

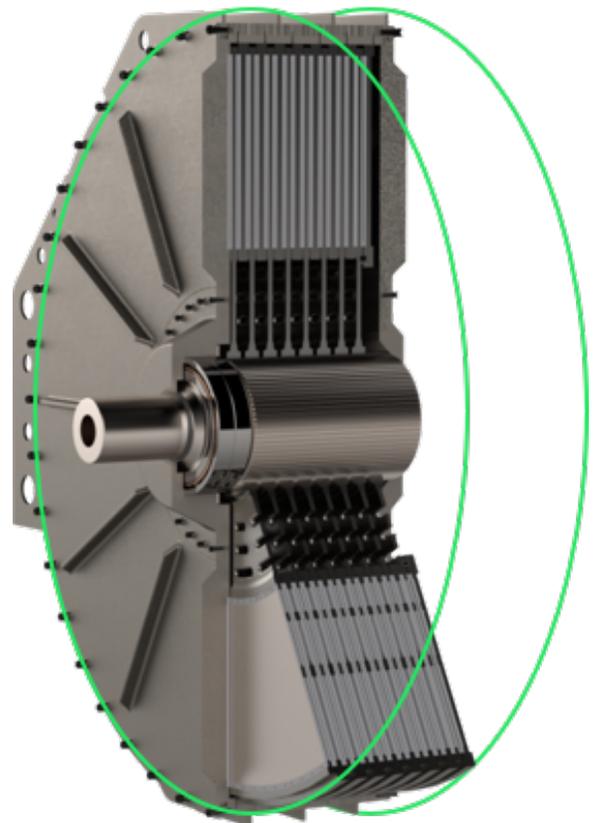


C·MOTIVE

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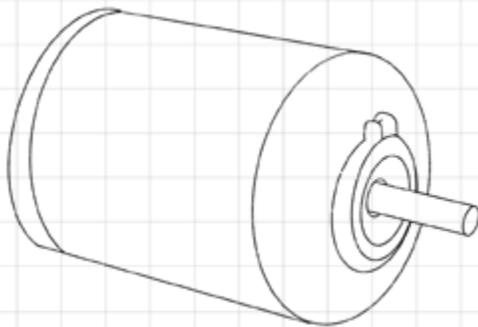
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Transforming Motion with Electrostatic Motors.

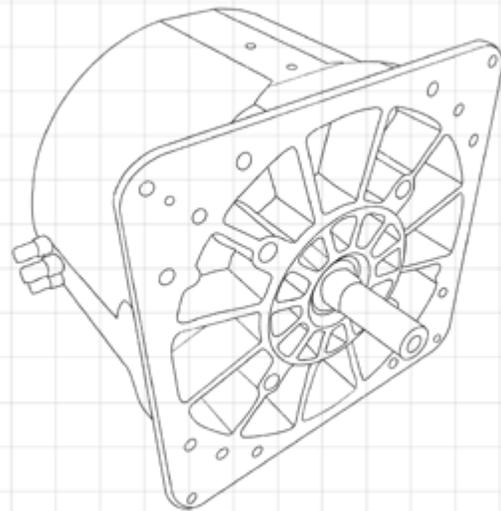
C-Motive is the only company developing and commercializing electrostatic motors and generators. Our patented machine design and enabling dielectric fluid allows us to create machines that harness the power of static forces without losing any efficiency to heat.

Electromagnetic Motors

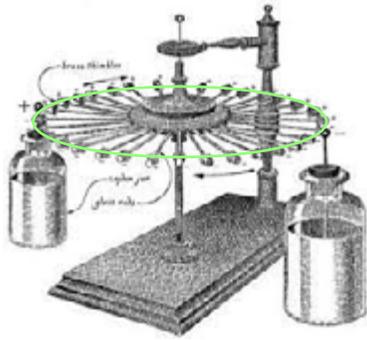


- Optimal at 1,000s to 10,000s RPM
- Focused on power density
- Gearboxes and active cooling necessary for torque applications
- Torque Production: Generated by current
- Losses: I^2R Heating
- Enabling Material: Permanent Magnets
- Drive: Voltage Source Inverter
- Up to 15% total weight is copper
- Up to 10% weight is from rare-earth permanent magnets

Electrostatic Motors



- Optimal at 10s to 100s RPM
- Focused on torque density
- Direct drive applications without gears, cooling, or magnets
- Torque Production: Voltage
- Losses: Fluid Drag
- Enabling Material: Dielectric Liquid
- Drive: Current Source Inverter
- Only 1% weight from copper
- Never any rare-earth permanent magnets



In 1748 Benjamin Franklin invented the Franklin Wheel, an electric motor powered by two Leyden Jars that served as early versions of modern capacitors. Even though this invention provided an early look into electrostatic technology, the idea of studying electrostatics was quickly abandoned due to limits in knowledge of material science and overall practicality to be used at the time. From then on, electromagnetic machines became the dominant technology to be used in electrically powered machines.

