Austrian Journal of Technical
and Natural Sciences, 2026 No 5–6
ISSN 2310-5607

PREMIER Publishing
ppublishing.org

DOI:10.29013/AJT-26-5.6-186-193

NEW DIRECTIONS IN MANUFACTURING TECHNOLOGIES FOR STRUCTURAL COMPONENTS

Dmytro Lysenko [1]

[1] Automotive Transport Specialist Florida, USA

Cite: *Lysenko D. (2026). New Directions in Manufacturing Technologies for Structural Components. Austrian Journal of Technical and Natural Sciences 2026, No 5–6.* https://doi.org/10.29013/AJT-26-5.6-186-193

Abstract

This article examines the influence of manufacturing technologies for structural components on the successful development, commercialization, and industrial implementation of innovative products. Particular attention is devoted to the relationship between engineering design solutions and manufacturing methods, demonstrating that technological feasibility represents one of the fundamental conditions for the practical realization of innovative concepts.

The publication analyzes the necessity of integrating manufacturing technologies into the engineering design process from the earliest stages of product development. As an illustrative example, the study considers fuel injectors for internal combustion engines, where the achievement of critical performance characteristics – including micron-scale outlet orifices and reliable sealing under ultra-high fuel pressures – requires the application of advanced manufacturing technologies such as laser machining. The article emphasizes that the novelty of an invention should be considered not only from the perspective of product design but also in relation to the manufacturing technologies required for its production.

Special emphasis is placed on the influence of evolving consumer requirements, regional market conditions, and industry-specific standards on the commercial success of innovative products. The study examines the concept of emerging consumer standards as an important factor affecting engineering decisions, product functionality, operational characteristics, and commercialization strategies.

The publication concludes that the successful commercialization of innovative engineering products requires the comprehensive integration of advanced manufacturing technologies, engineering design, and market-oriented product development. Even when technological risks have been minimized through successful testing and validation, failure to satisfy contemporary consumer standards may significantly reduce the commercial viability of an otherwise technically successful innovation.

Keywords: *Digital technologies; Elements of artificial intelligence; Elements of artificial neural networks; Innovative products; Innovation analysis; Creative activity; Technical and technological stereotypes; Specific local domain; Overcoming technical, technological, and design stereotypes; The most effective and non-obvious technical solutions; Combined*

highly effective and non-obvious technical solutions; Foresight techniques; The potential for developing technical solutions with auxiliary innovative functionalities

Introduction

In integrated engineering solutions, the methods and technologies used for manufacturing product components and structural elements constitute one of the most important factors determining the practical feasibility of implementing an innovative product.

As an illustrative example, let us consider a fuel injector for an internal combustion engine. Fuel injectors represent one of the highest-volume engineering products manufactured worldwide, with annual global production exceeding one billion units.

The commercial and functional value of such a product is determined by several key engineering parameters, primarily the diameter of the outlet orifices and the ability to maintain complete sealing under extremely high fuel pressures, which may reach up to 2,000 bar.

