

Where Are We Headed in Space? Charting the Industry's Trajectory Through Patent Filings

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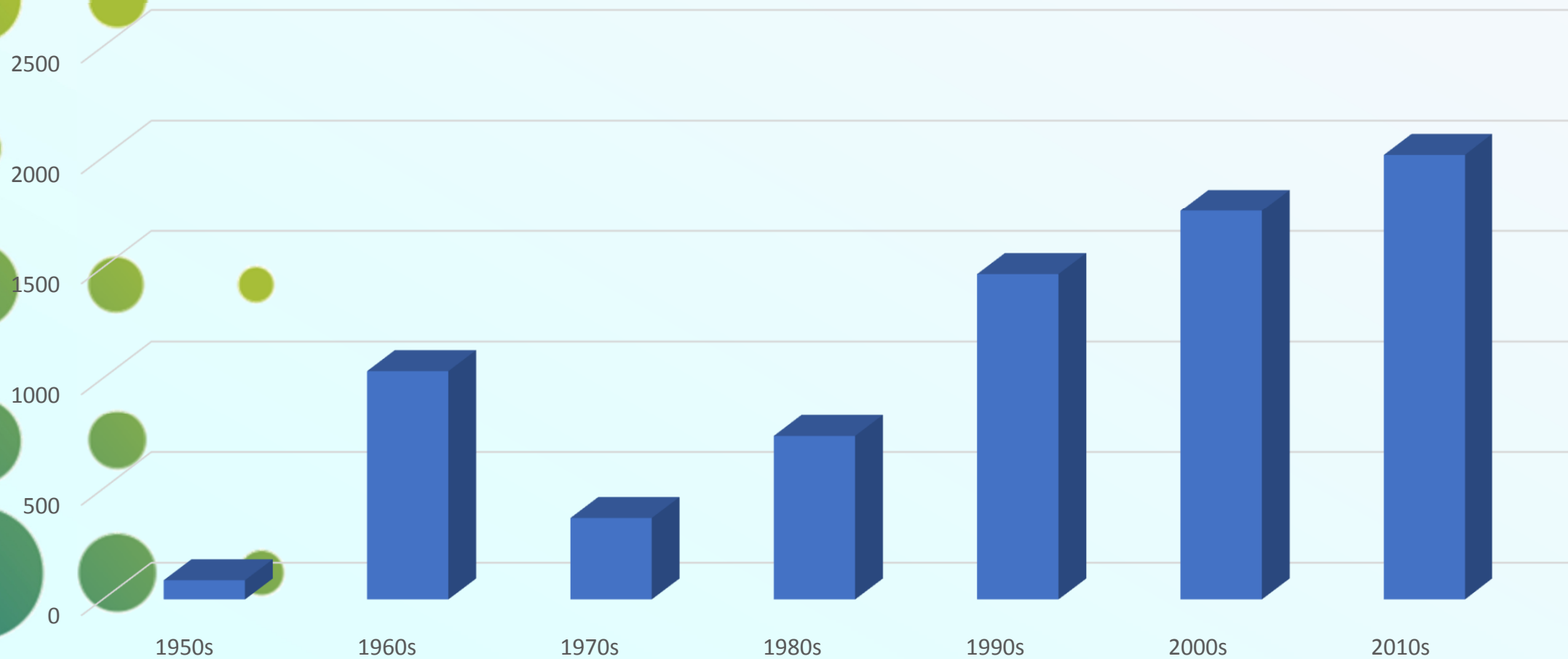
Presentation Outline

- Patent Basics
 - Historical Patent Filing Trends
 - Top Companies and Technologies Over Time
- The Rise of Privatization in Space Travel
 - SpaceX vs. Blue Origin
- Space Technologies on the Horizon

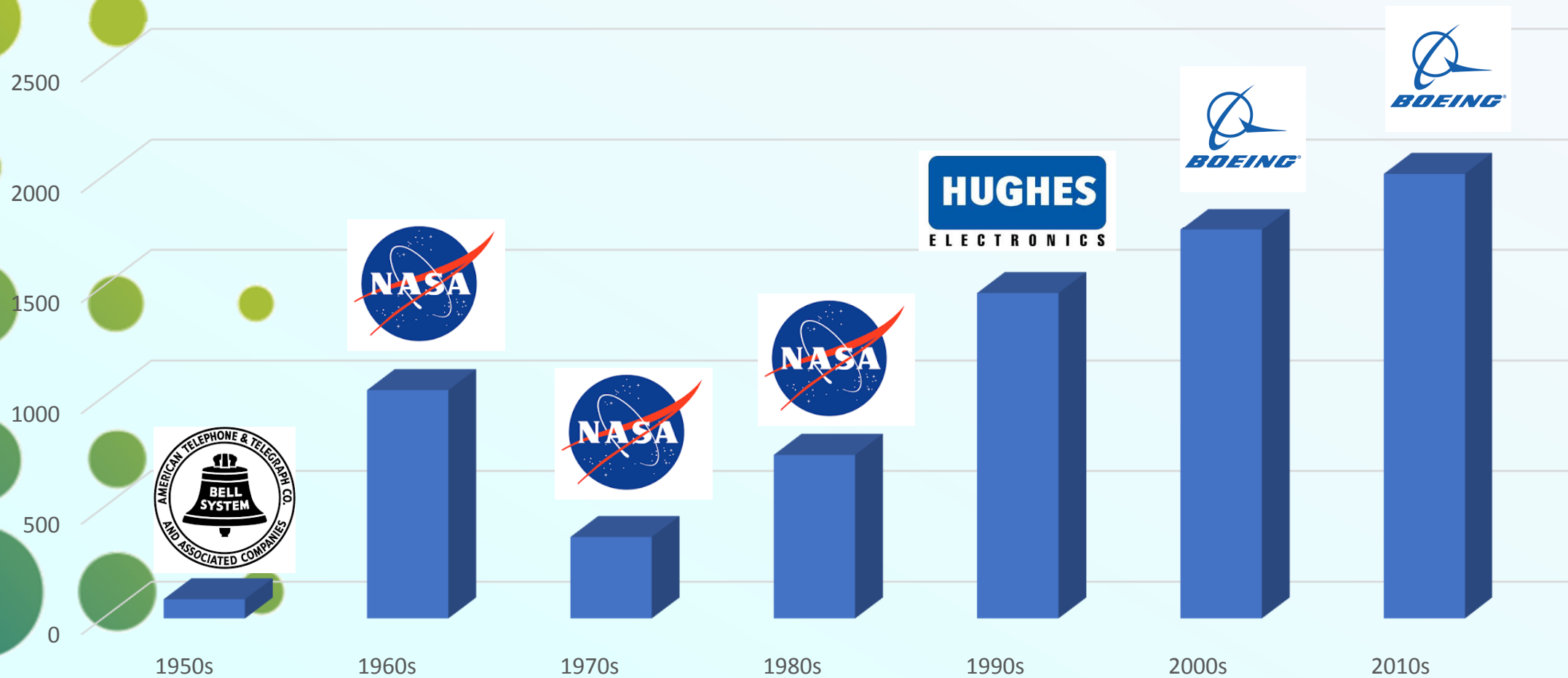
Patent Basics

- Limited monopoly in exchange for disclosure of invention
 - Any new and useful process, machine, manufacture, or composition of matter, or improvement thereof, may be patented
 - Must be novel and non-obvious
 - First inventor to file “wins”
 - Patent it within 1 year of disclosure, or dedicate it to the public
- Territorial rights - U.S. patent enforceable only in the U.S.

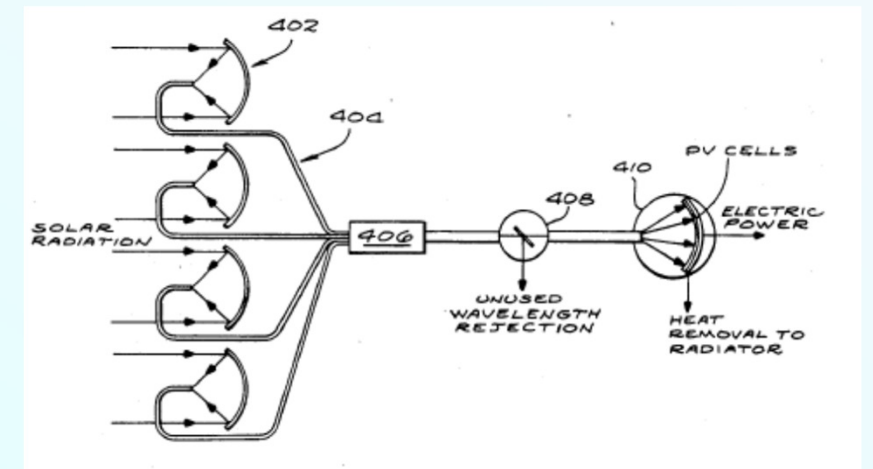
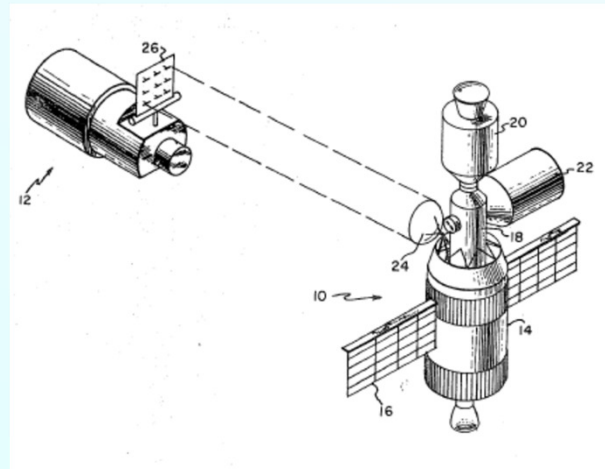
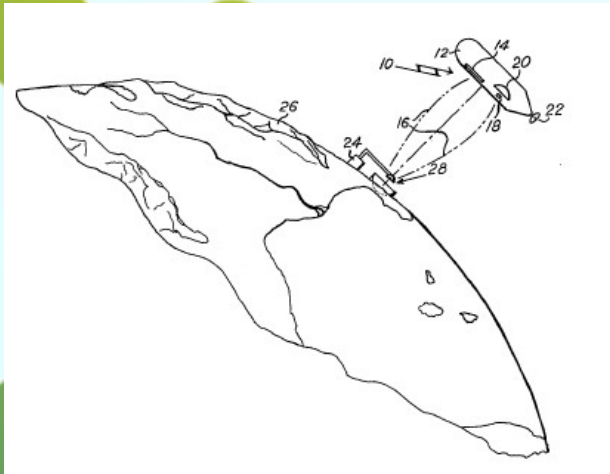
Space Technology Patent Filings in U.S.



