HYBRID TURBINE–MAGNETIC ENGINE WITH INTEGRATED ELECTRICAL GENERATION AND THERMAL MANAGEMENT

Inventor Draft / Provisional-Style Specification (Date: 2026-03-04)

Field of the Invention

The present invention relates to energy conversion systems, and more particularly to turbine engines integrated with electromagnetic power generation and thermal management subsystems.

In various embodiments, the invention provides a compact turbine-driven energy system capable of generating both mechanical energy and electrical power in a unified architecture.

Definitions

Turbine engine: a rotary mechanical device that converts energy from high-temperature gas flow into rotational mechanical energy.

Hybrid turbine–magnetic engine: an integrated system in which a turbine engine drives an electromagnetic generator within a shared mechanical structure.

Electromagnetic generator: a device that converts rotational mechanical energy into electrical energy using electromagnetic induction between rotating magnetic fields and conductive windings.

Thermal management subsystem: a system configured to regulate operating temperature of engine components using cooling fluids, heat exchangers, or other thermal transfer mechanisms.

Central rotor shaft: a rotating mechanical shaft connecting compressor, turbine, and generator subsystems.

Power conditioning system: electrical circuitry configured to convert raw generator output into usable electrical power through rectification, regulation, and distribution.

Background

Turbine engines are used for propulsion and power generation due to high power density. In many applications, electrical energy must be generated using separate generator systems coupled to turbine shafts through mechanical transmissions.

Such arrangements can increase structural complexity, weight, and mechanical losses. Moreover, high-temperature turbine operation can impose additional thermal constraints on nearby electrical components and power electronics.

Accordingly, there exists a need for an integrated turbine–generator architecture with reduced coupling losses and improved thermal stability while providing configurable electrical output suitable for portable, industrial, and remote power applications.

Summary

In one embodiment, the invention provides a hybrid turbine–magnetic engine system comprising: (i) an air intake and compression subsystem; (ii) a combustion subsystem; (iii) a turbine energy conversion subsystem; (iv) an integrated electromagnetic generator subsystem mechanically coupled to a turbine shaft; (v) a power conditioning subsystem; (vi) a thermal management subsystem; and (vii) a control and monitoring subsystem.

During operation, the turbine subsystem rotates a central rotor shaft which drives the compressor and generator subsystems. The generator subsystem produces electrical power through electromagnetic induction between a rotating rotor magnetic assembly and stationary stator windings. Electrical output may be rectified, regulated, and distributed via a DC bus architecture to external loads and/or energy storage.

Brief Description of the Drawings

FIG. 1 illustrates a front view of the intake assembly.

FIG. 2 illustrates a side cutaway view of the hybrid turbine–magnetic engine.

FIG. 3 illustrates an exploded assembly of major engine components.

FIG. 4 illustrates internal airflow paths through the engine.

FIG. 5A illustrates an electrical generation subsystem including stator windings, protection, and a rectifier with a DC link capacitor bank.

FIG. 5B illustrates a power regulation subsystem for establishing a regulated DC bus.

FIG. 5C illustrates a distribution subsystem including contactors, precharge, and output terminals.

FIG. 5D illustrates sensing and control circuitry and control signals for regulation and safety.

FIG. 5E illustrates an optional energy storage subsystem and anti-backfeed interface.

Detailed Description

Overall architecture. Referring to FIG. 2, the hybrid turbine–magnetic engine (100) includes a central rotor shaft assembly extending along a longitudinal axis. The rotor shaft mechanically couples a compressor assembly, a turbine assembly, and a generator assembly within a shared housing.

Air intake and compression. Referring to FIG. 1, an intake assembly may include an inlet nose cone, inlet guide vanes, and an intake housing. Air is directed to a multi-stage axial compressor comprising rotor discs, compressor blades, and stator vanes to increase pressure prior to combustion.

Combustion. Compressed air enters a combustion chamber containing a combustion liner, fuel injection nozzles, ignition elements, and flame stabilization structures. Fuel combustion generates a high-temperature, high-pressure gas flow.

Turbine energy conversion. The hot gas flow enters a turbine subsystem including turbine rotor discs, turbine blades, and stator vanes within a turbine housing. The turbine converts the gas flow into rotational energy delivered to the central rotor shaft.

