

Axial Flux Motors in Electric Vehicles



Introduction

Electric vehicles are seen as alternatives for standard combustion engine automobiles to deal with environmental challenges. Subsidies and tax relief provided by governments for the promotion of zero-emission vehicles and an increase in environmental awareness are some factors that have led to a growing demand for EVs in the market. Electric motors are used for the propulsion of EVs.

Radius flux motors which have been in use for a long time, have a rotor and a stator, and both interact radially, but now, axial flux technology is seen as a possible replacement, especially for EVs.

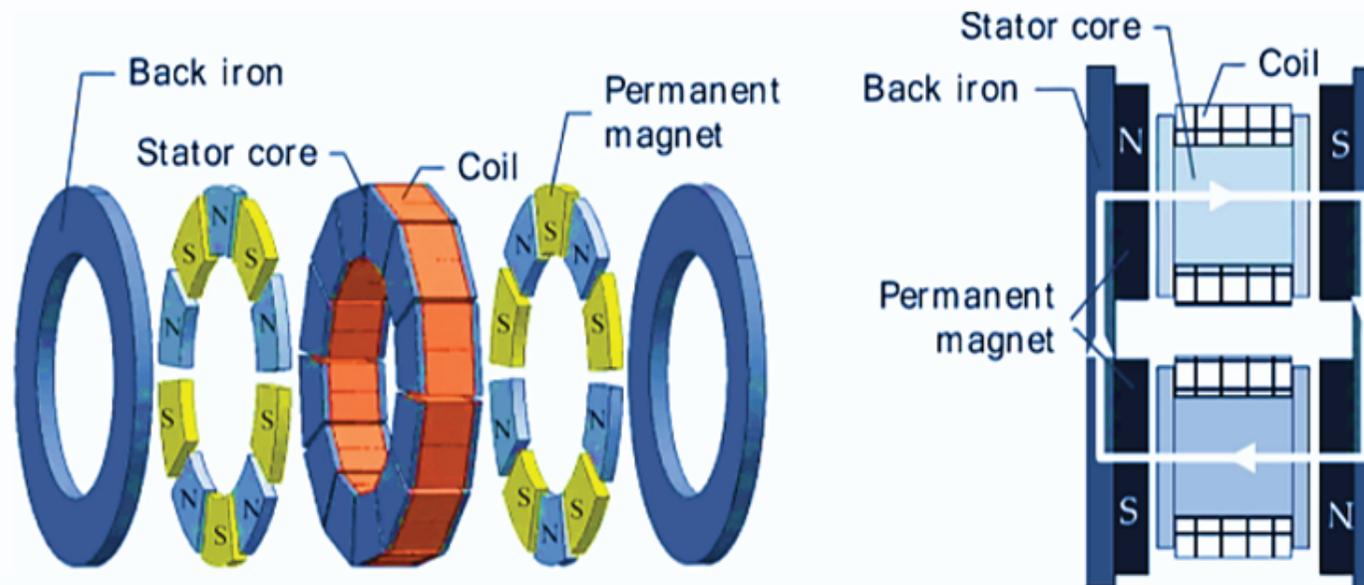
Axial flux motors are believed to be the ultimate future of EVs, specifically for electric aviation, due to their high torque to weight ratio.



What is Axial Flux Motor?

Axial flux motor is the world's first motor, even so it has been in use for the last two decades only. Previously it was being used for the stationary purposes such as elevators and machines used in agriculture, but now several manufacturers and researchers are working to enhance its designs and technology so that it can be used for different types of EVs and aircraft too.

The axial flux motor is wound in such a way that the flux is produced parallel to the axis of rotation, which means that the electromagnetic interaction is parallel to the axis. It simplifies the construction of the motor.