Top Filers Over Time

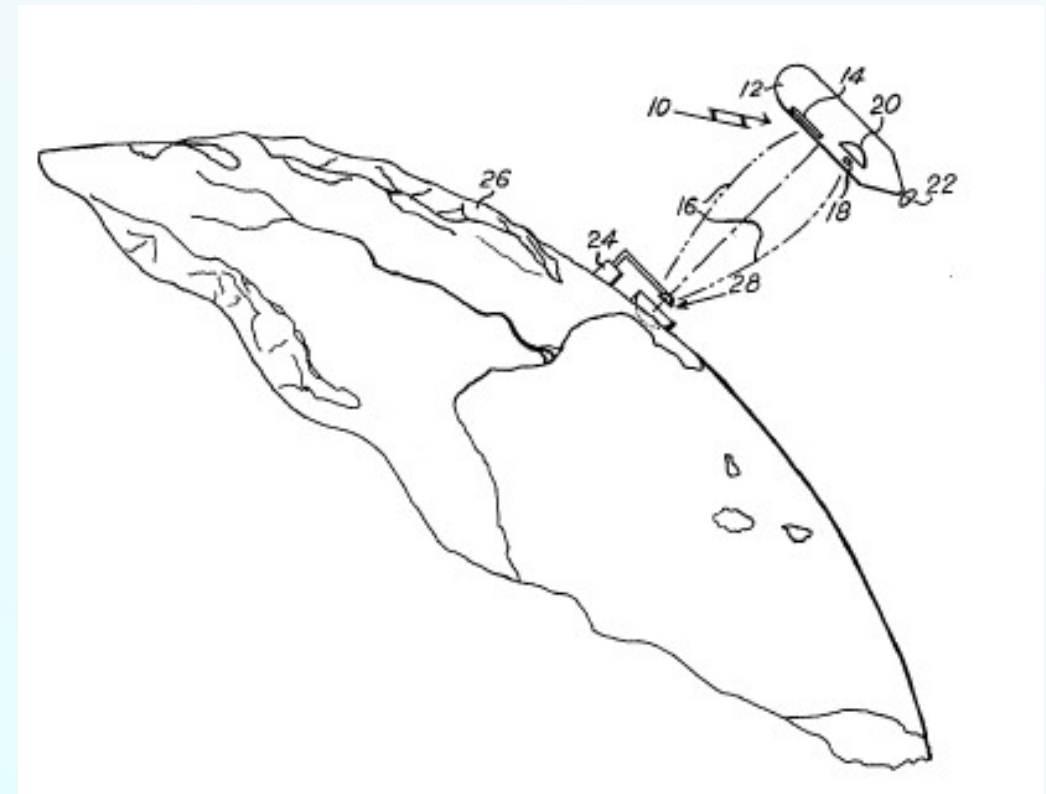


Most cited Patents Over Time



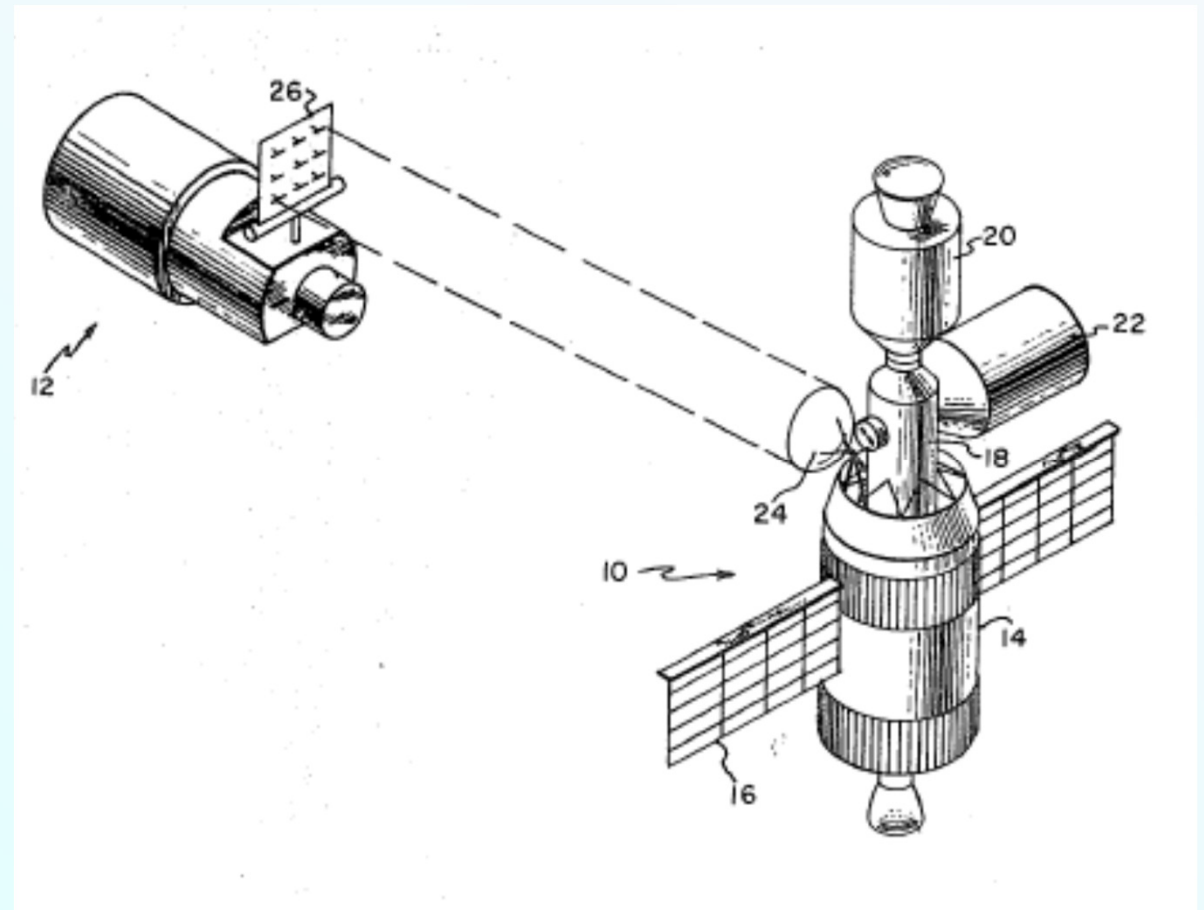
1950's: Raytheon Space Vehicle

- U.S. Patent 3,174,705
- Filed May 18, 1959
- Propeller powered by microwave electromagnetic energy beamed up from earth
- Still being cited in patents in 2019



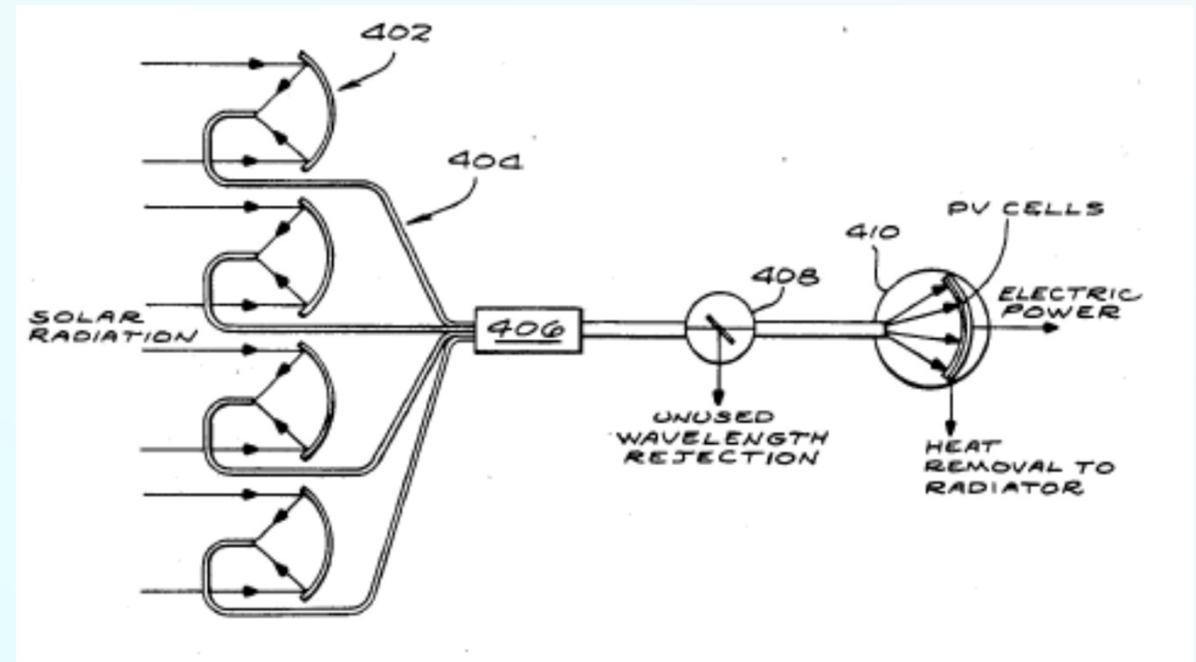
1960's: NASA Microwave power antenna

- U.S. Patent 3,535,543
- Filed May 1, 1969
- Antenna system for remotely powering a satellite from a space station