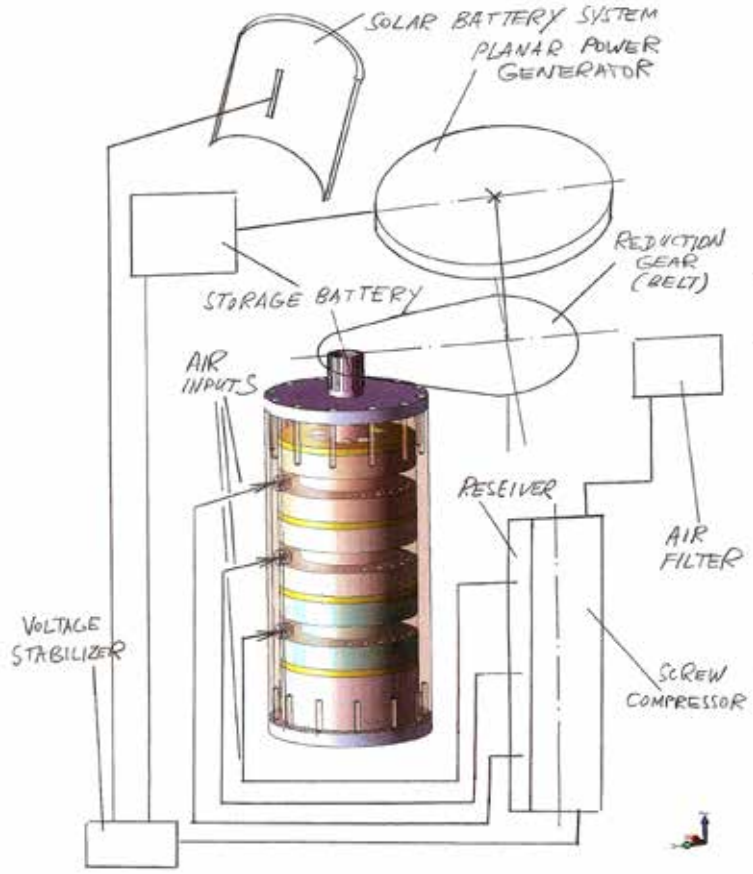
The use of conventional drilling technologies imposes practical limitations on the minimum achievable diameter of these outlet openings. Since high-pressure fuel injection systems require orifices with diameters measured in micrometers, their manufacture requires advanced processing technologies, such as laser drilling.

Consequently, the inventor of a new fuel injector should incorporate into the inventive concept not only the structural novelty of the product itself but also the manufacturing-related innovations required to satisfy the specific technological requirements of laser machining equipment.

Emerging Consumer Standards

Continuously evolving market conditions and changing customer expectations, together with regional consumption patterns and national and cultural traditions, give rise to local consumer requirements that gradually develop into informal yet widely recognized consumer standards.

Figure 5. *The figure presents the schematic diagram of the shoulder-mounted atmospheric water generator, illustrating the system configuration, electrical connections, and operating principle of the device for condensing potable water from ambient air*



The designations of the individual components are provided in the figure.

If the objective of an inventor is to achieve commercial success for an innovative product, one of the fundamental elements of the commercialization strategy must be a thorough understanding of the prevailing consumer standards, including the required technical, operational, and functional characteristics expected of the product by its target market.

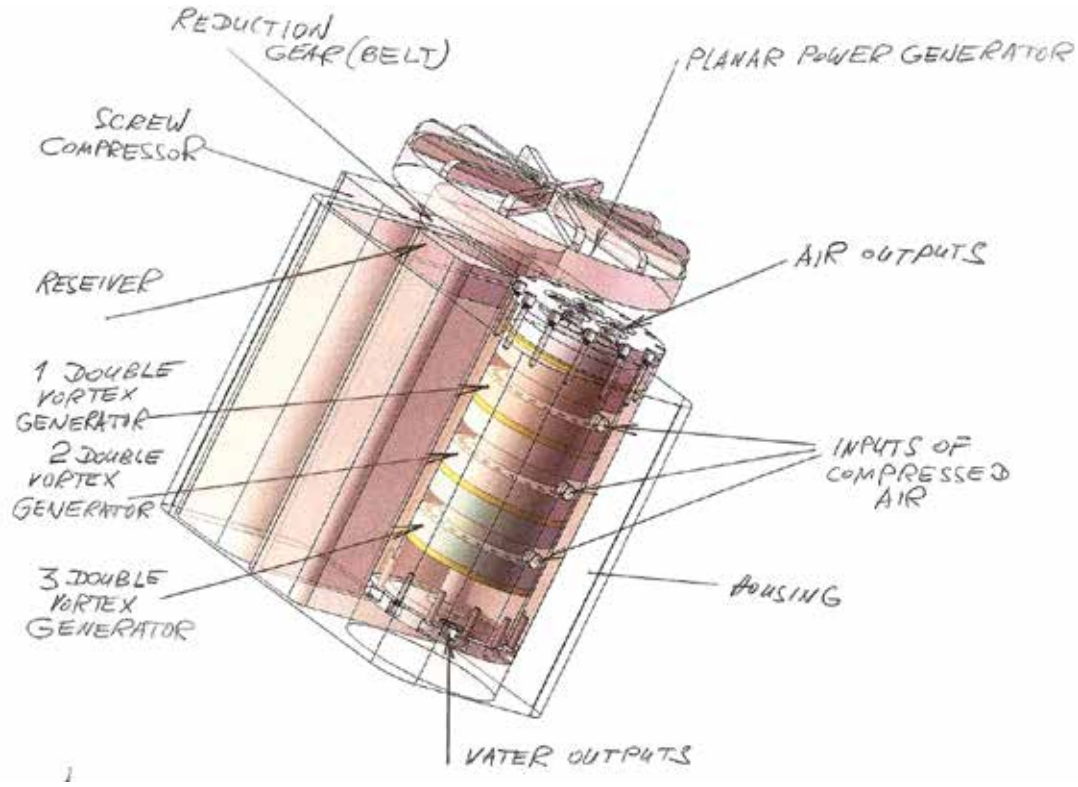
Even when technological risks have been successfully eliminated through comprehensive testing and validation of a new product, the risk of commercial failure may still remain. Such a risk exists whenever inventors and their commercialization partners fail to recognize or adequately understand the consumer standards governing the market for the proposed product.