Electrical generation. Referring to FIG. 5A, the generator subsystem includes a stator winding assembly and a rotor magnetic assembly coupled to the shaft. Relative motion induces three-phase electrical power which may be protected, rectified, and smoothed by a DC link capacitor bank.

Power conditioning and distribution. Referring to FIGS. 5B–5C, raw DC may be regulated via (i) shunt regulation using a dump load and switching elements and/or (ii) a DC-DC converter establishing a regulated DC bus. A distribution subsystem may include a main protection device, precharge path, main contactor, and output terminals.

Thermal management. A thermal management subsystem may include coolant reservoirs, pumps, heat exchangers, and sensors to regulate temperatures of turbine casing regions, generator housing, and power electronics. Cooling can be implemented using liquid coolant, air cooling, or other high-efficiency heat transfer fluids.

Control and safety. A controller module can monitor bus voltage, bus current, temperatures, and rotational speed. The controller can command regulation, contactors, and thermal management actuators, and can execute safe shutdown procedures under fault conditions.

Alternative Embodiments

Generator variants. The rotor magnetic assembly may be implemented as a permanent magnet rotor, a wound-field rotor, or a brushless-excited rotor. Stator winding topology may be wye or delta, and rectification may be diode-based or synchronous.

Regulation variants. Bus regulation may be achieved by shunt dump regulation, DC-DC conversion, or a combination thereof. Outputs may provide regulated DC, unregulated DC, and/or three-phase AC.

Thermal variants. Thermal management may be liquid-cooled, air-cooled, or hybrid. Cooling circuits may prioritize generator/power electronics cooling and may optionally include insulated lines and cold plates.

Structural variants. The generator may be positioned downstream of the turbine, partially within a turbine housing extension, or within a dedicated generator housing coupled to the shaft by a short coupling.

Manufacturing and Assembly Methods (Examples)

Compressor components may be manufactured via precision CNC machining and/or casting of rotor discs and blades, followed by dynamic balancing.

Turbine components may be manufactured via high-temperature alloy casting or additive manufacturing, followed by finish machining and protective coatings.

Generator components may be manufactured via laminated stator stacking, coil winding, vacuum impregnation, rotor magnet insertion, and housing machining.

Assembly may include bearing installation, shaft alignment, torque-controlled fasteners, seal installation, and electrical insulation testing. The assembled rotor may be balanced as a unit prior to final enclosure and wiring harness integration.

Industrial Applicability

Embodiments of the invention may be used for portable or distributed power generation, hybrid propulsion and auxiliary power, industrial backup power, remote installations, and other applications requiring compact combined mechanical and electrical energy production.

Reference Numerals (Example Set)

100	Hybrid turbine–magnetic engine system (overall)
110	Electrical generation subsystem (overall)
112	Three-phase stator assembly
114	Stator windings
116	Phase output terminals
118	Rotor magnetic assembly (PM rotor or wound-field rotor)
120	Phase protection devices (fuses/breakers)
122	Surge suppression devices (MOV/TVS)
124	EMI suppression capacitors
126	Phase inductors (optional EMI chokes)
130	Three-phase bridge rectifier
132	Rectified positive node (DC_RAW+)
134	Rectified negative node (DC_RAW–)
136	DC link capacitor bank
138	Snubber network (optional)
140	Shunt regulation subsystem
142	Shunt switch bank
144	Dump-load resistor bank
150	Power conversion subsystem (DC-DC converter)
160	Regulated DC bus
162	DC bus positive node (DC_BUS+)
164	DC bus negative node (DC_BUS–)
170	Distribution subsystem
172	Main circuit protection (CB/fuse)
174	Main contactor (K1)
176	Precharge relay (K_PRE)
178	Precharge resistor (R_PRE)
180	Output terminals (DC_OUT+, DC_OUT–)
190	Control subsystem (ECU/controller)
192	Controller module (ECU)
194	Voltage sensing network
196	Current sensing element
200	Temperature sensors
202	Fault detection network
204	Emergency stop input (E-STOP)

210	Contactor control output
214	Regulation control output
216	Thermal actuator control output
220	Energy storage subsystem (optional)
222	Battery pack or supercapacitor bank
228	Battery management system (BMS)
230	OR-ing / ideal diode controller

Claims (Expanded Example Set)

1. A hybrid turbine–magnetic engine comprising: an intake assembly; a compressor assembly configured to compress air; a combustion chamber configured to generate a high-energy gas flow; a turbine assembly configured to convert the gas flow into rotational energy; a generator subsystem mechanically coupled to the turbine assembly; a power conditioning subsystem configured to condition electrical output of the generator subsystem; and a thermal management subsystem configured to regulate operating temperature.