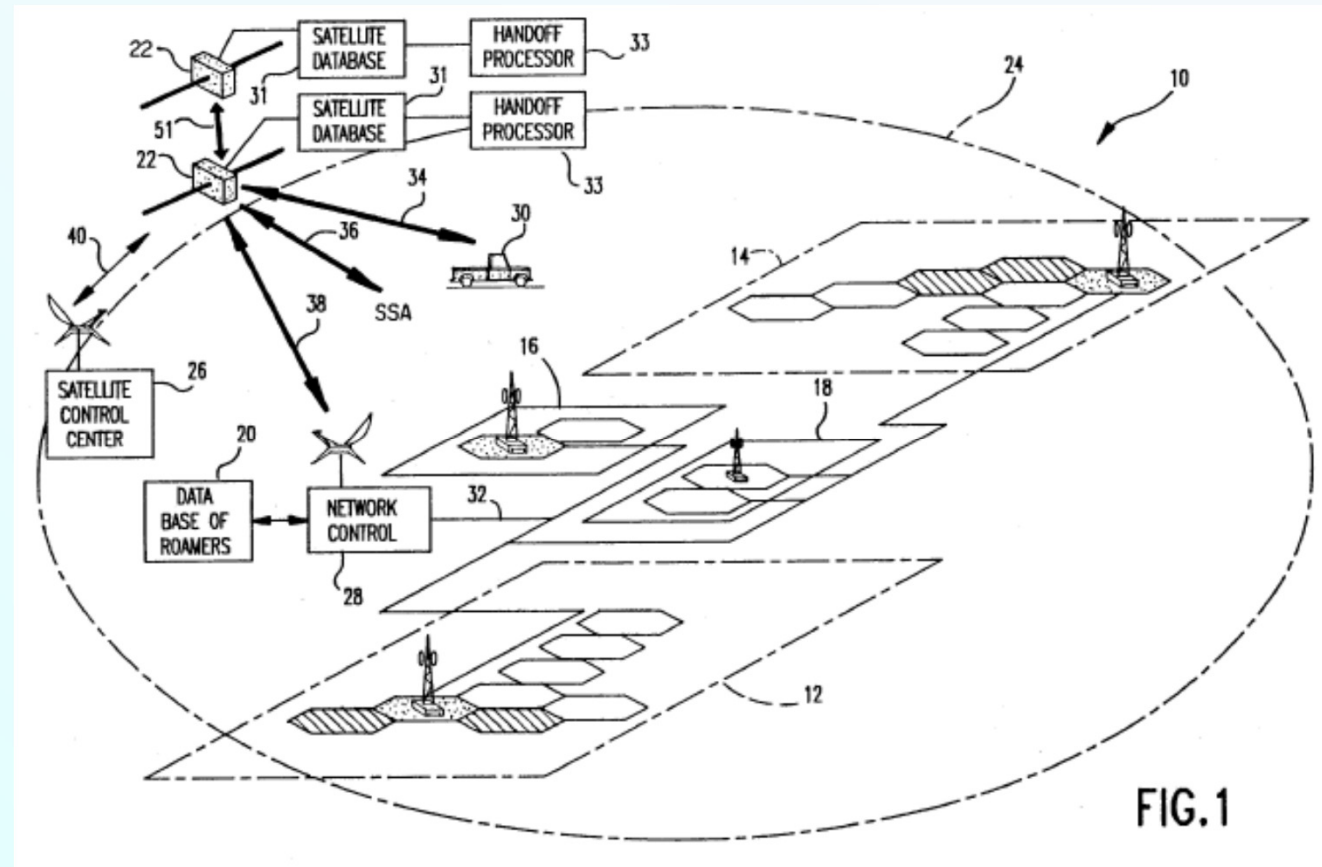
1980's: Solar Power for Spacecraft

- U.S. Patent 5,089,055
- Filed December 12, 1989
- Solar system employing optical lenses to concentrate solar energy

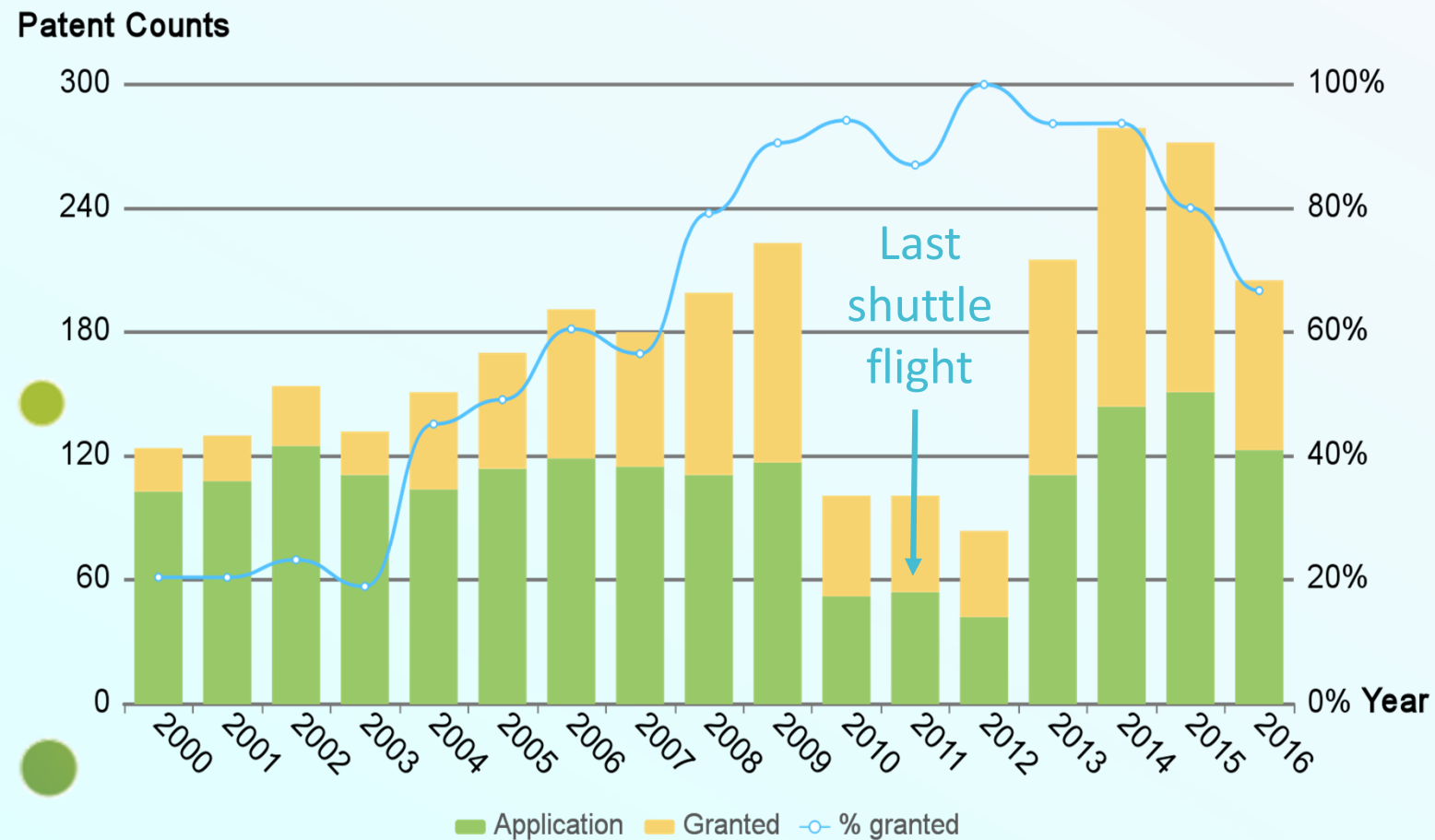


1990's: Satellite Telephone

- U.S. Patent 5,303,286
- Filed March 29, 1991 by Space Systems Loral (SSL)
- Satellites provide roaming capability when outside reach of cellular network

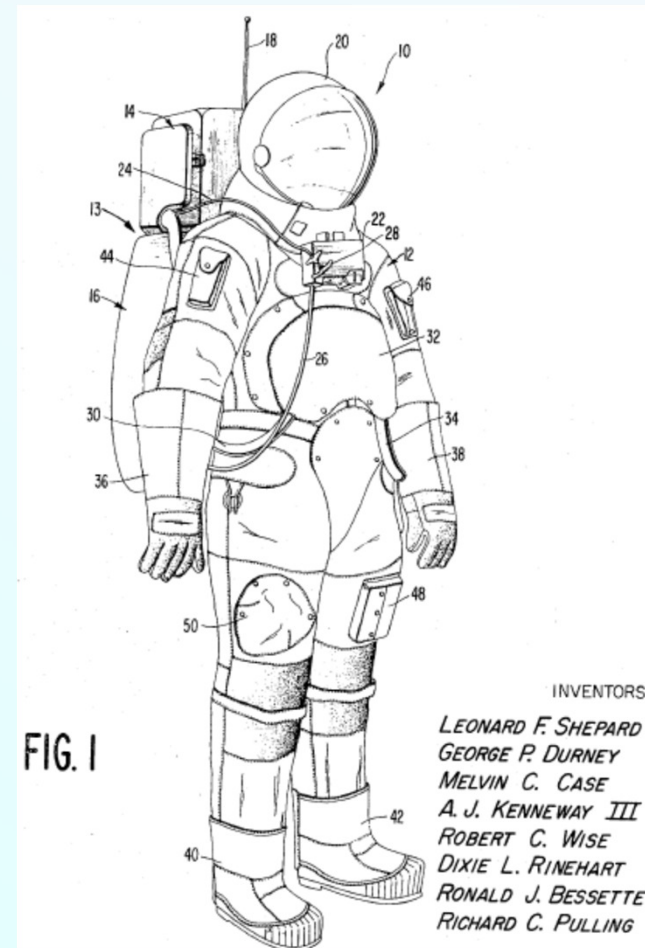


NASA's Patent Filings



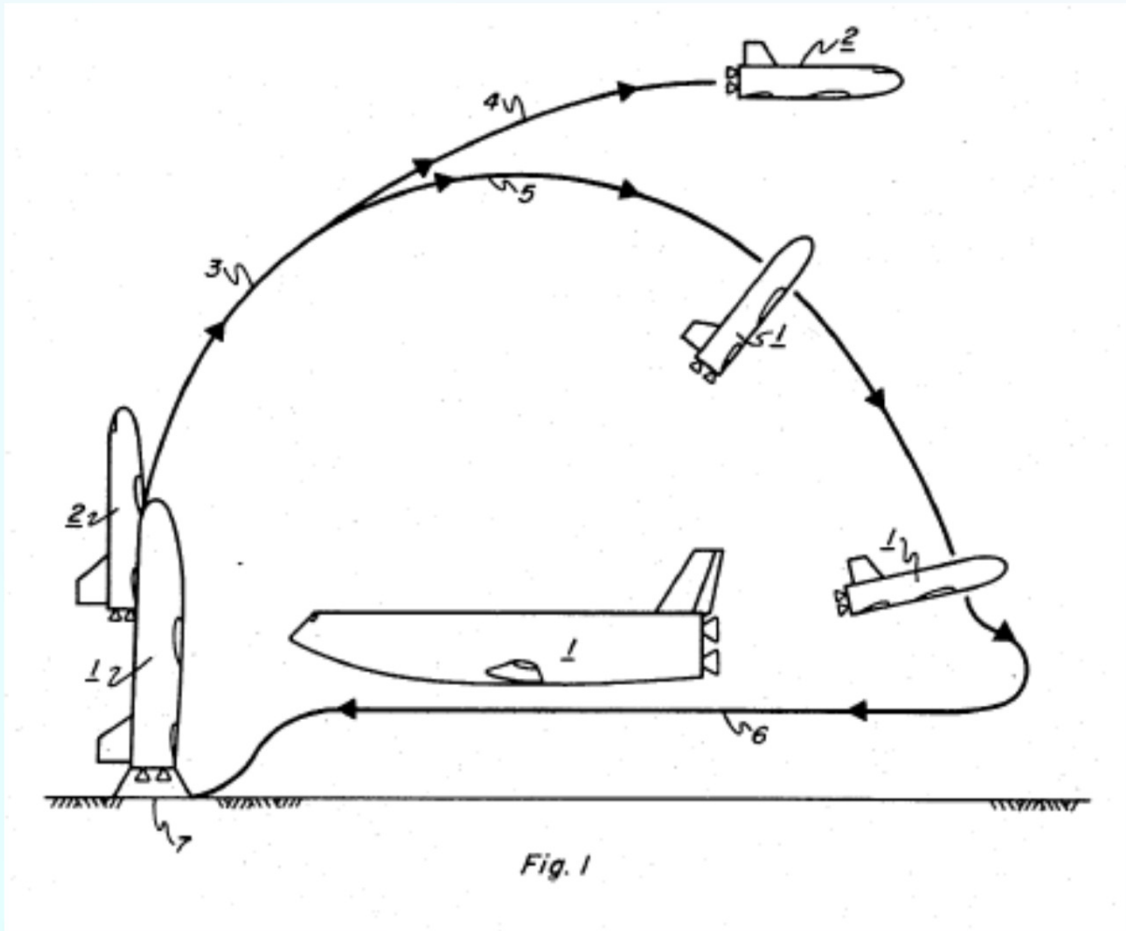
Key NASA Patents

- U.S. Patent 3,751,727 – Space Suit (filed 1968)
- Designed for Apollo missions
- First self-sustaining system to enables astronauts to freely perform extravehicular activities



