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An Electrically Heated Air-Breathing Jet Engine for Civil Aircraft: Conceptual Architecture, Thermodynamic Framework, And Novel Electrically Civil Jet Engine Idea

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Abstract— *This research paper proposes an electrically heated air-breathing jet propulsion system comprising an intake fan, an electrically driven compressor, a resistance-heated air chamber, and an exhaust nozzle. The architecture interprets the supplied concept sketches as a system in which atmospheric air is compressed, heated using electrical energy rather than combustion, and expanded through a nozzle to generate thrust. A preliminary analytical framework is developed to relate compressor pressure ratio, heater power, mass flow rate, nozzle conditions, and net thrust. Particular attention is given to the distinction between increasing exhaust velocity and improving overall electrical-to-propulsive efficiency. The proposed research evaluates whether the addition of an electric heating stage provides a useful benefit relative to an unheated electrically driven propulsion system under equivalent operating constraints. No experimental performance is claimed. Instead, the paper identifies the measurements, operating potential, and comparison methods needed to establish feasibility. My novel concept is suitable for exploration as an electrothermal air-breathing propulsion architecture; its suitability for aircraft remains dependent on demonstrated thrust-to-power ratio, installed system mass, thermal reliability, and onboard energy requirements.*

Keywords— *Electrothermal Propulsion; Electric Aircraft; Air-Breathing Jet; Resistance Heating; Compressor–Nozzle Matching; Propulsion Feasibility*.

I. INTRODUCTION

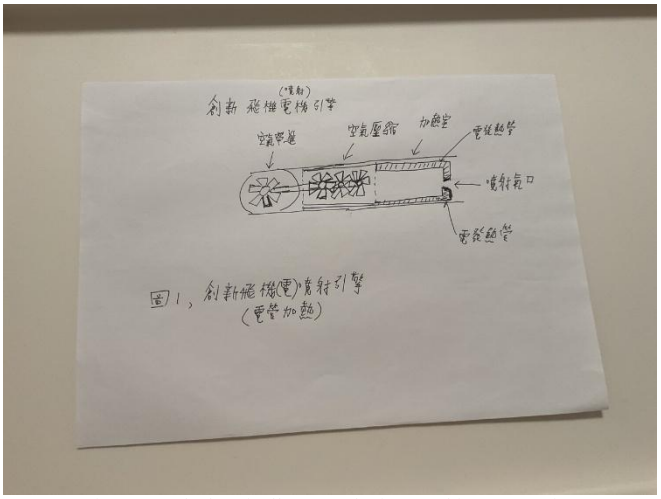
Jet propulsion produces force by changing the momentum of a flowing working fluid and, where applicable, maintaining a pressure difference between the nozzle exit and the surrounding atmosphere. For an air-breathing engine, the net force therefore depends on both the incoming airflow and the discharged exhaust, rather than on exhaust velocity alone.

My proposed design replaces the combustion-based heat-addition stage of a conventional thermally driven jet architecture with an electrically powered heating chamber. The supplied sketches depict an upstream fan, a compression section, a heated duct containing elements labelled "電發熱管," and a rear outlet labelled "噴射氣口." They also identify the intake or air-induction region, compression region, and heating chamber.

Innovative Idea Concept

The underlying research question is:

Can electrical heating of compressed atmospheric air provide sufficient additional useful thrust to justify its power consumption, thermal hardware, and installed mass when compared with an unheated electric propulsion baseline?



Pic 1: Novel Electrically Heated Air-Breathing Jet Engine

This question is more demanding than asking whether heated air can produce a jet. The conventional nozzle relations establish that exit velocity depends on nozzle inlet total temperature and pressure ratio; however, those relations alone do not establish the aircraft-level benefit of supplying additional electrical heat.

Therefore, we purposed the novel electric heated air propulsion system. The contribution of this paper is therefore a structured formulation of the proposed configuration and a possible potential method.

Proposed System Architecture

2.1 Interpretation of the supplied drawings

The drawings are interpreted as a left-to-right flow arrangement:
Atmospheric intake → fan → compressor → electrically heated chamber → exhaust nozzle.

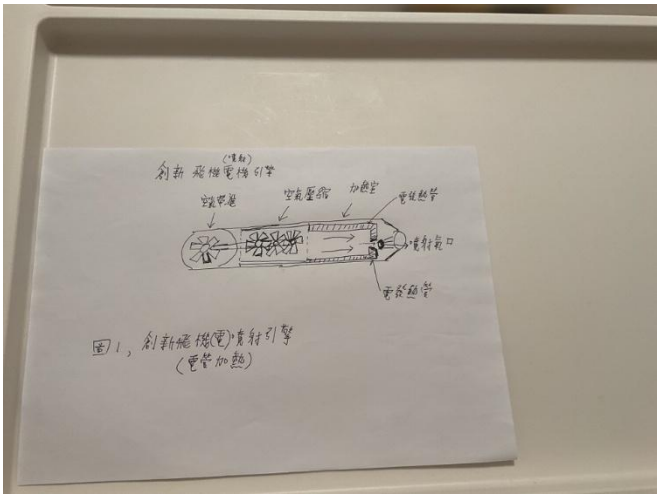
The first two photographs show a more enclosed rear outlet, while the third depicts a simpler outlet opening.