2. The engine of claim 1, wherein the generator subsystem comprises a stator winding assembly and a rotor magnetic assembly configured to produce multi-phase alternating current.

3. The engine of claim 2, wherein the rotor magnetic assembly comprises permanent magnets.

4. The engine of claim 2, wherein the rotor magnetic assembly comprises a wound-field rotor configured to receive excitation current.

5. The engine of claim 1, wherein the generator subsystem is coupled to a common shaft shared with the turbine assembly.

6. The engine of claim 1, wherein the compressor assembly is coupled to the common shaft and configured to be driven by the turbine assembly.

7. The engine of claim 1, wherein the power conditioning subsystem comprises a multi-phase rectifier configured to convert alternating current to direct current.

8. The engine of claim 7, wherein the power conditioning subsystem further comprises a DC link capacitor bank coupled across rectified DC nodes.

9. The engine of claim 1, wherein the power conditioning subsystem comprises a regulation subsystem configured to establish a regulated DC bus.

10. The engine of claim 9, wherein the regulation subsystem comprises a DC-DC converter configured to regulate bus voltage over a range of turbine rotational speeds.

11. The engine of claim 9, wherein the regulation subsystem comprises a shunt regulation circuit configured to dissipate excess power into a dump load.

12. The engine of claim 1, further comprising a distribution subsystem configured to selectively couple the regulated DC bus to an external load.

13. The engine of claim 12, wherein the distribution subsystem comprises a main contactor and a precharge path including a precharge resistor and a precharge relay.

14. The engine of claim 12, wherein the distribution subsystem comprises a main circuit protection device including at least one of a fuse and a circuit breaker.

15. The engine of claim 1, wherein the thermal management subsystem comprises a coolant reservoir, a pump, and a heat exchanger.

16. The engine of claim 15, wherein the thermal management subsystem comprises coolant lines thermally coupled to at least one of a generator housing and a power electronics housing.

17. The engine of claim 1, further comprising a control subsystem configured to monitor operating conditions and control at least one of regulation, distribution, and thermal management.

18. The engine of claim 17, wherein the control subsystem comprises a voltage sensing network configured to provide a bus voltage signal.

19. The engine of claim 17, wherein the control subsystem comprises a current sensing element configured to provide a bus current signal.

20. The engine of claim 17, wherein the control subsystem comprises temperature sensors configured to provide at least one temperature signal.

21. The engine of claim 17, wherein the control subsystem is configured to command a safe shutdown upon detection of at least one fault condition.

22. The engine of claim 1, further comprising phase protection devices coupled between stator phase outputs and a rectifier input.

23. The engine of claim 22, wherein the phase protection devices comprise fuses and surge suppression devices.

24. The engine of claim 1, wherein the generator subsystem produces three-phase electrical power.

25. The engine of claim 1, wherein the generator subsystem produces alternating current configured for distribution as AC without rectification.

26. The engine of claim 1, wherein the intake assembly comprises inlet guide vanes configured to set an inlet flow angle into the compressor assembly.

27. The engine of claim 1, wherein the compressor assembly comprises multiple axial compression stages including rotor blades and stator vanes.

28. The engine of claim 1, wherein the combustion chamber comprises an annular combustion liner and a plurality of fuel injectors.

29. The engine of claim 1, wherein the turbine assembly comprises turbine rotor blades and turbine stator vanes arranged to receive the high-energy gas flow.

30. The engine of claim 1, wherein the generator subsystem is located downstream of the turbine assembly along the longitudinal axis.

31. The engine of claim 1, wherein the generator subsystem is positioned within an extension of an engine housing adjacent to the turbine assembly.

32. The engine of claim 1, wherein the power conditioning subsystem includes an EMI suppression network coupled to at least one phase node.

33. The engine of claim 1, further comprising an energy storage subsystem coupled to the regulated DC bus.

34. The engine of claim 33, wherein the energy storage subsystem comprises at least one of a battery pack and a supercapacitor bank.

35. The engine of claim 33, further comprising an OR-ing controller configured to reduce or prevent backfeed into the generator subsystem.