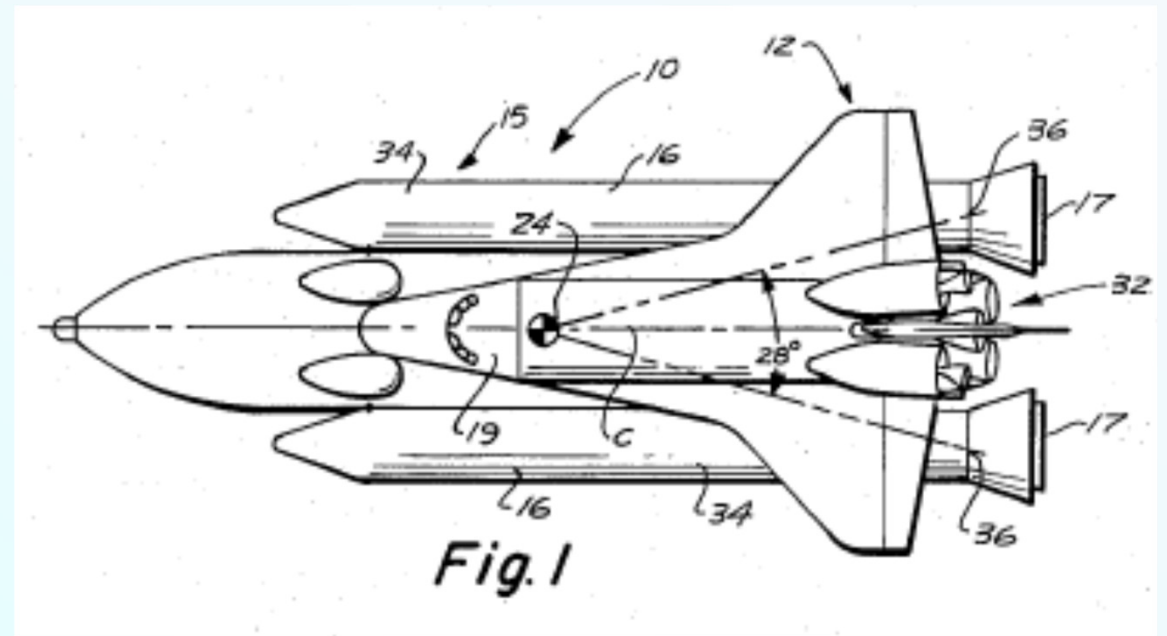
Key NASA Patents

- U.S. Patent 3,702,688 – Space Shuttle Vehicle (filed 1971)
- Reusable shuttle for transporting passengers and cargo to orbit
- “Booster” and “orbiter” joined piggy back

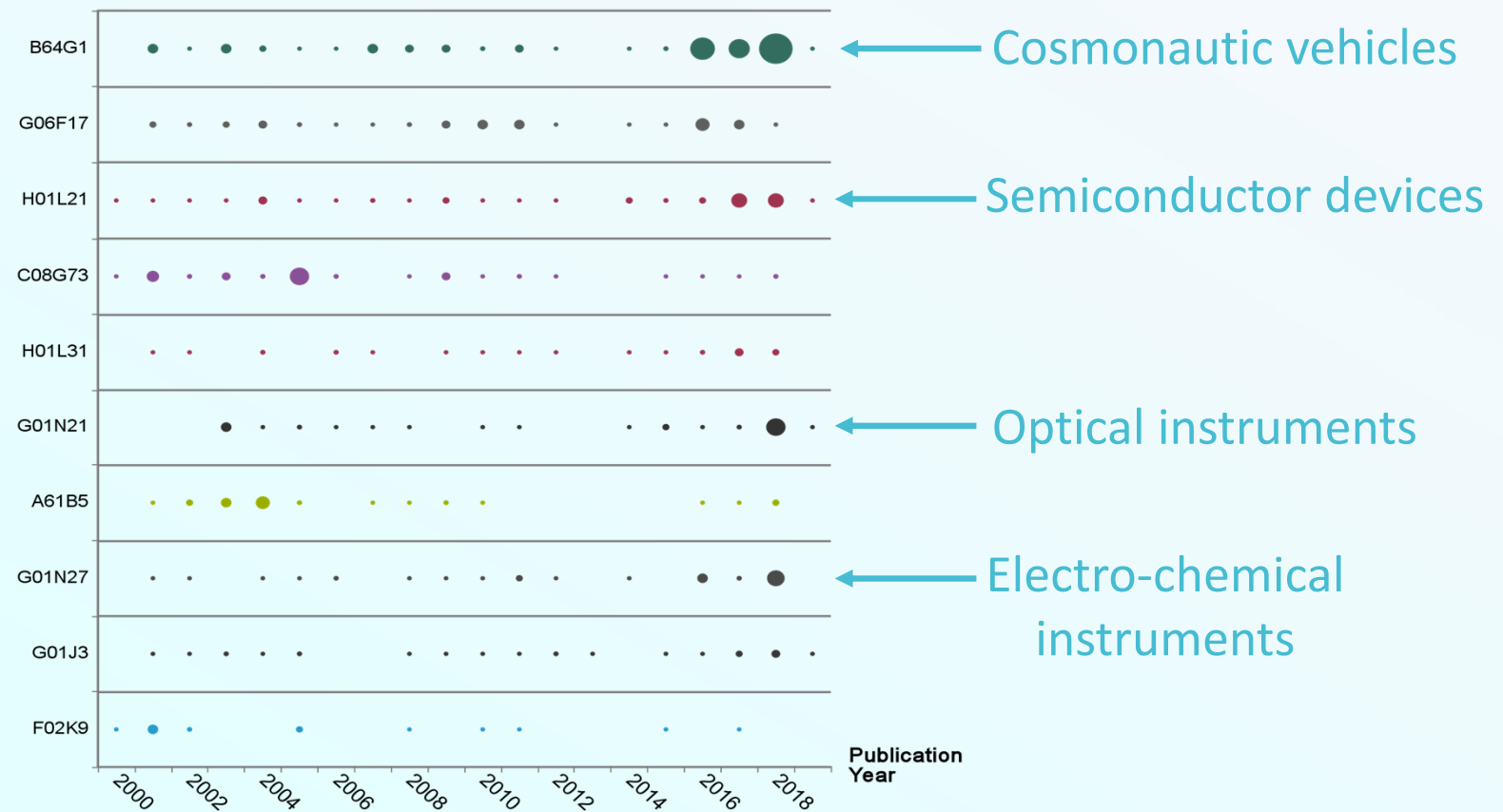


Key NASA Patents

- U.S. Patent 3,866,863 – Space Vehicle (filed 1974)
- An orbiter with re-entry capabilities including a liquid rocket engine and a pair of solid rocket boosters that are releaseably connected to the orbiter



Recent Patent Filings for NASA



• Rise of Privatization in Space

- Scaled Composites / Virgin Galactic
 - Blue Origin
 - SpaceX
- Sierra Nevada Corporation
 - Boeing
- United Space Alliance (Lockheed & Boeing)

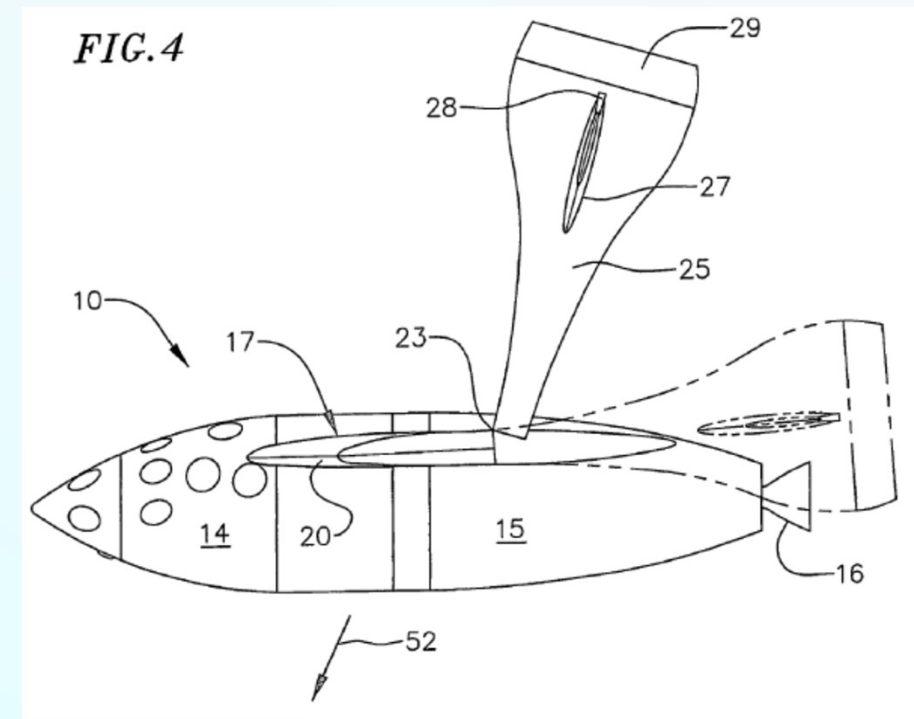
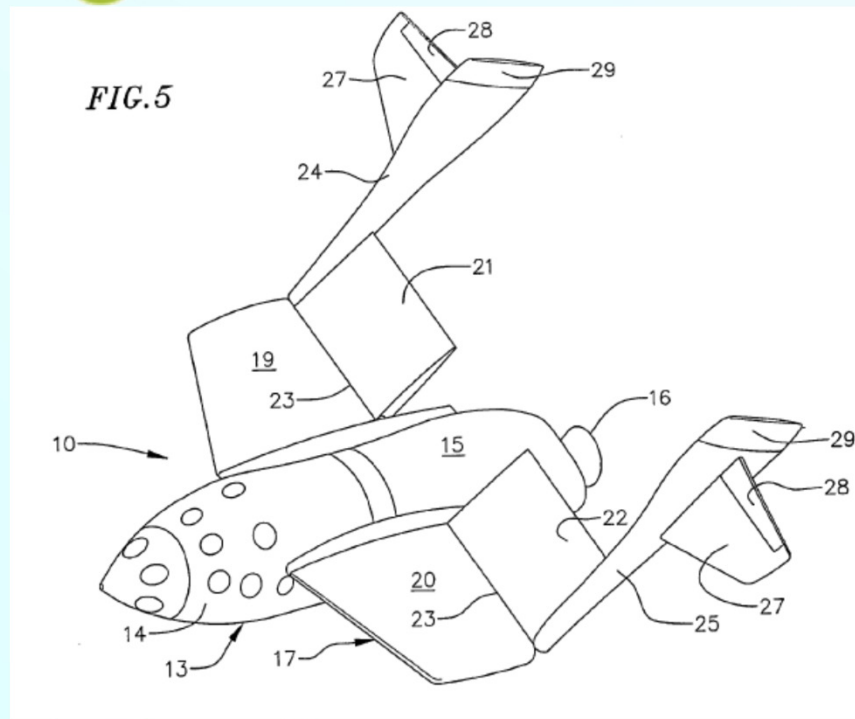
Space Technology Patent Filings Continue to Rise