C-Motive has challenged the electric machine market by revisiting the technology brought to light by Benjamin Franklin. By combining specific chemical and mechanical elements to an optimized electric machine, C-Motive's technologies are able to deliver an improvement 45,000 times greater than what Benjamin Franklin ever considered possible.

Chemical Improvements

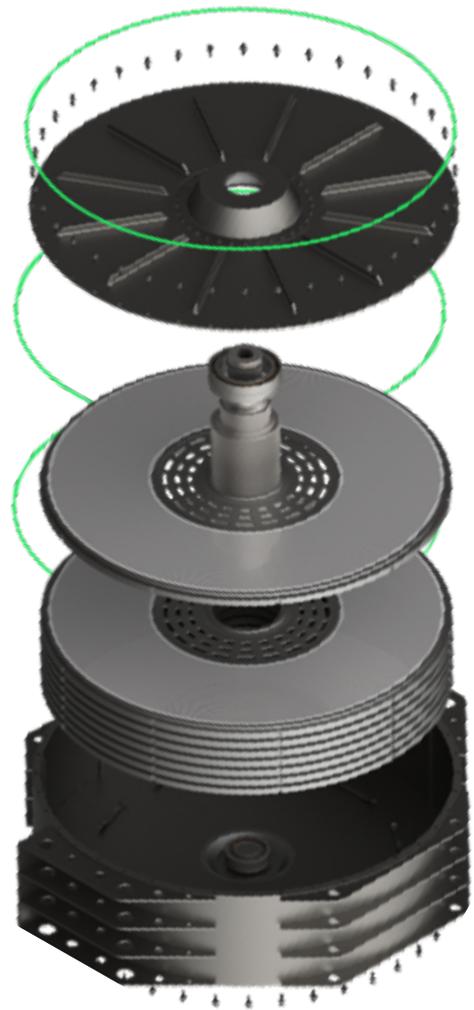
The motor is filled with a non-toxic, non-flammable **dielectric liquid** with high breakdown strength and high permittivity to maximize shear forces. The liquid is designed for maximum torque and efficiency with over 10 years of life built in.

Electrical Improvements

Optimized pole design on rotor and stator plates and **reimagined power electronics** maximize the static force network. With no copper windings, steel laminations, or rare-earth metals, torque density can reach 10x of what is expected from a traditional machine. Ultra-high efficiency and voltage-driven torque means that **no cooling is necessary**.

Mechanical Improvements

Pairs of **rotor & stator plates** inside the machine maximize the surface area to transfer shear forces into maximum possible torque. This is achieved at a low speed, so there's **no need for a gearbox**.



We know what we're talking about.

Our team knows what it takes to unlock the potential of electrostatic machines; after all, we are the only company in the world commercializing this technological breakthrough. Why hasn't anyone done this before? It's simple - our founders were the only ones to take a multidisciplinary approach to the design and patented the advancements along the way.

50+

trade secrets

20+

patents in progress

15

owned patents and applications

12

exclusively licensed patents

See for yourself:

[Self-conforming plates for capacitive machines such as electrostatic motors and generators](#)

[Electrostatic machine system and method of operation \(Granted 2019\)](#)

[Varying capacitance rotating electrical machine](#)