Radial Flux VS Axial Flux Motor

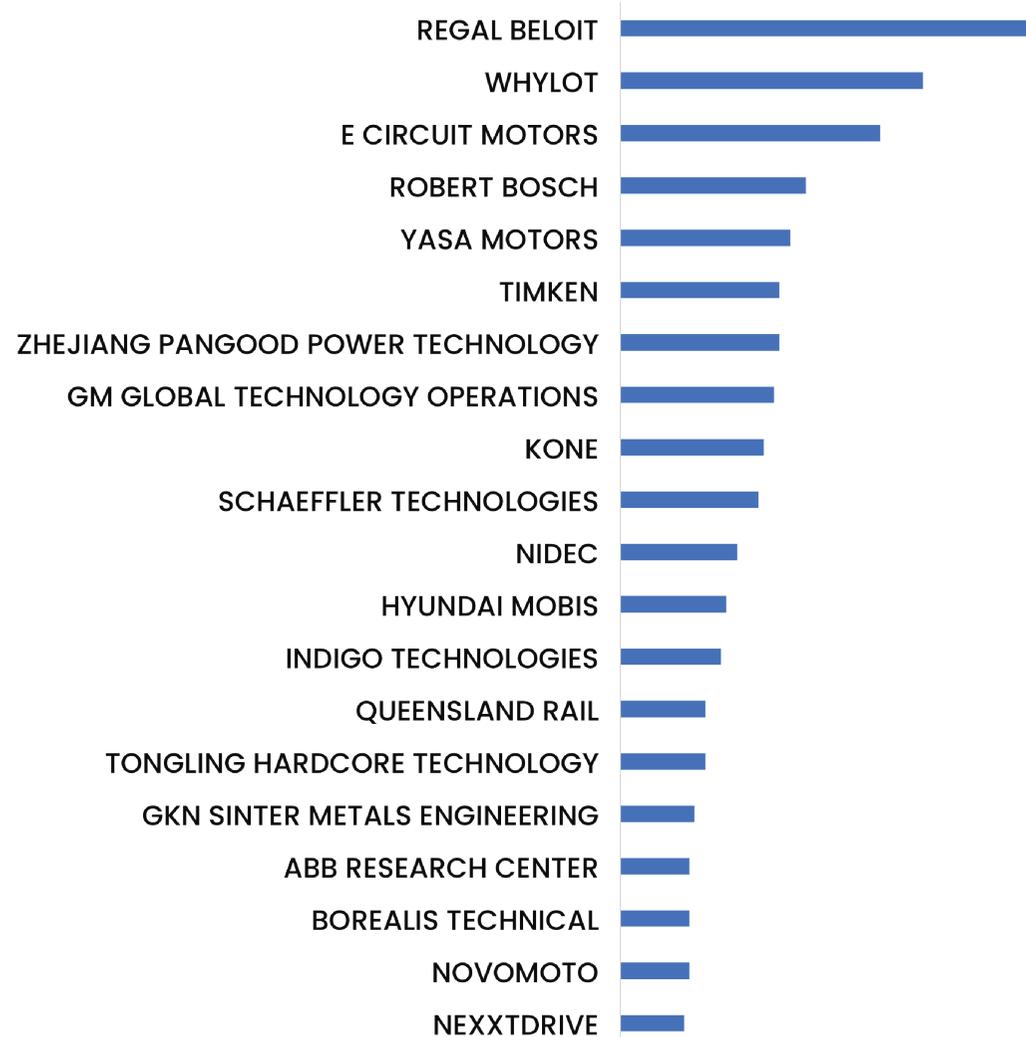
Radial flux motors have been dominating the industry for a long time. But there are advantages that axial flux motors offer when compared to conventional radial flux motors. Due to various reasons such as less coil overhang (leading to enhanced thermal properties), use of grain-oriented steel (lower iron losses), higher flux interaction, etc., axial flux motors provide better thermal and torque performance as compared to radial flux machines.

Parameter	Radial Flux	Axial Flux
Torque Density	-	30 -40 % higher
Cooling	-	Efficient
Production	Comparatively complex	Easier
Footprints	High	Low
Dimension	-	Comparatively Smaller
Cost	-	Comparatively Expensive