Scaled Composites & Virgin Galactic

- Burt Rutan filed a patent application for a “Winged Spacecraft” in 2003
- Features aft wing sections that move from a normal airfoil shape to an elevated position producing high drag for slowing the spacecraft during reentry
- U.S. Patent 7,195,207 granted in 2007

Scaled Composites & Virgin Galactic



U.S. Patent 7,195,207

Virgin Galactic

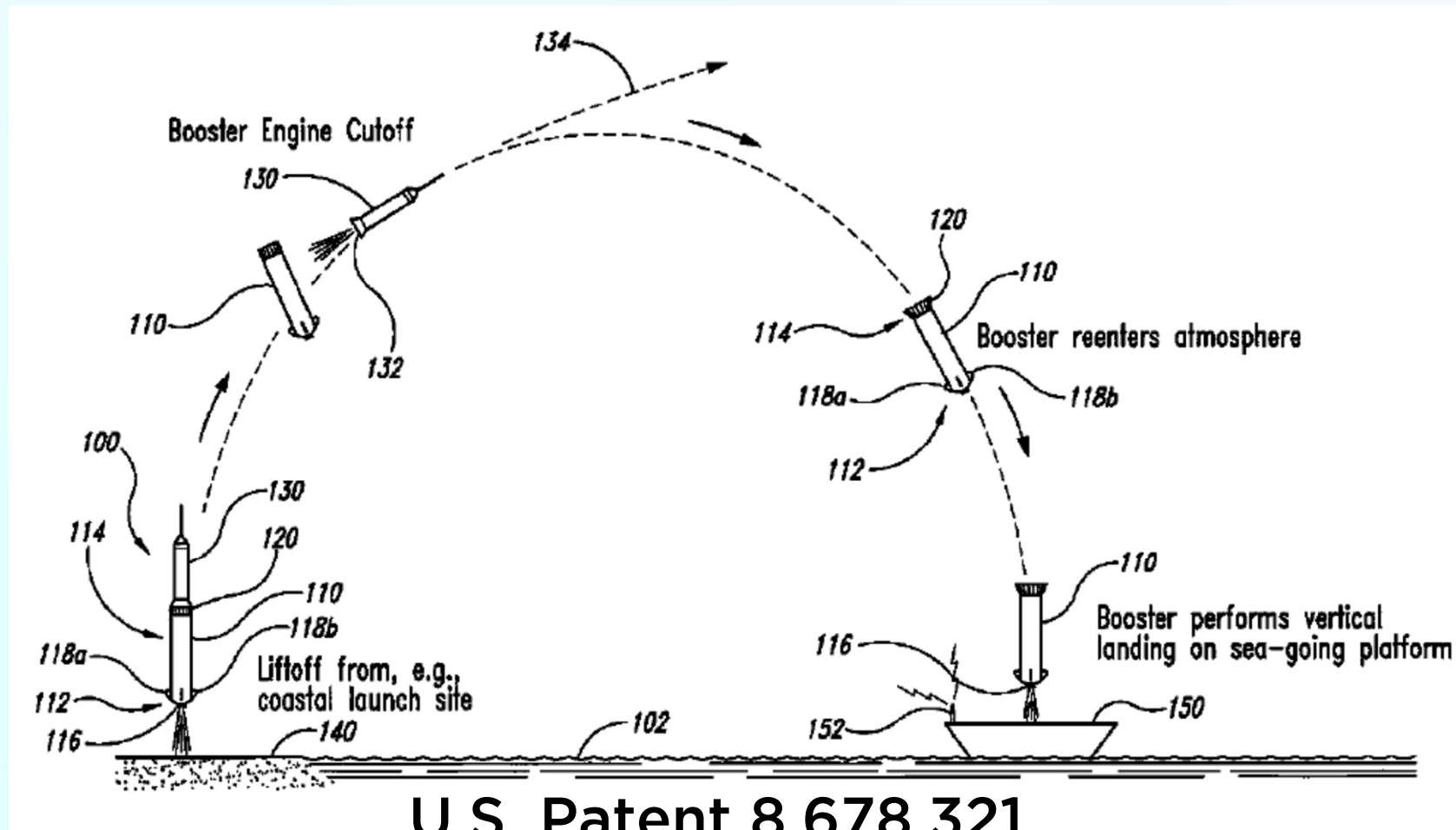


Blue Origin founded by Jeff Bezos

- Founded by Jeff Bezos of Amazon
- Focus on vertical takeoff and vertical landing (VTVL) space vehicles
- 23+ U.S. Patents and pending patent applications
- Filed patent application in 2009 for method of landing space vehicle tail-first on a floating platform
- Granted in 2014 as U.S. Patent 8,678,321

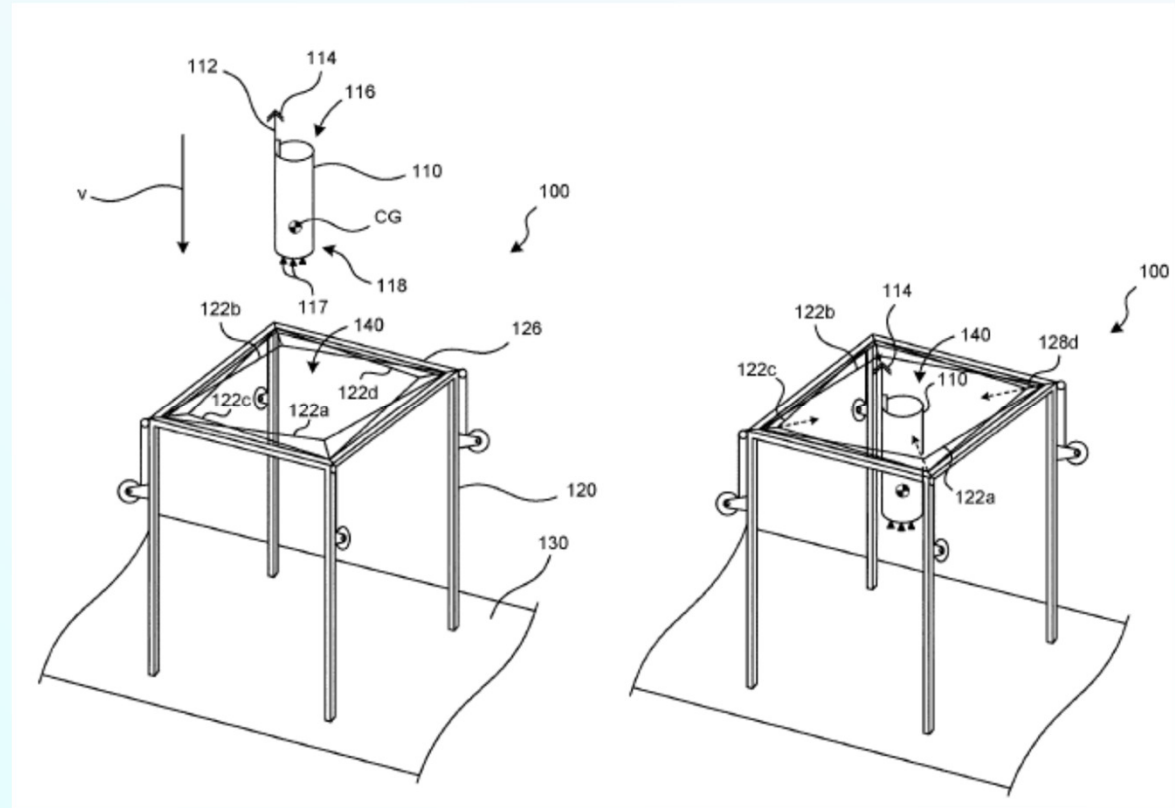


- Blue Origin - VTVL on Water



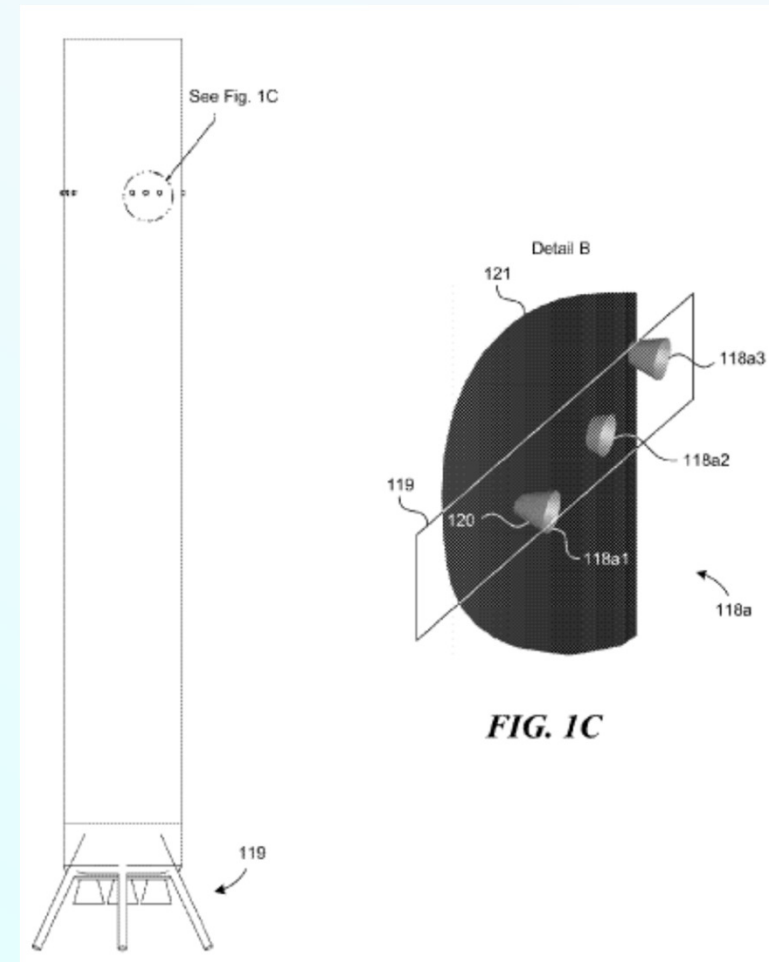
What's Next for Blue Origin?

