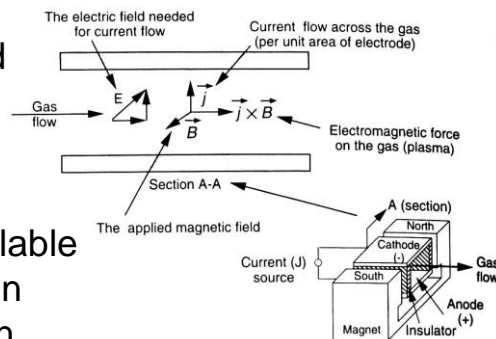


Electromagnetic Propulsion Devices

Electromagnetic Propulsion Systems

- Use applied or induced magnetic fields to produce acceleration of propellant
 - high currents/powers required to produce significant induced fields
 - high power available only (normally) in pulsed operation



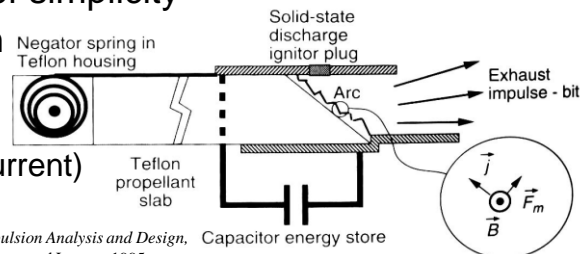
Space Propulsion Analysis and Design, Humble, Henry and Larson, 1995

EM Propulsion Technologies

- Number of approaches have been proposed and studied, including
 - PPT, Pulsed Plasma Thruster
 - MPD, Magnetoplasmadynamic Thruster
 - PID, Pulsed Inductive Thruster
 - VASIMIR, Variable Specific Impulse Magnetoplasma Rocket

Pulsed Plasma Thruster

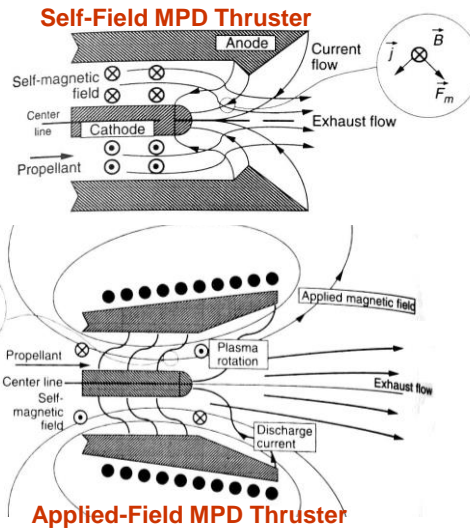
- Propellant produced by vaporizing solid material with discharge
- B field induced by discharge also acts to accelerate vaporized propellant
- Advantage of simplicity
- Acceleration force $\sim j^2$ (discharge current)



Space Propulsion Analysis and Design, Humble, Henry and Larson, 1995

Magnetoplasmadynamic (MPD) Thrusters

- Resemble arcjets
- Lower flow densities to attain higher exhaust velocity
- Diffuse discharge, low erosion
- Self field requires high J
- Applied B field
 - allows higher V at lower discharge currents
 - increase accel.
 - larger Hall effect



Space Propulsion Analysis and Design,
Humble, Henry and Larson, 1995

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AE6450 Rocket Propulsion

MPD Thrusters (con't)

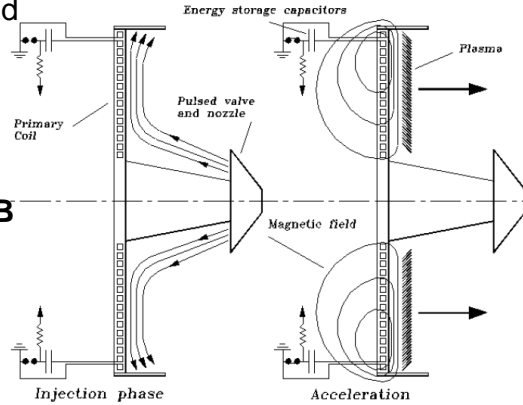
- Most efforts focused on applications with exhaust velocities (I_{sp}) greater than arc jets
- Typically require higher powers than currently available on in-space vehicles
- Exhaust speed $u_e \propto j^2 / \dot{m}$
 - limited by erosion and oscillations at high j

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Pulsed Inductive Thruster

- Plasma created by inductive breakdown of gas layer
 - gas pulsed onto surface of induction coil
 - capacitors switched to coil, azimuthal **E** produces rapid ionization and creates ring of current that interacts with coil **B**
- Acceleration as propellant entrained and ejected by Lorentz force along thruster axis

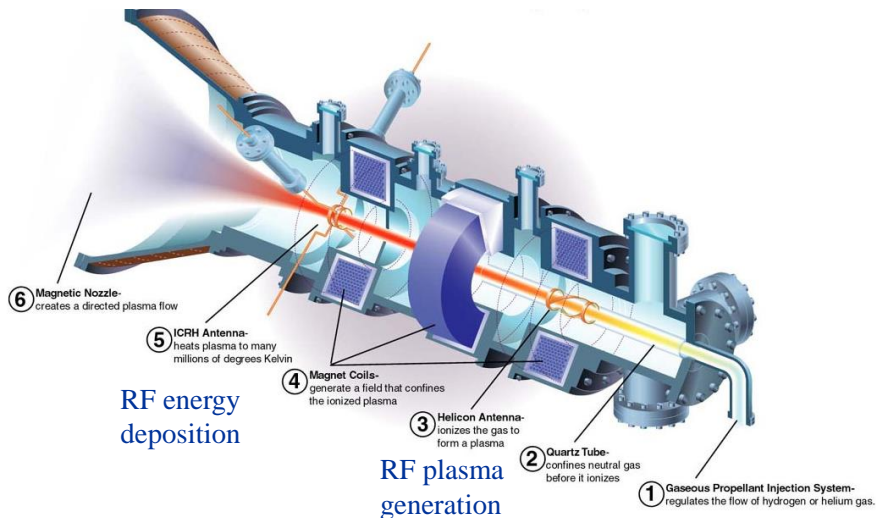


Frisbee and Mikellides, AIAA 2005-3892

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VASIMIR



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