As shown in the schematic, the device is powered by a miniature photovoltaic solar panel equipped with a voltage stabilizer connected to an energy storage battery.

The energy storage battery is, in turn, connected to a planar electric generator that supplies electrical power to all functional subsystems of the device, primarily to the dual vortex generators responsible for producing the vortex tubes in which the accelerated condensation process takes place. Air compression is performed by means of an innovative screw compressor.

Accordingly, the entire supersystem of the shoulder-mounted atmospheric water generator represents an integrated sequential assembly comprising several innovative subsystems. Both collectively and individually, these subsystems satisfy the criteria of non-obviousness required for innovative engineering solutions.

Figure 6. *The figure presents a three-dimensional conceptual model illustrating the configuration, interconnection, and operating principle of the shoulder-mounted atmospheric water generator designed for the condensation of potable water from ambient air. The principal assemblies and functional components of the system are identified and labeled in the figure*



The aerodynamic mechanism responsible for generating the primary vortex tube, which accumulates multiple localized vortex tubes, consists of three dual localized vortex generators operating as an integrated aerodynamic system.

Figure 7. *The figure presents a three-dimensional model of the vortex generator, which serves as the principal operating mechanism of the compact shoulder-mounted atmospheric water generator designed for the condensation of potable water from ambient air*

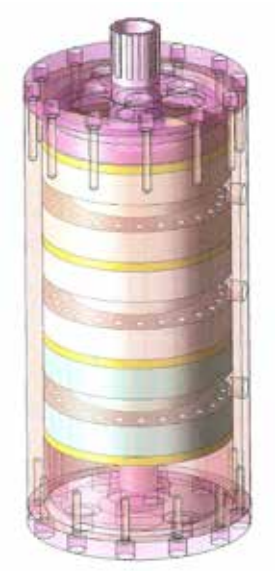
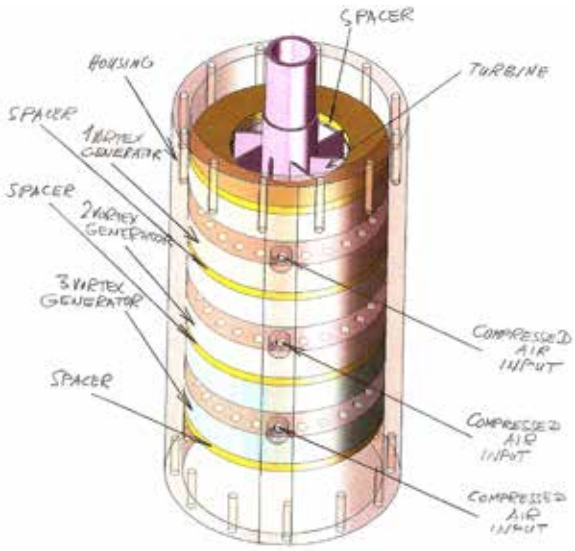


Figure 8. *The figure presents a three-dimensional model of the central accumulating vortex generator, with the principal structural assemblies and functional components identified and designated in the illustration*



It is appropriate at this stage to relate the structural characteristics and engineering features of the generator to the contemporary development of innovative technologies as integral components of intelligent technological systems.