- U.S. Pub. 2018/0178930
- Vertical landing system
- Cable net catches rocket as it returns to land or sea



• What's Next for Blue Origin?

- U.S. Pub. 2017/0349301
- Lateral thrusters for vertical landing
- Provide control even when a main engine is lost

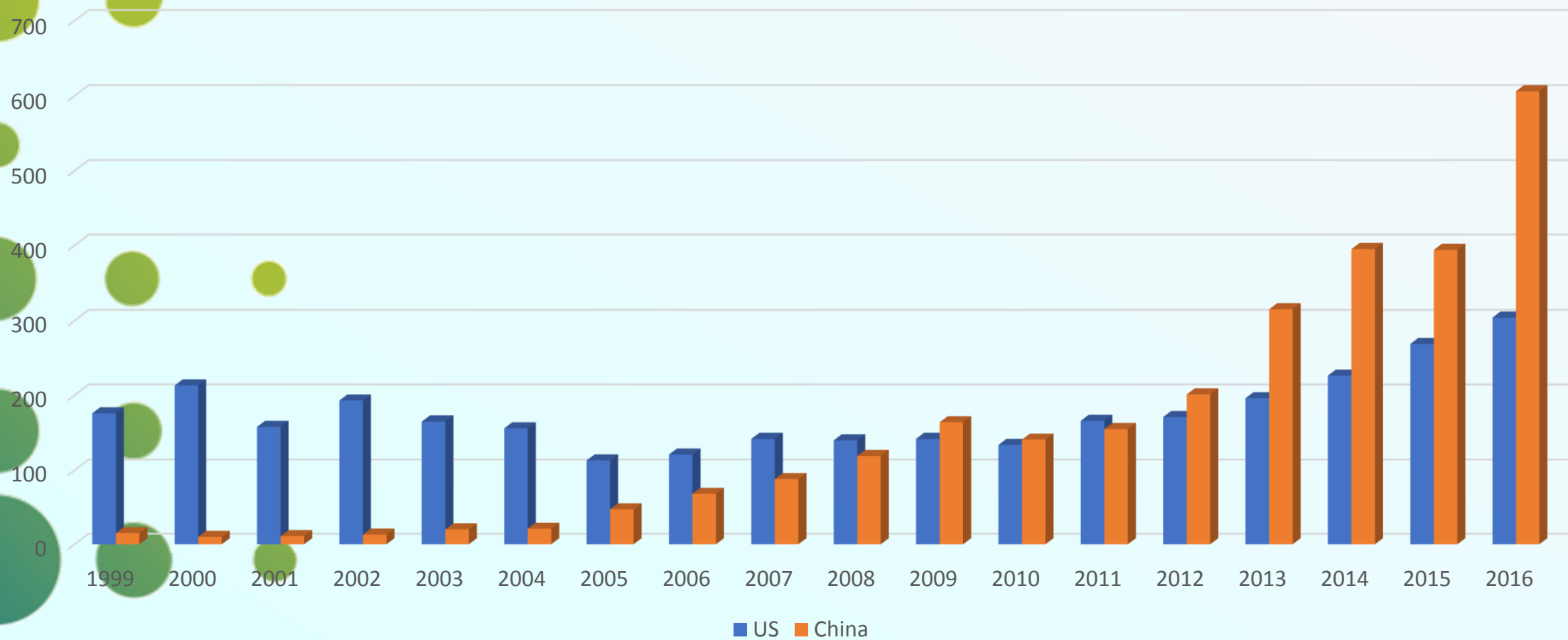


- **SpaceX founded by Elon Musk**

- **SpaceX owns one U.S. Patent**
 - **“We have essentially no patents in SpaceX. Our primary long-term competition is in China—if we published patents, it would be farcical, because the Chinese would just use them as a recipe book.” - Elon Musk, Wired Magazine, Oct. 2012**

The SpaceX logo, featuring the word "SPACEX" in a blue, sans-serif font, followed by a stylized grey and blue swoosh representing a rocket trail.

Patent Filings in U.S. vs. China



Patents vs. Trade Secrets

- Give up patent monopoly but avoid disclosure
- Trade secret advantageous for internal processes and information to be forever hidden from public
- But, protected only until public disclosure/use of the technology
- May lose rights to another who first files a patent application first
- Prior use rights (35 USC 273) – protected only when accused infringer has been commercially using technology at least 1 year before other's patent application filing

SpaceX Landing on Drone Ship (2016)



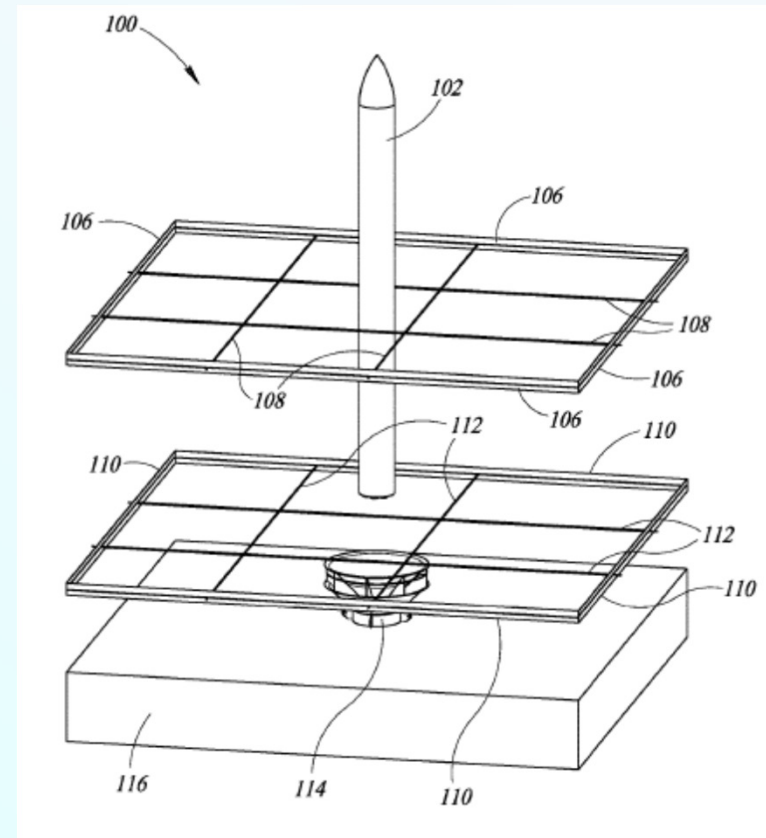
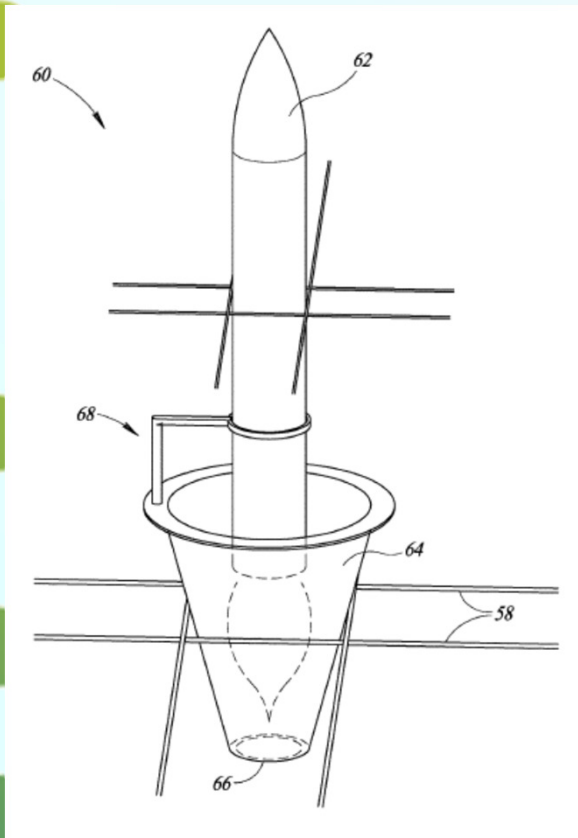
SpaceX Landing on Drone Ship (2016)