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These are treated as novel outlet representations, with an nozzle designs.

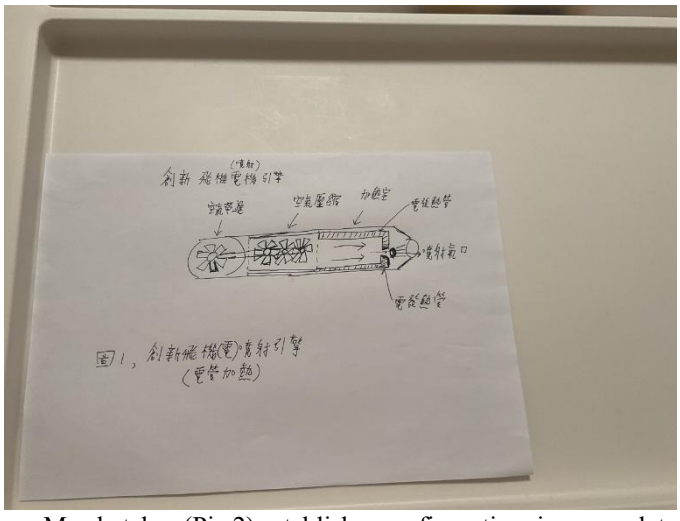
For our novel design, the manuscript (pic 2) introduces several components that are necessary to define a complete system, and we specified in the sketches: an electric motor, motor controller, heat power controller, electrical supply, thermal insulation, and instrumentation.



Pic 2: Novel Electrically Heated Air-Breathing Jet Engine

TABLE 1: Integrate function and system of a Novel Electrically Heated Air-Breathing Jet Engine

Subsystem	Proposed function	Status in the concept
Intake and fan	Admit and accelerate atmospheric air	Shown schematically
Compressor	Increase air total pressure	Shown schematically
Electric drive	Supply shaft power to rotating components	Assumed for analysis
Heating chamber	Transfer electrical energy into the airflow	Shown schematically
Exhaust nozzle	Convert available flow energy into exhaust velocity	Outlet shown; geometry unspecified
Power source and controls	Supply and regulate electrical power	Electrical power & Solar Energy



My sketches (Pic 2) establish a configuration, is a complete innovative new concept design of the engineering specification.

2.2 Operating principle

The proposed compressor supplies a pressurized airflow to the heating chamber. Electrical resistance elements transfer heat to that airflow, increasing its total enthalpy. The downstream nozzle then converts part of the available enthalpy into directed kinetic energy. In an adiabatic nozzle without shaft work, total enthalpy is approximately conserved while static enthalpy decreases as velocity rises.

Our second layer chamber refer to as an air compressor by integrate an accumulate the dozen of fan nozzle, which provide an appropriate inlet-to-ambient pressure ratio to produce the intended expansion and acceleration; increasing temperature and flow compatibility is a sufficient engine design method.

II. Innovative Electric Jet Engine Research Objectives and Hypotheses

The proposed novel research has four objectives:

1. Develop a coupled compressor–heater–nozzle model.
2. Measure the change in thrust caused by electrical heating.
3. Determine whether that change is advantageous under equal-power and equal-mass comparison conditions.
4. Identify operating limits associated with temperature, pressure loss, flow stability, and electrical demand.

The key hypothesis is that electrical heating can increase exhaust velocity and potentially thrust at selected operating points. This expectation follows from the dependence of nozzle exit velocity on total temperature, provided that a useful pressure ratio is maintained.

My, deliberately novel hypothesis is that the heated configuration offers an aircraft-level advantage. The heater increases the static thrust which provide an similar air dynamic thrust for the airplane to fly.

III. Thermodynamic And Propulsive Model

4.1 Assumptions definitions

A first-order model is proposed using steady, one-dimensional flow and a calorically perfect gas. Constant specific heat is an approximation and should be replaced with temperature-dependent properties if the selected operating range requires it.

The stations are:

- 0: ambient atmosphere and flight condition;
- 2: compressor inlet;
- 3: compressor outlet;
- 4: heater outlet and nozzle inlet;
- e: nozzle exit.
- The model includes compressor inefficiency, heater-to-air heat-transfer efficiency, heater pressure loss, and nozzle inefficiency. It excludes detailed inlet distortion, blade aerodynamics, structural deformation, and three-dimensional heat transfer at this preliminary stage.