The rapid evolution of software products, together with the increasing complexity of modern engineering systems – particularly electronic and microelectronic devices – has fundamentally transformed the principles governing their protection as non-obvious, multifunctional, and technologically integrated intellectual property.

Furthermore, the recent emergence of technical classifications such as **smart technologies**, **smart devices**, and **smart materials** has created the need for additional technical arguments capable of substantiating the inventive character of such engineering solutions.

For inventions of this type, structural features, circuit configurations, and combinations of engineering solutions alone are no longer sufficient to characterize the invention in its entirety. In many cases, these structural solutions can only be transformed into a functional system or prototype under specific manufacturing conditions and through specialized production and quality-control technologies. Consequently, the manufacturing process itself, combined with the demonstrated non-obviousness of the engineering design, frequently becomes one of the principal characteristics defining the inventive concept.

The continuing development of processor-based control systems likewise determines the practical viability of engineering solutions. As a result, control algorithms, software, data processing methods, and feedback mechanisms linking the structural or functional elements of a system have become an integral component of the technical solution underlying a modern invention.

This consideration should be supplemented by the results of systematic, step-by-step analysis of the innovative system together with the application of non-obvious methods involving artificial intelligence and artificial neural networks.

Accordingly, a modern invention frequently represents the integration of several distinct technologies within a single engineering concept. Such integration, together with the functional relationships established between the individual technological components, should be reflected in the patent claims in a manner that clearly demonstrates the unity of the inventive concept

and prevents the patent examiner from separating the invention into a number of independent technical solutions belonging to a single technological field.

The possibilities of integrative patent protection in the field of information technologies extend across virtually every sector of modern society.

Whereas technological sectors could previously be defined with relatively clear boundaries, the widespread penetration of advanced digital technologies and information technologies into all areas of engineering has fundamentally transformed both classification systems and intellectual property protection mechanisms, creating a new system of technical, commercial, and legal interrelationships that requires detailed substantiation of inventive step and non-obviousness.

Today, even relatively simple engineering systems and manufacturing processes increasingly incorporate technologies that did not previously exist. The emergence of new technological platforms, including quantum computing and related computational architectures, has resulted in engineering systems characterized by both horizontal and vertical technological integration. These systems combine technical methods, processes, and engineering principles that were previously unrelated and therefore constitute non-obvious technological combinations. Furthermore, the integration of conventional engineering solutions with the capabilities provided by modern information technologies has fundamentally transformed the concept of an invention itself, requiring that it be considered as a complex system of interrelated engineering solutions.

This technological evolution, occurring at the intersection of classical engineering disciplines and advanced digital technologies, has substantially changed the methodology for defining and protecting those structural elements and their combinations that may now be recognized as integrated engineering solutions satisfying the fundamental requirements of patentability and based upon composite engineering and manufacturing principles.

New Environmental Standards

Environmental regulations continue to become increasingly stringent worldwide. Consequently, during the development of any innovative product whose operation may affect parameters regulated by environmental legislation, it is essential to ensure full compliance with all applicable environmental standards and regulatory requirements throughout the product's operational life.

Environmental standards are continuously revised and progressively strengthened. As a result, regulatory requirements that are currently acceptable are likely to become significantly more demanding within the next several years.

This consideration is particularly important in the development of energy systems, atmospheric water condensation technologies, internal combustion engines, and other engineering systems whose operational characteristics are directly influenced by environmental performance requirements.