Blue Origin vs. SpaceX

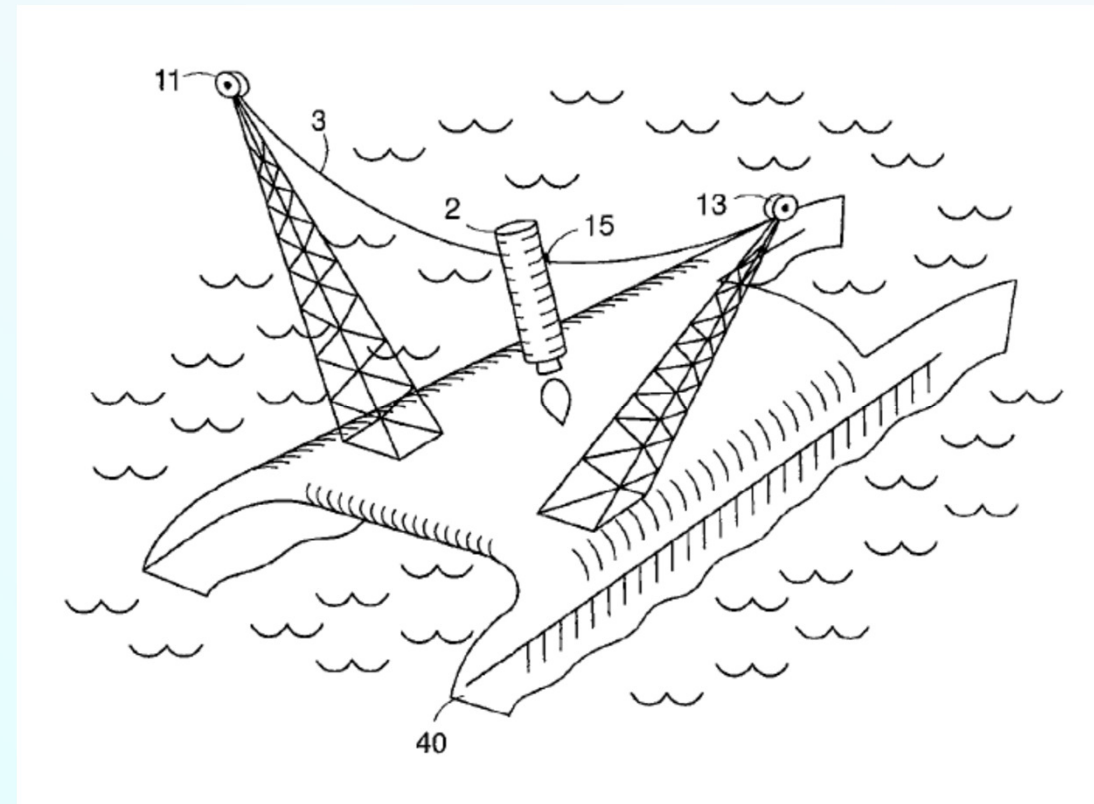
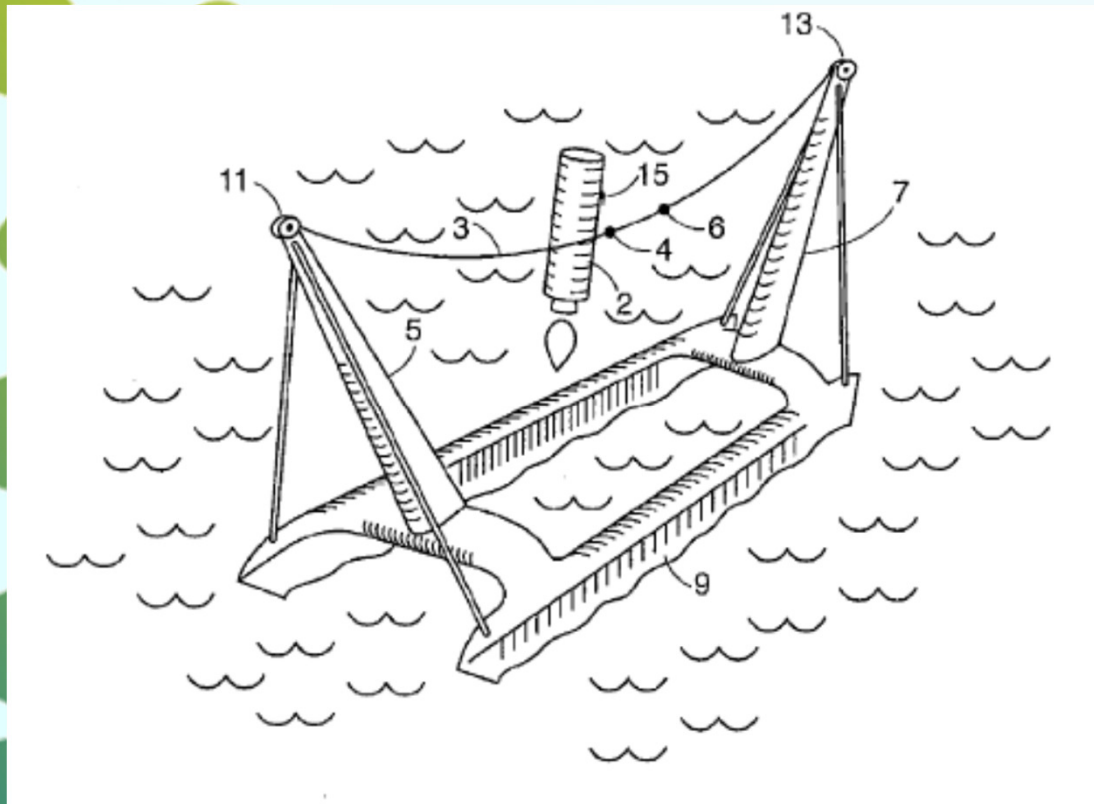
- Blue Origin patent on landing space vehicle tail-first on a floating platform filed in 2009
- In 2014, SpaceX filed Inter Partes Review (IPR) challenging patent based on earlier Japanese space program article
- 2 claims survived IPR
- Blue Origin currently pursuing a Reissue Patent with 70 new claims

More Vertical Takeoff and Vertical Landing



U.S. Patent 10,093,433

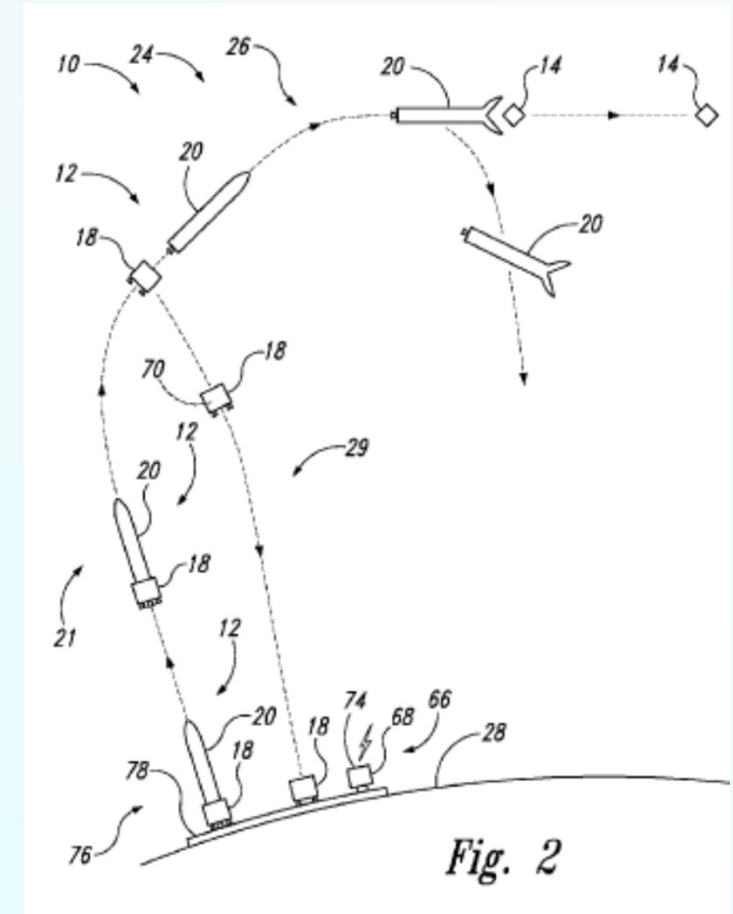
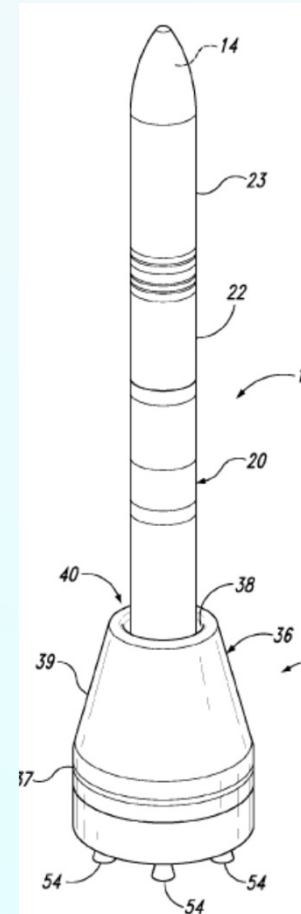
More Vertical Takeoff and Vertical Landing



U.S. Pub. 2018/0044035

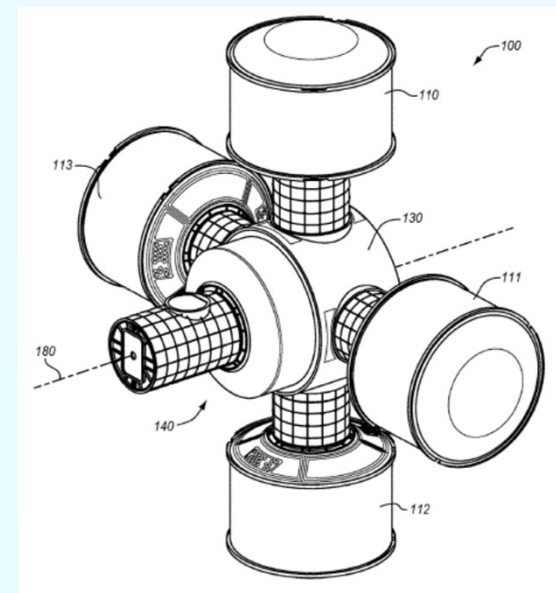
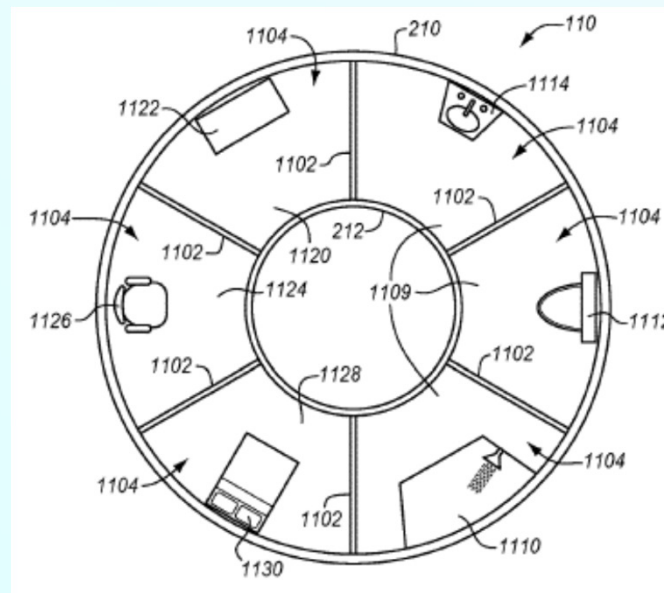
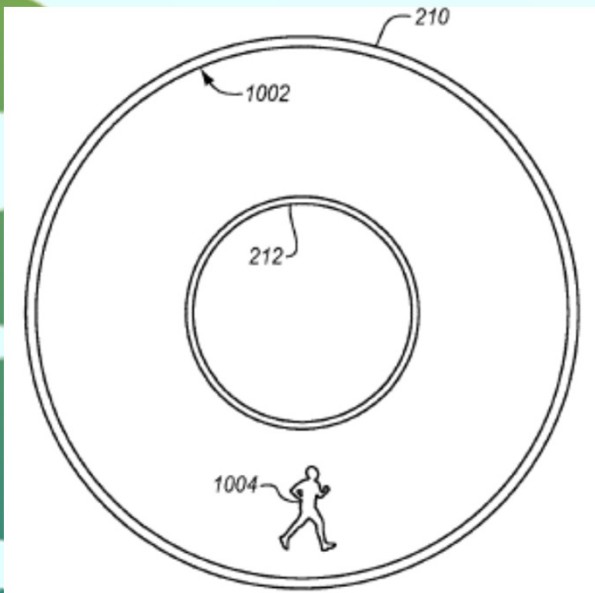
Boeing Multi-Stage Rocket with VTVL