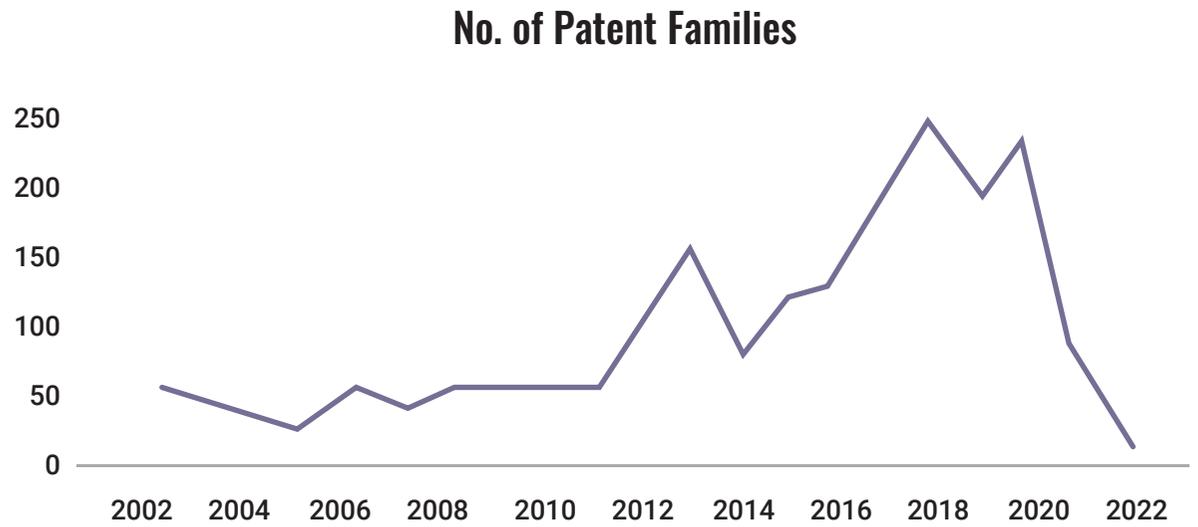
IP Trends

Top 20 Assignees

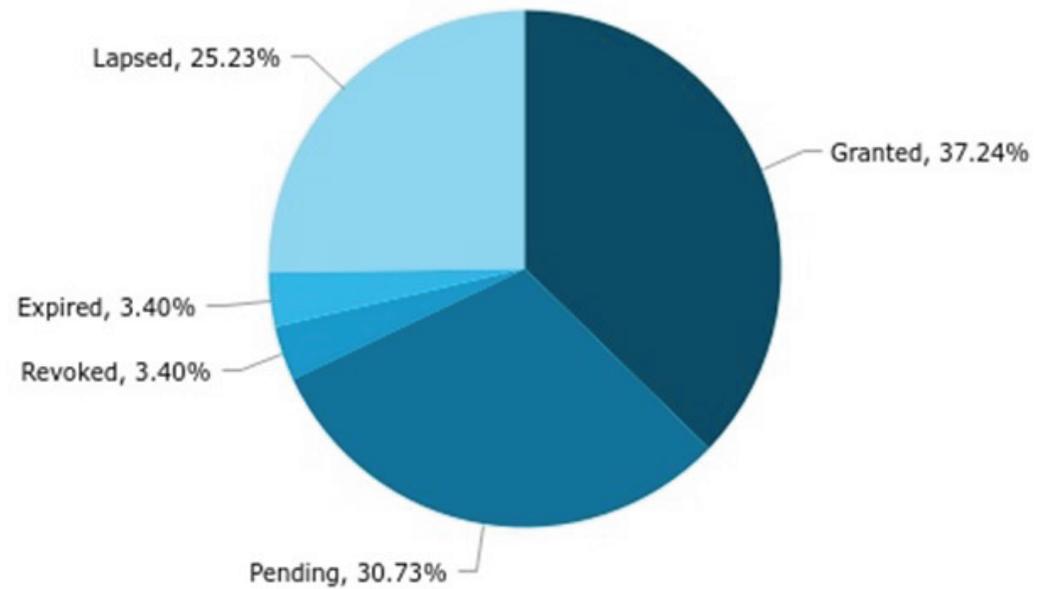
Count of Patent Families



Priority Trend (Year-Wise)