Figure 9. *The figure presents a three-dimensional model illustrating the airflow and water flow paths within the central accumulating vortex generator, which serves as the principal operating mechanism of the compact shoulder-mounted atmospheric water generator designed for the condensation of potable water from ambient air*

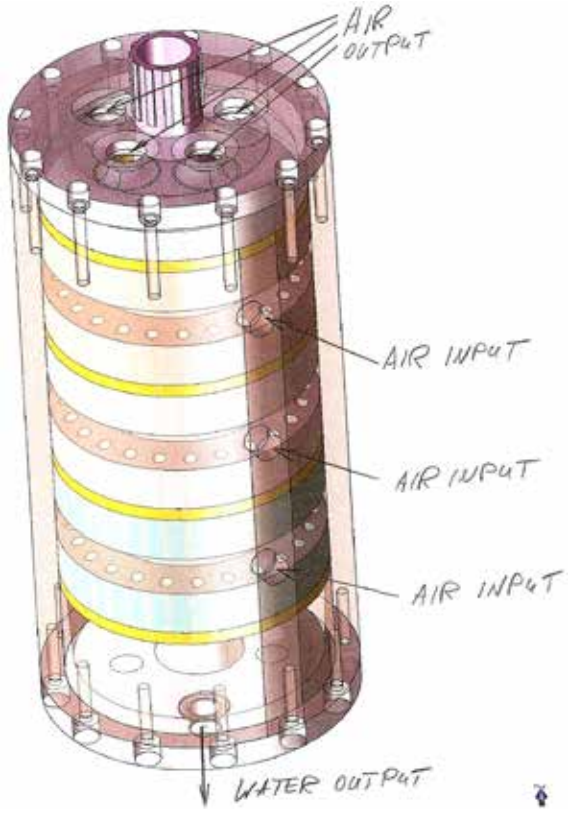
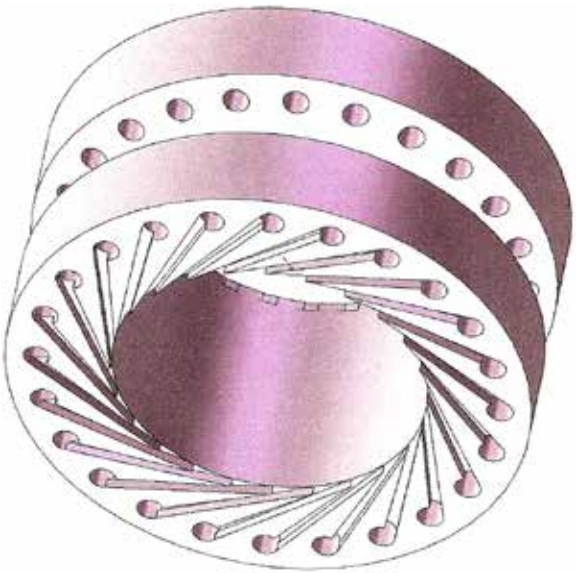


Figure 10. *The figure presents a three-dimensional model of the external configuration of the device designed for the condensation of potable water from atmospheric air*

Figure 11. *The figure presents a three-dimensional model of a local vortex-generator subsystem configured as a dual vortex generator. Air is introduced through the central annular channel, which is connected by axial passages to the individual vortex-generating elements*



The aerodynamic mechanism responsible for generating the primary vortex tube, which accumulates the localized vortex tubes, consists of three dual localized vortex generators, each operating autonomously while contributing to the formation and stabilization of the central accumulating vortex flow.

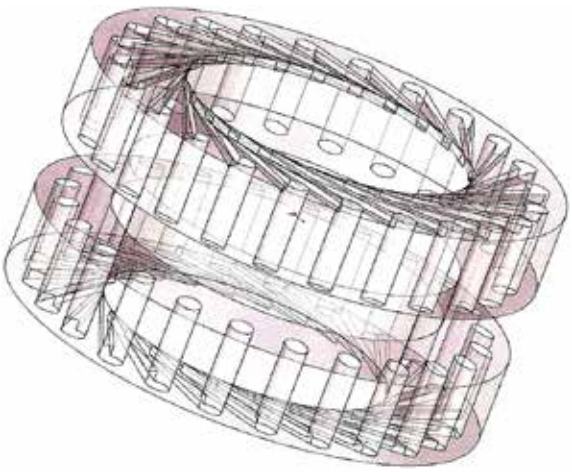
Availability of Fundamentally New and Non-Obvious Materials

As illustrative examples, two new engineering and technological directions may be considered: the development of highly efficient vortex tube generators and the design of composite vortex generators based on advanced mixing systems incorporating aerodynamic and hydrodynamic activation.