- U.S. Patent 9,676,498
- Separable first stage rolls off, returns to earth, and lands vertically



Boeing's Artificial Gravity in Space

- Boeing pursuing patents on creating artificial gravity environment in space
- 5 new “artificial gravity” patents granted in the last 6 months



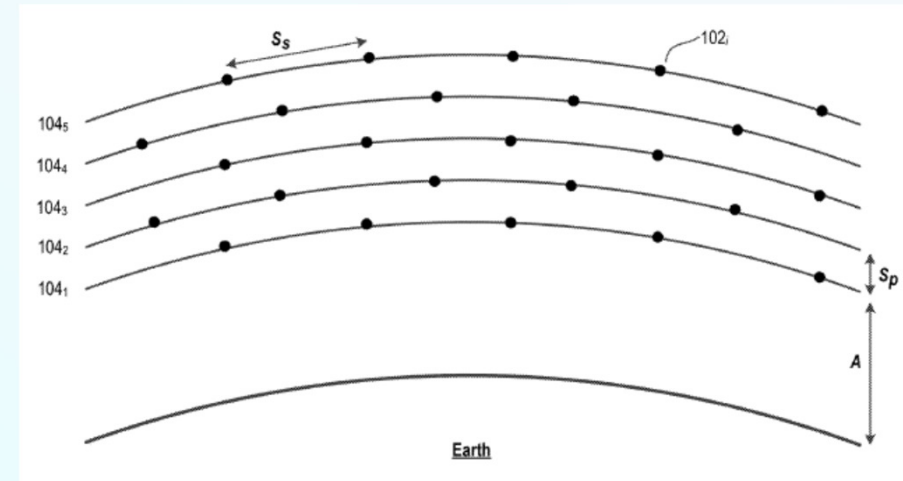
Artificial Gravity in Space

- Artificial gravity first “invented” in the 1960’s
- Rotating centrifuge from 2001: A Space Odyssey (1968)



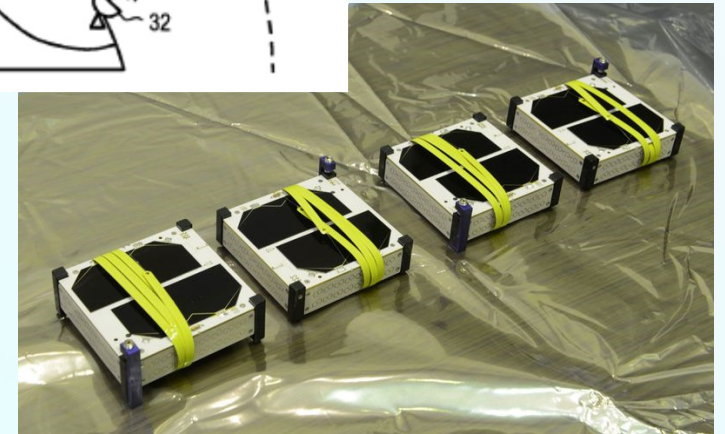
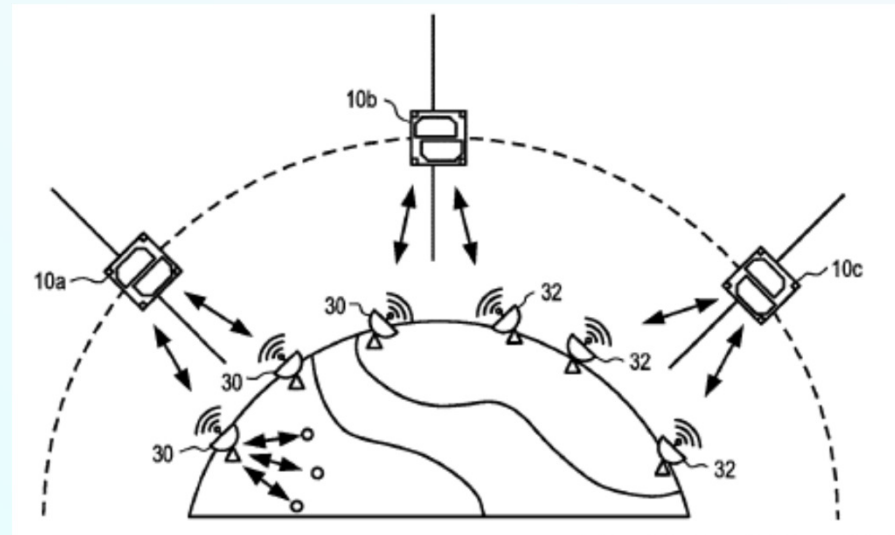
• Satellite For Global Internet

- OneWeb Satellites
- US20180022474 - constellation of LEO satellites stacked in different planes
- Plans to provide global communications network
- 1st group of satellites launched on February 27, 2019



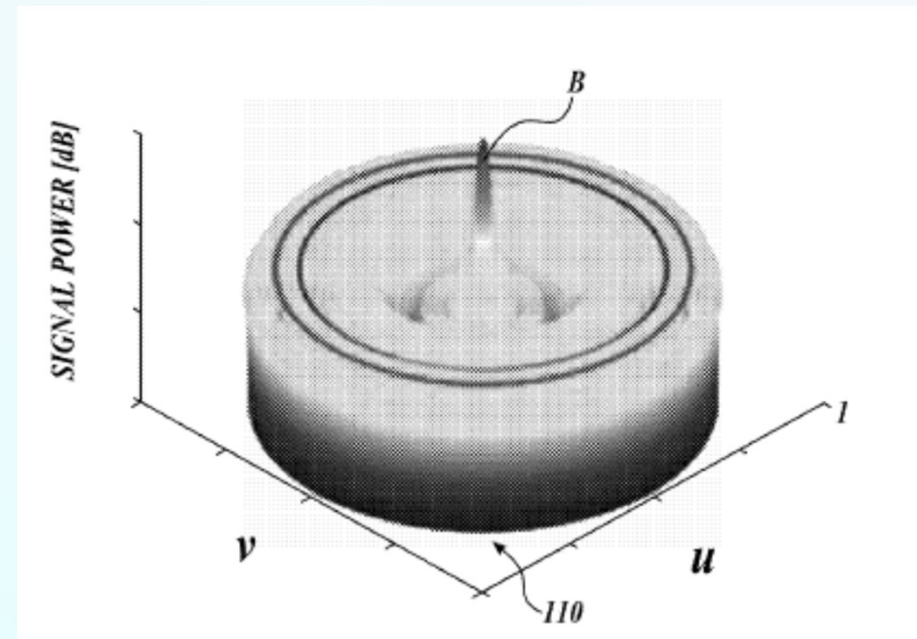
• Satellites For Global Internet

- Swarm Technologies
- US20180346155 - stabilization and distribution for small satellites
- Passive attitude control that requires no power



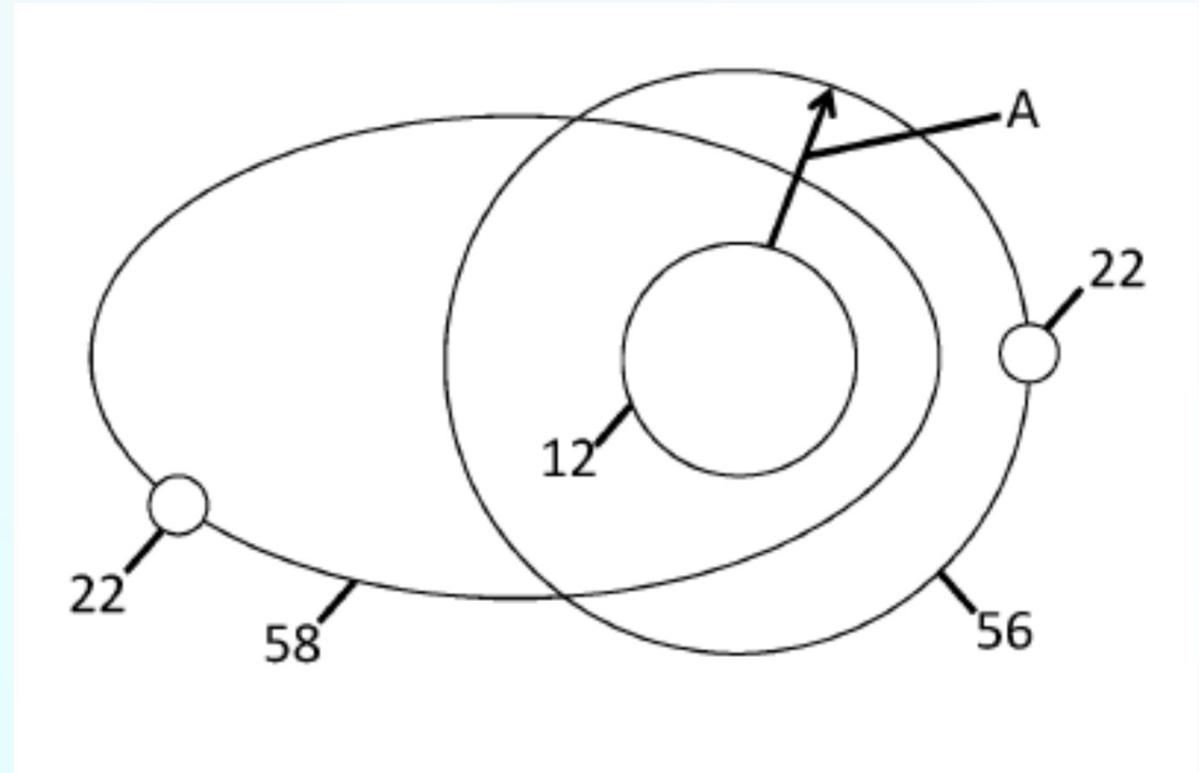
• Satellites For Global Internet

- SpaceX
- US20180241122 - phase array antenna for satellite



• Satellites For Global Internet

- “Blue Digs LLC” aka Boeing
- US20180309507 – satellite constellation
- US20180309208 – satellite array structure



Inventions & Infringement in Space

- What happens if you create or use an invention in space?
- 35 USC 105: Any invention made or used in space on a space object under the jurisdiction or control of the U.S. shall be considered to be made or used within the U.S., unless otherwise provided for by treaty or carried by a foreign state
- Outer Space Treaty of 1967 - A party on whose registry an object launched into outer space is carried retains jurisdiction and control over it while in outer space or on a celestial body
- Registration Convention of 1974 - parties register space objects with UN and mark with registration number

Thank You

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