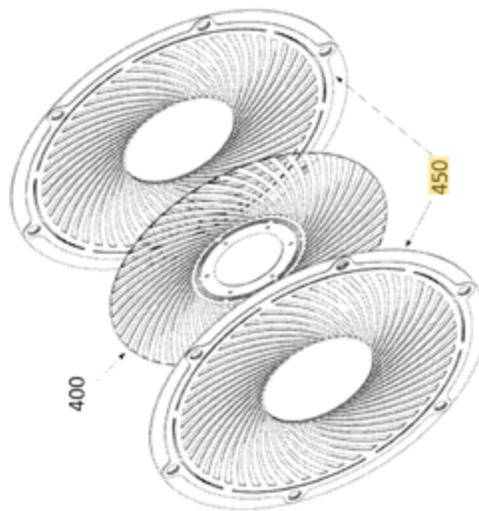


FIG. 9A

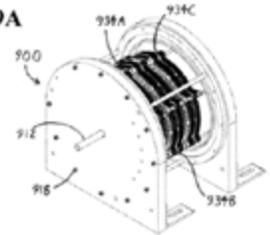


FIG. 9B

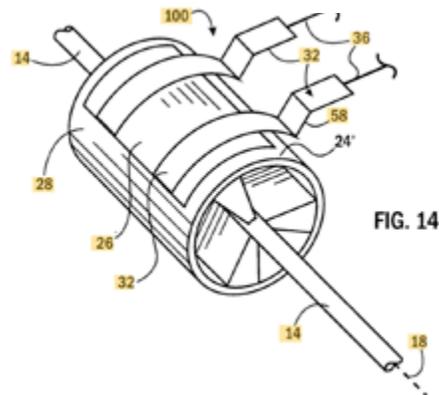
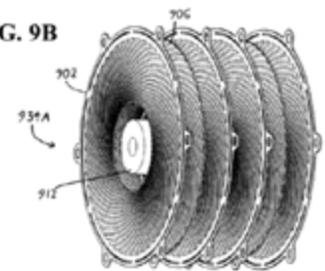


FIG. 14

Torque, Efficiency, Simplicity.

Electrostatic machines offer greater torque density and energy efficiency which allow for simpler motor installations; eliminating all rare-earth metals and nearly all copper is an added sustainability benefit that is unique to C-Motive. Our machines have been engineered to deliver quiet, efficient torque delivery in a wide array of applications without compromise.

Performance Report Card

	C-Motive's Electrostatic Machines	Permanent Magnet	AC Induction	Switched Reluctance
Torque Density	A	C	D	D
Low Speed Efficiency	A	C	C	C
Torque Ripple	A	B	A	D
Audible Noise	A	B	B	D
Power Density	D	A	C	C
Sustainability	A	C	B	B
Temperature Tolerance	A	C	B	B
Unique Form Factor	A	C	D	D
System Price	A	C	A	B

This performance report card reflects an overview of industry applications and where C-Motive is able to provide the best fit in comparison to other motor foundations.

Achieve More With Less.

Copper has been called “the new oil.”* Decreasing resource availability and increasing price volatility have made building motors with copper and permanent magnets less attractive than more sustainable options.

Traditional electromagnetic motors are dependent on copper, iron, and permanent magnets. Permanent magnets require rare-earth metals that are difficult to mine and have an intensive refining process. While copper can be recycled, it isn't always put through the process. Permanent magnets and rare earths (including dysprosium and neodymium) are not recyclable.

Torque in traditional motors is created by passing electric current through copper wires, meaning there is no way around having copper in traditional motors.

Not only are C-Motive's machines more efficient in their use of electricity, they generate more torque for each unit of resources that the motor is made of.

There's a lot of discussion around the importance of saving electricity and the direct impact it has on carbon emissions. That said, sustainability is not just about the amount of electricity that is needed to run the motors, but to produce and refine the raw materials that go into the motors.

In the last 10 years:

3x

increase in copper prices

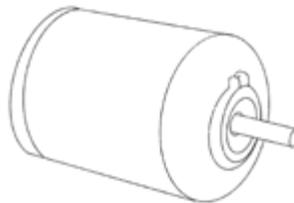
3x

increase in dysprosium prices

2x

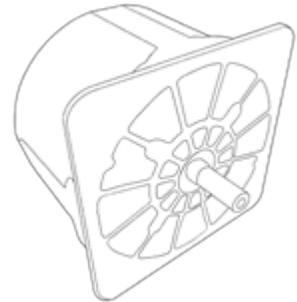
increase in neodymium prices

OTHER MOTORS



Copper Use: 40kg
Permanent Magnet Use: 15kg
Torque Generation: 450 Nm

C-MOTIVE'S COOLTORQ™ MACHINE



Copper Use: < 1 kg
Permanent Magnet Use: 0 kg
Torque Generation: 450 Nm

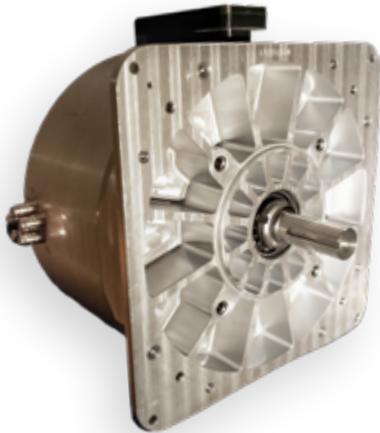
At least **90%**
of the world's permanent
magnets are sourced
internationally

*<https://www.goldmansachs.com/insights/podcasts/episodes/05-18-2021-nick-snowdon.html>

The CoolTorq™ Platform

C-Motive's CoolTorq Industrial Motor Product line is a flexible platform capable of scaling from 1 kW to nearly 50 kW in power output. The two platform building blocks are 25 cm and 50 cm in diameter and offer flexible lengths to meet application requirements. Engineered for high torque, low speed applications, the CoolTorq product line is tailor made to replace traditional magnetic motors, gearboxes, belts, and pulleys with a simple, direct drive machine that requires no additional cooling.

CoolTorq™ 10



MECHANICAL SPECIFICATIONS

- Diameter: 10.0" / 25.4 cm
- Length: 6.3" / 16.0 cm
- Volume: 494 in³ / 8.1 L
- Weight: 26 lbs / 12 kgs
- Various mounting options available upon request

PERFORMANCE SPECIFICATIONS

- Torque: 25 Nm
- Continuous Power: 1.25 kW
- Continuous Speed: 500 RPM
- Peak Speed: 1,000 RPM
- Typical Efficiency: 96%

CoolTorq™ 20



MECHANICAL SPECIFICATIONS

- Diameter: 20.0" / 50.8 cm
- Length: 8.0" / 20.3 cm
- Volume: 2,511 in³ / 41 L
- Weight: 187 lbs / 85 kgs
- Various mounting options available upon request

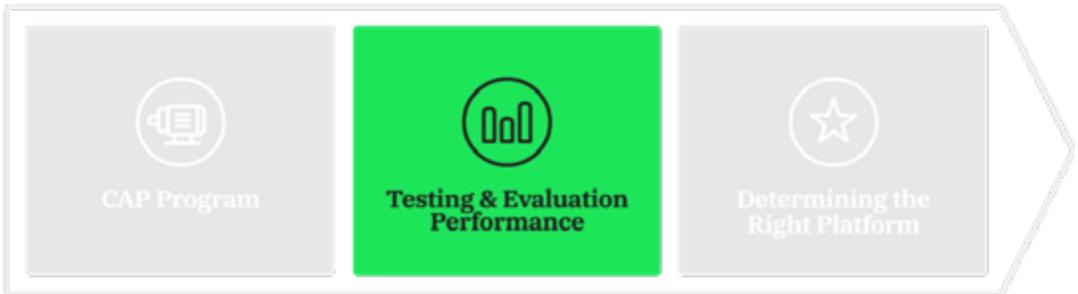
PERFORMANCE SPECIFICATIONS

- Torque: 400 Nm
- Continuous Power: 20 kW
- Continuous Speed: 500 RPM
- Peak Speed: 1,000 RPM
- Typical Efficiency: 97%

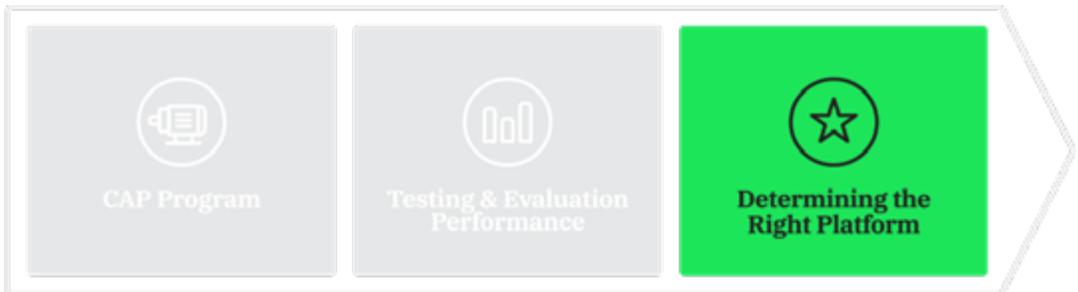
The CAP Program.



