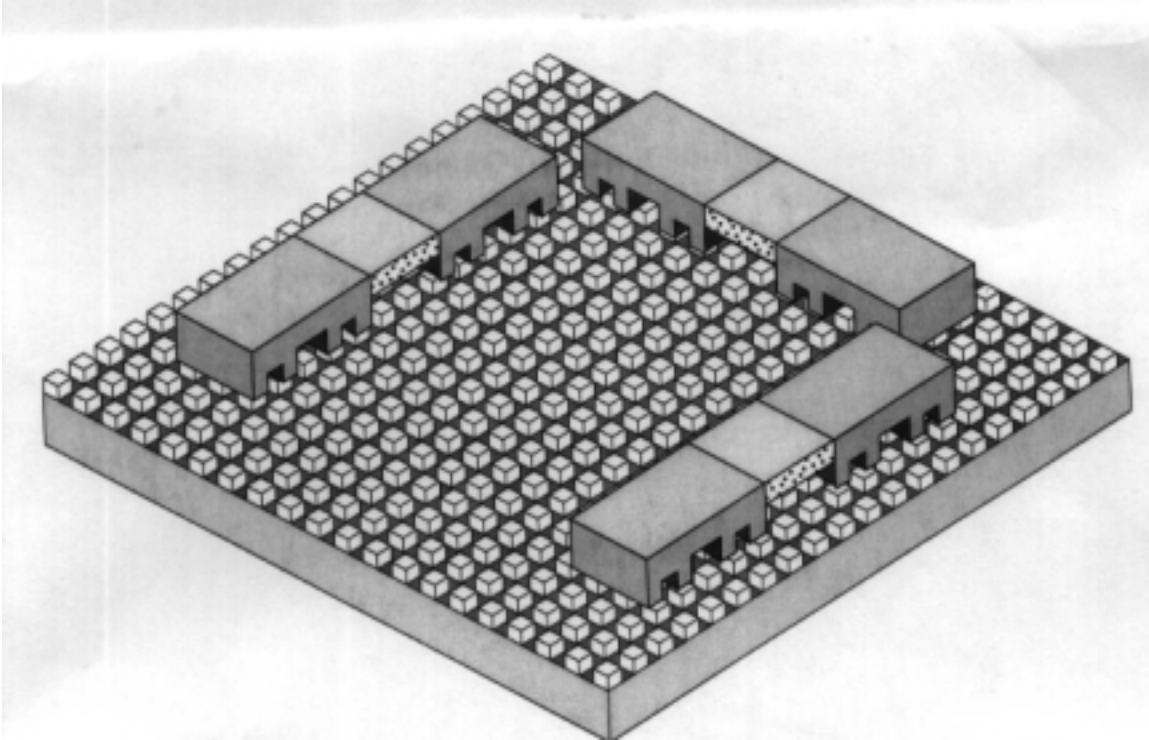


Stepping motors

- Simple design
- Modest efficiency.
- High attractive force requires robust bearings.
- Microstepping can be used.
- Closed loop servo mode, good to sensor resolution.
- Current sequence in a Sawyer motor to produce linear motion:



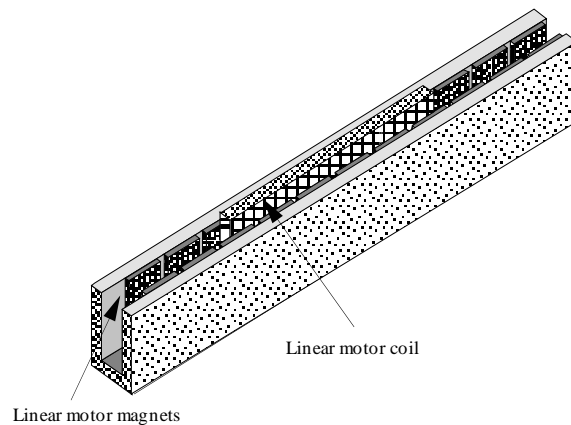
- A two axis *Sawyer* motor¹ (platen and air bearing to support the motor not shown).
- Multiple forcers are used to control yaw.



¹ These motors are sold by Northern Magnetics Corp., and Electroglas Corp.

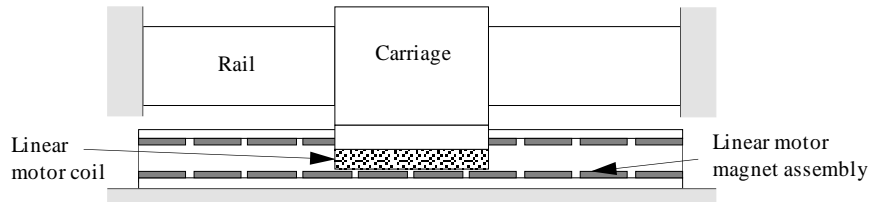
Brushless DC Linear motors

- Never a problem with an un-used portion's brush surfaces corroding.
- Good power density.
- Non-contact generation of force.
- Closed loop control provides resolution limited only by sensor and electronics.
- Ironless-core design has flux crossing gap that is intersected by windings.
 - No attractive force to load bearings.
 - Requires a sandwiched design.

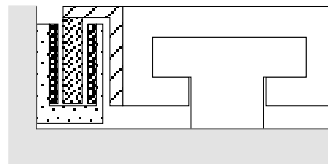


Mountings

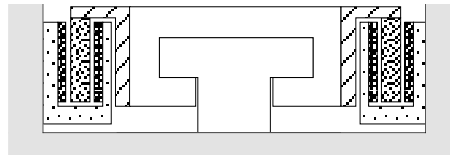
- **Linear motor moving coil mounted to underside of an air bearing carriage that rides on a simply supported rail:**



- **Linear motor moving coil mounted to the side of an air bearing carriage that rides on a T-shaped rail that is fully supported along its length.**



- **Linear motor moving coil mounted to the sides of an air bearing carriage that rides on a T-shaped rail that is fully supported along its length.**



- **Linear motor moving coil mounted to the inside of an air bearing carriage that rides on a T-shaped rail that is fully supported along its length.**