Legal Status





RegalRexnord gm BOREALIS
Keep Discovering
WHYLOT
indigo



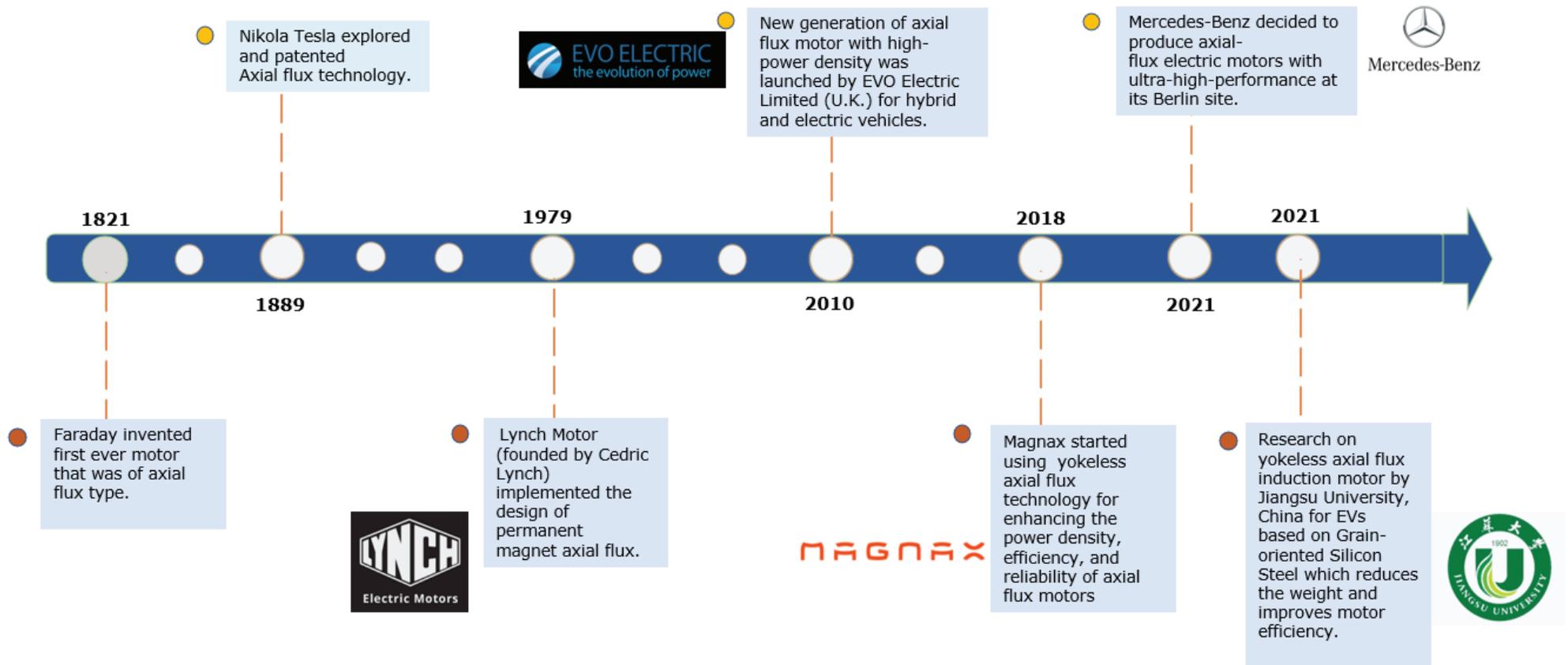
RegalRexnord PANGOOD 邦國 邦
GMCC Nidec



RegalRexnord KONE TIMKEN
WHYLOT
Collins Aerospace



Evolution of Axial Flux Motor



Need for Axial Flux Motor

Axial flux motors are preferable for EVs due to their multiple advantages.

- The axial flux motor can be mounted on a wheel-hub due to its shape and size.
- Seven times higher flux interaction can be obtained in axial flux technology, which results in higher power density, developing 30-40% more torque than a radial motor of the same size.
- Axial flux motor is highly efficient (about 96%), which is due to the smaller flux path in comparison to radial flux motors.
- A greater torque-to-weight ratio is obtained in axial flux motors as a result of dual permanent magnet rotors.

Application Areas

Axial flux motors have an extended range of possible applications, specifically for high torque density and compact space applications. Its technology is being enhanced and improved continuously to make it cost-effective for different power levels and power density applications.

One of the considerable application areas is the e-axle. Due to its smaller width, the motor and gearbox together can be packaged in the axle. Important application areas of axial flux motors are electric motorbikes, large electric buses and trucks, hybrid applications, and electric aircraft.



E-Bike & Quadbikes



Buses & Trucks



Electric aircrafts



Manufacturing

Top Innovations and Companies

Some companies are working around the improvement of the axial flux technology and innovating the traction motors for electric vehicles.

- U.K.-based motor manufacturer YASA Limited removed the stator yoke in its design of axial flux motor, which results in less iron mass by nearly 80%. The company has also developed a direct oil cooling solution due to which the motor can reach higher power for a long time.



- UK-based company Saietta Group has claimed that its axial flux motor can be integrated into lightweight zero-emission vehicles with ease. Saietta's technology can also be used as a replacement for motors of small internal combustion engines.



- Belgium-based motor developer company Magnax has proposed yokeless axial flux technology for enhancing the power density, efficiency, and reliability of axial flux motors for automotive powertrains. The company has been in the research and development of this technology, and now they are presenting new motors of this technology which have higher power densities.