36. The engine of claim 1, further comprising an inverter coupled to a DC output to provide an AC output.

37. The engine of claim 1, further comprising an external DC output interface including a connector and protective circuitry.

38. The engine of claim 1, wherein the thermal management subsystem includes a control-actuated pump configured to be driven according to monitored temperature.

39. The engine of claim 17, wherein the control subsystem is configured to regulate bus voltage using at least one of shunt modulation and converter modulation.

40. The engine of claim 17, further comprising an emergency stop input configured to de-energize a contactor and disable regulation circuitry.

41. A method of generating electrical power using a turbine engine, comprising: compressing air via a compressor assembly driven by a turbine shaft; combusting fuel with the compressed air to generate high-energy gas flow; rotating a turbine assembly using the gas flow to drive the turbine shaft; rotating a generator rotor using the turbine shaft to induce electrical power in a stator winding assembly; and conditioning the induced electrical power to provide a usable electrical output.

42. The method of claim 41, further comprising rectifying the electrical power and smoothing the rectified power with a DC link capacitor bank.

43. The method of claim 41, further comprising regulating a DC bus using at least one of shunt regulation and DC-DC conversion.

44. The method of claim 41, further comprising cooling at least one engine component using a pumped coolant loop and a heat exchanger.

45. The method of claim 41, further comprising sensing bus voltage, bus current, and temperature and controlling regulation in response to the sensed values.

46. The method of claim 41, further comprising precharging a downstream load capacitance prior to closing a main contactor.

47. A power generation apparatus comprising: a turbine engine configured to produce shaft power; an electromagnetic generator coupled to the shaft power and configured to produce multi-phase electrical power; a rectifier configured to provide rectified DC; a regulation subsystem configured to establish a regulated DC bus; and a thermal management subsystem configured to cool at least one of the electromagnetic generator and the regulation subsystem.

48. The apparatus of claim 47, wherein the regulation subsystem comprises a dump load configured to absorb excess power.

49. The apparatus of claim 47, wherein the thermal management subsystem comprises liquid coolant lines and a heat exchanger mounted to a housing of the generator.

50. The apparatus of claim 47, further comprising an energy storage subsystem selectively coupled to the regulated DC bus and controlled by a controller module.

Figures (Illustrative Drawings)

The following figures are illustrative and support the conceptual embodiment. Reference numerals in the text correspond to labeled elements in the drawings where available.

FIG. 1–5 (combined illustrative set)