4.2 Net thrust

- With mass addition through the heater, the general thrust equation becomes
- $F = \dot{m}(V_e - V_0) + (p_e - p_0)A_e$,

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- where $\dot{m}$ is air mass flow rate, V_e is exhaust velocity, V_0 is flight velocity, p_e and p_0 are exit and ambient static pressures, and A_e is nozzle exit area.
- When the exit pressure matches ambient pressure,
- $F = \dot{m}(V_e - V_0)$.

4.3 Compressor electrical demand

- For the proposed ideal-gas compressor model, define
- $\pi_c = \frac{p_{t3}}{p_{t2}}$.
- Using an isentropic reference process and compressor efficiency η_c,
- $T_{t3} = T_{t2}[1 + \frac{\pi_c^{(\gamma-1)/\gamma}-1}{\eta_c}]$.
- The associated compressor electrical demand is represented by
- $P_{\text{comp,el}} = \frac{\dot{m}c_p(T_{t3}-T_{t2})}{\eta_d}$,
- where η_d represents combined motor and drive efficiency.
- These expressions define the preliminary model of my novel compressor performance map to determine feasible combinations of mass flow, pressure ratio, rotational speed, and efficiency.

4.4 Electrical heat addition

- Define η_h as the fraction of heater electrical power transferred to the flowing air. The steady heater energy balance is
- $\eta_h P_{\text{heater,el}} = \dot{m}c_p(T_{t4} - T_{t3})$.
- Thus,
- $T_{t4} = T_{t3} + \frac{\eta_h P_{\text{heater,el}}}{\dot{m}c_p}$.
- This relation makes explicit the power required to achieve a selected temperature rise. It implies that all supplied heat will be utilized and becomes jet kinetic energy.
- The preliminary pressure-loss model is
- $p_{t4} = (1 - \delta_h)p_{t3}$,
- where δ_h is the fractional total-pressure loss through the heater assembly. The value must be measured or obtained from a validated flow model.

4.5 Nozzle expansion

- For an unchoked nozzle expanded to ambient pressure, a preliminary exit-velocity estimate is
- $V_e = \sqrt{2\eta_n c_p T_{t4}[1 - (\frac{p_0}{p_{t4}})^{(\gamma-1)/\gamma}]}$,
- where η_n is nozzle efficiency. Our new nozzle electricity jet place performance relation and demonstrates the joint influence of total temperature and nozzle pressure ratio.

My research solves the conventional nozzle geometry and choking as determinants of both mass flow and thrust; consequently, the compressor, heater, and nozzle must be solved as a coupled system.

4.6 System performance metrics

Total electrical demand is defined as

$$P_{\text{total}} = P_{\text{comp,el}} + P_{\text{heater,el}} + P_{\text{aux}}.$$

For static analysis, a primary comparison metric is

$$\Phi_F = \frac{F}{P_{\text{total}}},$$

in N/kW.

For flight, useful propulsive power is

$$P_u = FV_0,$$

and electrical-to-useful-propulsive efficiency is defined as

$$\eta_{\text{el}\to\text{prop}} = \frac{FV_0}{P_{\text{total}}}.$$

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$$\eta_{\text{el}\to\text{prop}} = \frac{FV_0}{P_{\text{total}}}.$$

These definitions distinguish static thrust production from useful electricity power delivered to an aircraft in motion.

Our innovative approach is to compress the air in the second layer of the chamber, and use electricity heat the Tube in the third chamber, to provide thrust. So, the integrated power to heating is preferable to allocating it to the baseline electric propulsor.

IV. Aircraft Dynamic Integration

An aircraft valuation must include the complete installed system, not merely the compressor and hot duct. For the proposed analysis, installed mass should include the electrical energy source, motor, power electronics, heater, insulation, structure, controls, and necessary thermal-management equipment.

Our novel preliminary mission energy efficiency would be as:

$$E_{\text{mission}} = \int_0^{t_{\text{mission}}} E\, P_{\text{total}}(t)\, dt.$$

Our research study will improve aircraft performance using consistent assumptions for available energy, reserves, component mass, and flight conditions.

Our novel proposed heater removes the need for a combustion process within that component, but this manuscript does provide available potential establish lifecycle emissions, environmental superiority, and commercial practicality. Those claims require evidence beyond the supplied sketches.

V. Conclusion

This research paper formulates the supplied electric air-jet concept as an electrically driven compressor coupled to a resistance-heated chamber and exhaust nozzle. The drawings provide a recognizable preliminary arrangement for investigating electrothermal air-breathing propulsion, while established thrust and nozzle relations provide a basis for analytical modelling. My research provides an novel of the solution, to the electrical heat addition provides sufficient useful propulsion benefit after accounting for compressor demand, heater power, pressure loss, nozzle matching, and installed mass. My novel research present contribution is a testable new conceptual architecture and research framework. Experimental demonstrations are required before stronger claims concerning performance, aircraft suitability, can be supported. Hope my research can contribute to the world and the mankind.

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