An announcement has been made by the company for the expansion of its R&D efforts towards yokeless axial flux motors. The company declared that in its patented design, the windings of the motor remain cool, and the resistance of copper remains low, resulting in higher power efficiency.



Investments, Acquisitions and Partnerships

Partnerships and investments are some of the major actions taken by the players in the axial flux motor market. Key players in this market are AVID Technology, YASA Limited, Emrax, Magnax BV, Ashwoods Electric Motors, Saietta Group, Lynch motors, Agni Motors, Nidec Corporation, Quanteon Powertrain, Traxial (a subsidiary of Magnax), Whylot, and Omni Powertrain Technologies.

Saietta Group took a step forward to introduce its axial flux motor technology in the Indian market by partnering with Padmini VNA in May 2021.



Saietta Group got a major grant in November 2020 from Advanced Propulsion Centre (APC) to manufacture axial flux traction motors.



Renault Group has invested in acquiring a 21% minority stake in Whylot, a company based in the Lot region of France that is developing axial flux motor technology. Renault signed a partnership with Whylot to develop and industrialize on a large scale an innovative axial flow automotive e-motor.



Mercedes-Benz implemented YASA's axial flux motor technology in its AMG electric-only platform.



Magnax (Belgium) has secured 16-million-euro in the funding round of series A. This investment will support Magnax in its mission to further develop and scale its ground-breaking yokeless axial flux electric motor technology.



Future of axial flux motors in EVs

Public awareness of the environment and a sustainable world are considerable causes for an increase in demand for EVs, which can result in huge growth opportunities for the axial flux motor market for the period of 2022-2027.

Compact and Higher Torque for Central Motor configuration

Due to the growth in investment for EVs and initiatives for the electrification of automobiles all over the world, axial flux motors are anticipated to see major demand in the automobile sector, which is analysed to be the largest shareholder and set to witness the fastest growth of CAGR 13% till 2026. This aims to replace a portion of existing radial flux motors in light and medium-duty vehicles offering higher torque and more compact central motors for these applications.

Promoting In-wheel motors

Axial flux technology offers advantages that make it possible for the motor to fit inside the wheel and eliminate the need to use transmissions and differential arrangements, which leads to lower losses and lower weight of the drivetrain. Also, vehicles with in-wheel motors offer advantages such as enhanced stability control due to the distribution of power to each wheel.

Key Challenges

There are multiple advantages of axial flux motors, but there are several problems in their design and manufacturing, too, which make them much more expensive in comparison to the long-established radial motors.

High Cost

Radial flux motors are well-known and adopted in various industries. But axial flux motors lack available production technologies and machinery that, lead to a higher cost of production.

Mechanical Challenges

Some technical and material problems are being faced in keeping a uniform air gap of high tolerance between the rotor and the stator because of the strong magnetic forces working between them.

Thermal Challenges

In axial flux technology, dual rotor configurations suffer from cooling problems. These windings are situated between two rotor discs and deep within the stator.

Conclusion

Earlier, the development of axial flux motors was negatively affected by the material and technology levels which were present at the time of its invention. But now, several manufacturing companies are working persistently for the advancement of its technology and preparing it for mass production for use in EVs. The market of axial flux motors in electric vehicles is small today, but over the next ten years, a huge increase is expected to be seen in its demand, especially in high-performance vehicles and for some hybrid applications.

Reference

https://www.linquip.com/blog/what-is-axial-flux-motor/#Applications_of_Axial_Flux_Motor

<https://www.industryarc.com/Report/19433/axial-flux-motor-market.html#:~:text=As%20of%202020%2C%20the%20market,R.%20S.r.l.%20Nidec%20Corporation%20and%20others.>

<https://www.allaboutcircuits.com/news/axial-flux-designs-rev-up-future-electric-motors/>

<https://www.traxial.com/blog/why-arent-all-electric-vehicle-motors-axial-flux-yet/>

<https://www.emobility-engineering.com/axial-flux-motors/>

<https://www.allaboutcircuits.com/news/axial-flux-designs-rev-up-future-electric-motors/>

Get in Touch

India Office

207-208 Welldone TechPark, Sohna Road
Sector 48, Gurugram, Haryana 122018, India
+91 124 429 4218

info@iebrain.com

US Office

4 Heinrick Way Bridgewater,
New Jersey 08807, USA
+1 347 480 2054
+1 202 697 9162