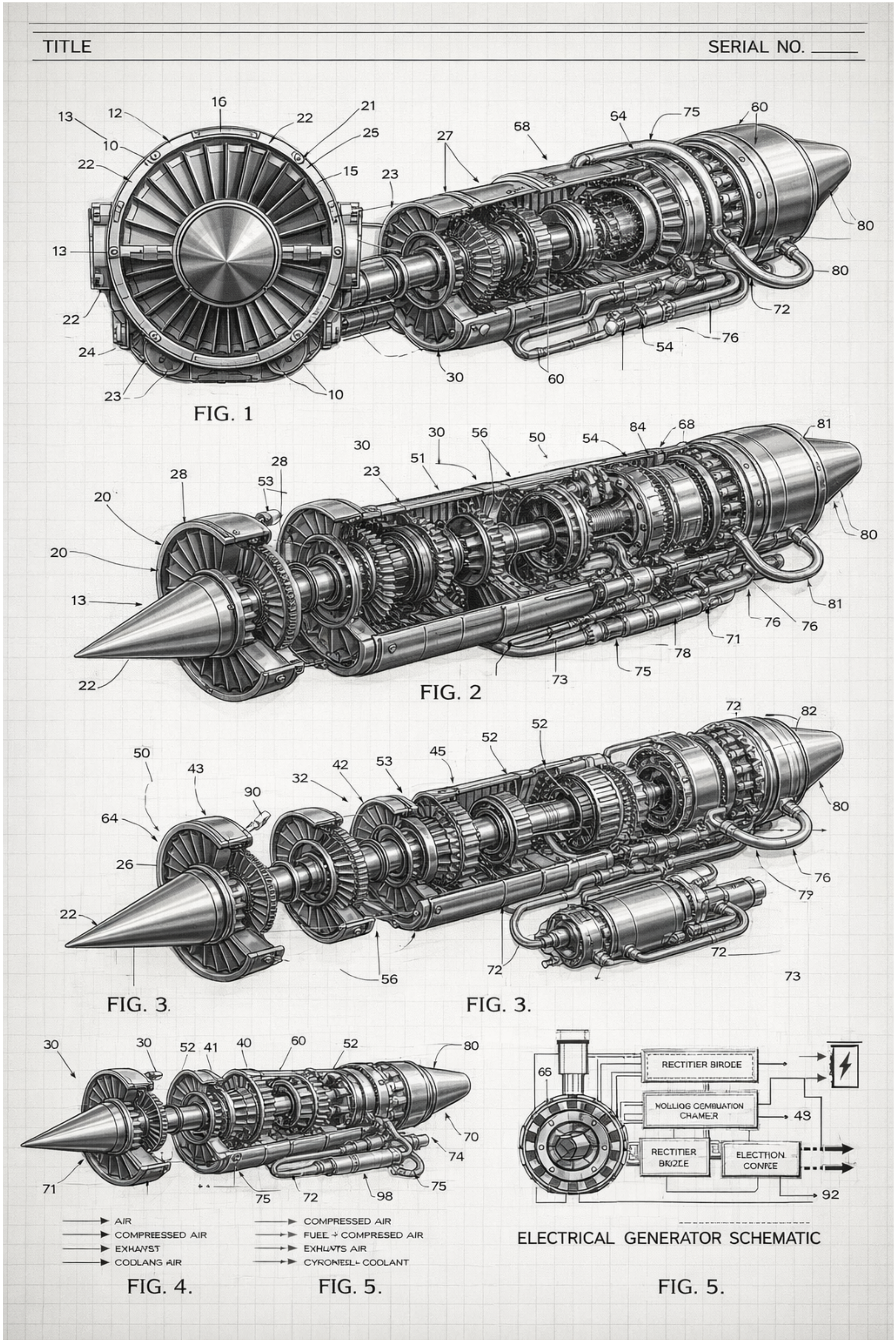

FIG. 3 (exploded assembly illustrative)