The first step to determine if an electrostatic machine is a good fit for your application is to join the C-Motive CoolTorq Advanced Prototype (CAP) program. Sharing application needs, machine specifications, and previous technical challenges will give C-Motive's technical team the necessary information to model how an electrostatic machine will do the job. Our team will evaluate those details against the CoolTorq10 and CoolTorq20 machine platforms and provide performance projections for your application.



The next phase of the CAP program is to sign up to receive demo units for testing at your facilities or share test profiles with C-Motive for testing in our laboratory. Electrostatic prototype machines can be rented for a period of time for in-house testing. Sharing test results with C-Motive will allow our team to compare performance projections to actual data and understand the refinements necessary (if any) to meet the needs of the application.



Determining the proper CoolTorq platform is more than just understanding size, torque, and speed. Collaborating on details of mounting design challenges, output shaft design, or other requests will allow C-Motive to recommend, spec, and quote electrostatic machines for purchase. While entry into the C-Motive CAP program is limited, it offers more than just an advanced look at the next generation of the electric machine, it is a way to secure competitive advantages in the marketplace with the most efficient, highest torque density, and easiest to integrate machine available the market.

Easy. Cool. Direct.

Electrostatic machines offer exceptional value in a wide array of applications - from stationary to mobile and from small generators to huge propulsion machines. Any application where motors are sized to deliver torque, C-Motive offers both performance and efficiency while also enabling an overall simpler system design. The overall result is lower initial cap-ex, better operational efficiencies, and reduced recurring maintenance from a sustainable rare-earth magnet free product.



RENEWABLE GENERATION

Ultrahigh Efficiency: C-Motive electrostatic generators can be designed for 99% efficiency at direct drive operation below 15 RPM.

Field Upgradable: Future improvements for power density can be implemented in the field.

Flexible Interconnect Options: Output from the electrostatic generator can be customized for medium voltage interconnect strategies.



INDUSTRIAL AUTOMATION

Lossless Torque Holds: C-Motive motors can hold load with > 90% less power draw than traditional electromagnetic motors resulting in no heat generation or derating.

No Torque Ripple: Ultrahigh pole count means no torque ripple even in precision motion operation.

Torque Density: The highest torque density on the market means no gearboxes necessary.



COOLING TOWER FANS

Direct Drive: Eliminating gearboxes, driveshafts, and bearings leads to significant cap-ex savings.

Efficiency: In 24/7/365 operation, efficiency means lower utility bills and ongoing op-ex savings.

Torque Density: At 1/5th the weight of comparable machines, transport, construction, and retrofitting is simpler.



ELECTRIC MOBILITY

Simplicity and Efficiency: Eliminating gearboxes, active cooling systems, and increased motor efficiency delivers more range per battery kWh.

Torque: Start / stop urban driving needs torque, not power to optimize drive experience.

Flexible Form Factors: Can be designed for hub or driveshaft installations in a variety of vehicle sizes.



HEAVY HYBRID DRIVETRAINS

Torque Density: More towing, payload, and hillclimb capability and flexibility than geared electromagnetic machines.

Low Speed: Optimized for operation below 500 RPM including crawling and ultra-quiet operations.

Flexible Form Factors: Can be easily designed for both hub and driveshaft installations.



MARINE PROPULSION

Torque Density: From personal watercraft to container ships, higher torque density enables more efficient propulsion-system designs.

No Torque Ripple: When precision motion is needed, no torque ripple means smooth propulsion.

Efficiency: The most efficient electric motors deliver the lowest emissions in large ships.

Interested in exploring how electrostatic machines can enable the next level of performance and efficiency from your applications and give you a competitive advantage in the market? Curious if electrostatic machines can be tailored to your specifications or how your application could be optimized around the performance and efficiency of an electrostatic machine? Reach out to C-Motive today to discuss your applications, product needs, and inquire about demonstration opportunities.

Let's talk.

Have an application that needs the world's best low-speed, high torque electric machine? Developing a next-gen system and interested in saving your customers money by implementing more efficient operations? Interested in joining the C-Motive CAP Program? Let's talk and see how we can work together.



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