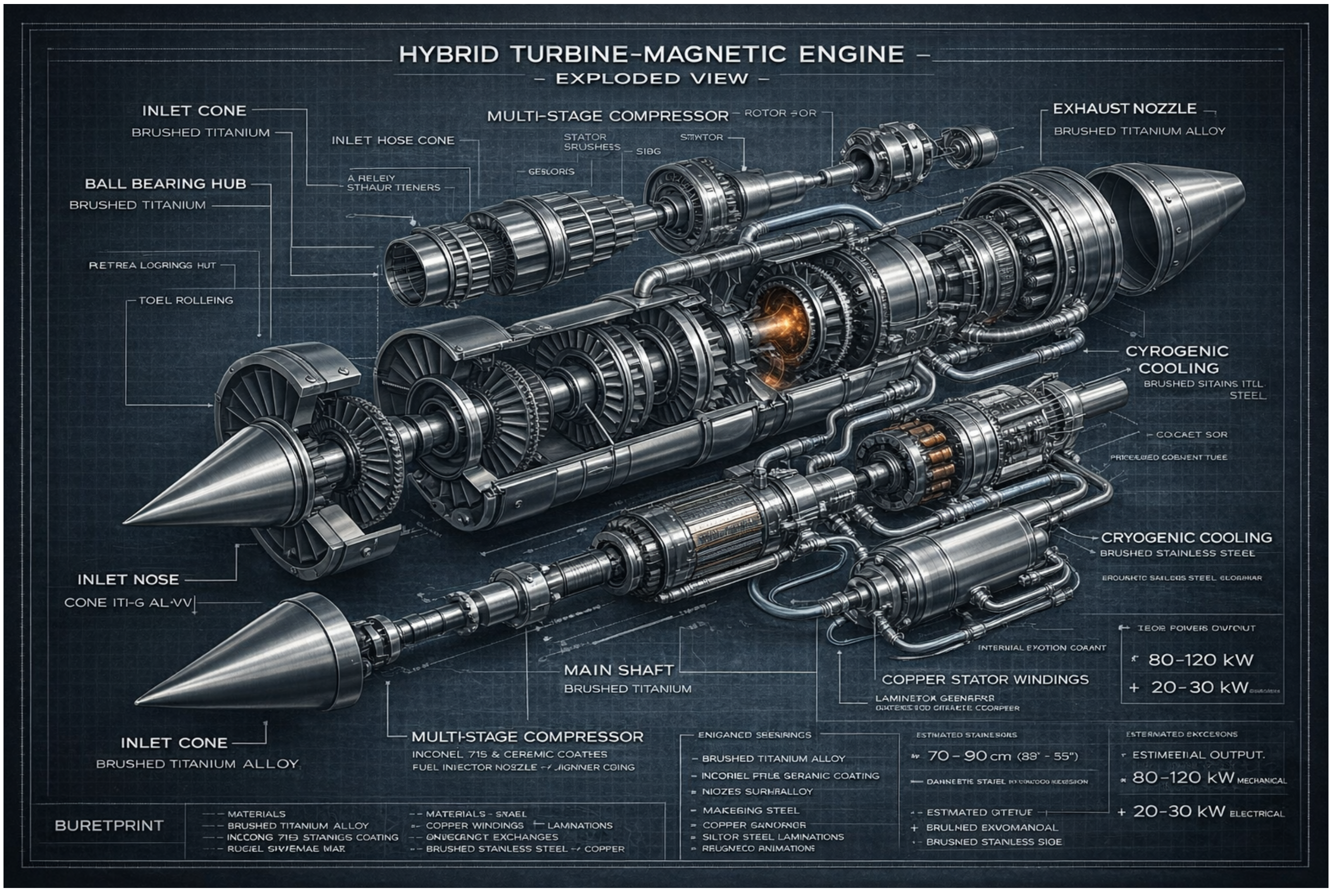

FIG. 2 (side cutaway illustrative)

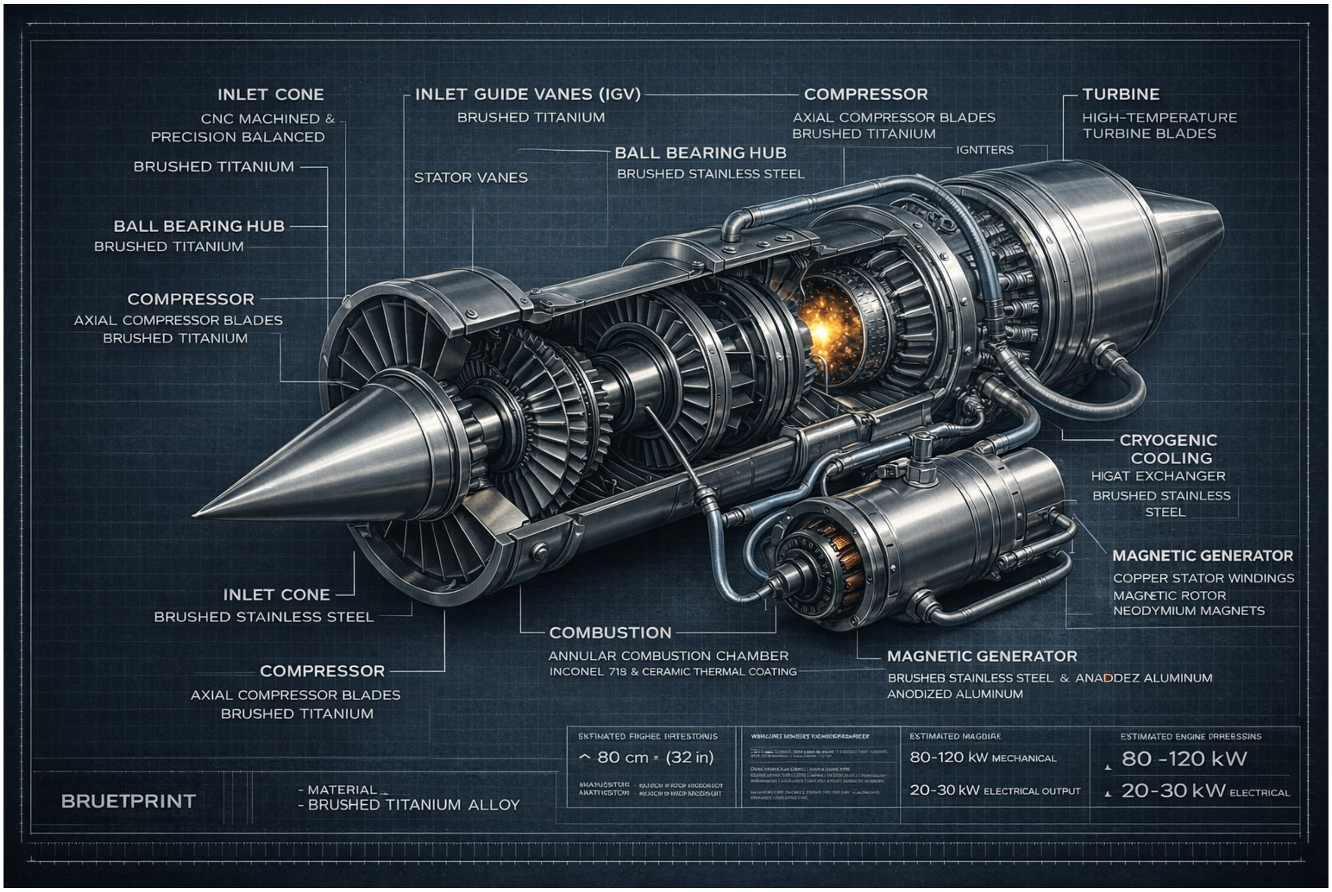

FIG. 5A (electrical generation subsystem)

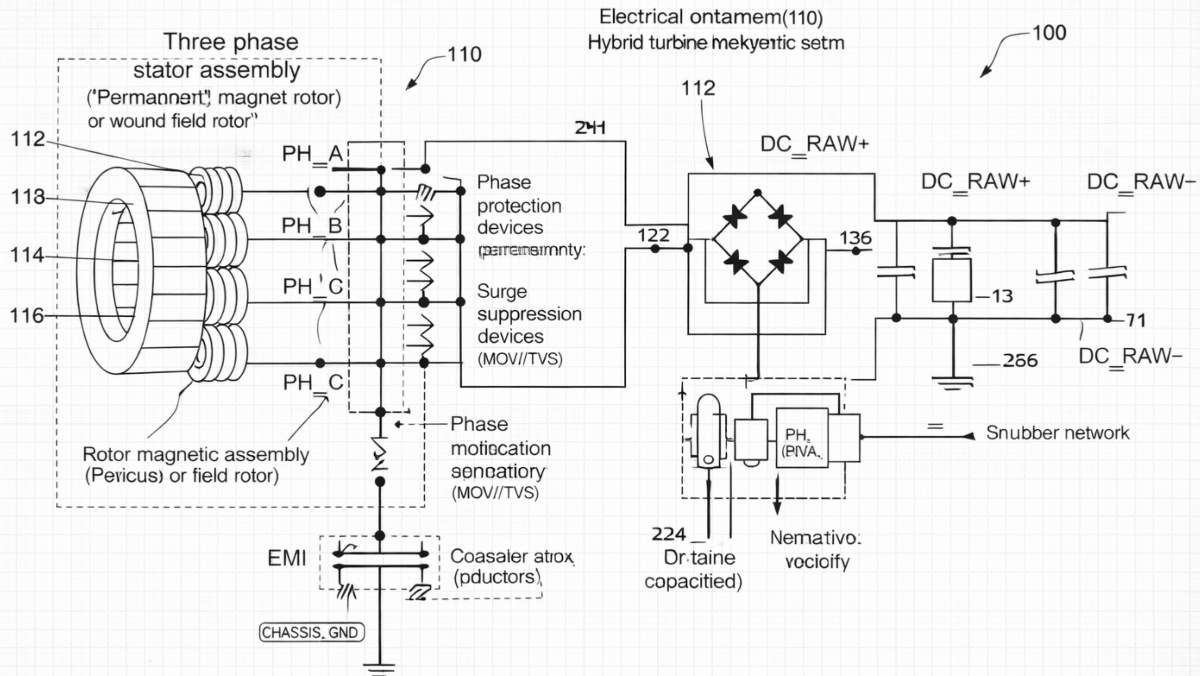

FIG. 5A Electrical generatior subsystem (110)

Abstract

A hybrid turbine–magnetic engine system is disclosed that integrates a turbine engine and an electromagnetic generator within a unified architecture capable of producing both mechanical and electrical energy. The system includes an intake assembly, compressor, combustion chamber, turbine assembly, and generator subsystem mechanically coupled through a central shaft. Electrical energy generated by the generator subsystem is conditioned through rectification and optional regulation circuitry and distributed via a DC bus. A thermal management subsystem regulates operating temperature of engine and electrical components. The integrated architecture can reduce mechanical complexity and improve packaging for compact applications.