Both technological directions require the development and application of advanced structural materials whose physical and mechanical properties make it possible to achieve performance characteristics that cannot be attained using conventional engineering materials.

However, the application of such innovative materials is not unconditional. Their successful implementation requires an initial integrated engineering solution that combines both structural design and manufacturing technology, thereby creating the necessary conditions for the effective utilization of these materials within the proposed technical system.

Figure 12. *The figure presents a transparent three-dimensional model of a local vortex-generator subsystem configured as a dual vortex generator. Air is introduced through the central annular channel, which is connected by axial passages to the individual vortex-generating elements*



Considering the relatively complex structural configuration of the dual vortex generator, it is appropriate to revisit the environmental aspects that must be taken into account during the development of technically sophisticated innovative systems.

There are numerous examples in engineering practice where an innovative internal combustion engine incorporating a novel cylinder arrangement and an exceptionally efficient fuel-saving system nevertheless failed to satisfy future environmental requirements because the concentrations of nitrogen oxides (NO*x*) and particulate emissions exceeded the limits established by an environmental standard scheduled to enter into force only two years later.

This circumstance alone was sufficient to require a complete redesign of the engine. As a result, the original engineering solution evolved into an integrated composite technological system through the incorporation of an innovative fuel preparation and activation subsystem that was functionally integrated with the original design. The implementation of this integrated technological solution made it possible to achieve a substantial reduction in the concentration of harmful emissions in the engine exhaust while preserving the principal performance advantages of the original design.

Figure 13. *The figure shows a three-dimensional model of the local subsystem of the vortex generator in cross-section*

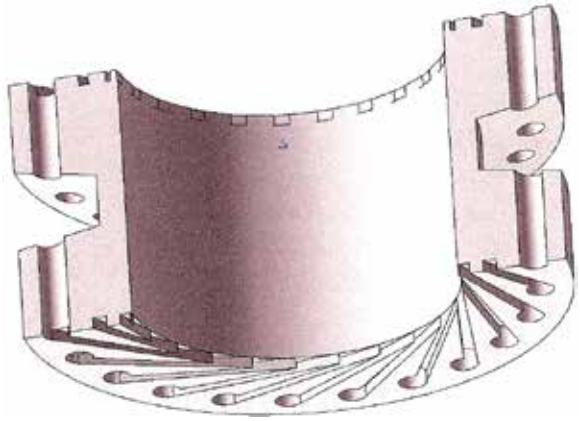
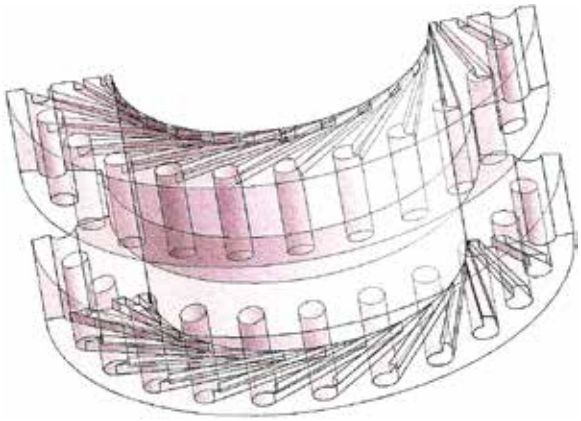


Figure 14. *The figure shows a transparent three-dimensional model of the local subsystem of the vortex generator in cross-section*



References and Patent Information

Ackerman. *Water Harvester and Purification System*. U. S. Patent No. 10,071,918, issued September 11, 2018.

Catherwood, Sr. *Dehydrating Air-Filtering Apparatus*. U. S. Patent No. 4,594,082, issued June 10, 1986.

Rolandson. *Exhaust Gas Recirculation Compressor Inlet Thermal Separation System*. U. S. Patent No. 10,767,659, issued September 8, 2020.

Hedlund. *Self-Contained Photovoltaic Distillation Apparatus*. U. S. Patent No. 10,759,677, issued September 1, 2020.

Kow. *Humid Air Stream Generator*. U. S. Patent No. 10,731,880, issued August 4, 2020.

Stuckenberg. *Atmospheric Water Generation Systems and Methods*. U. S. Patent No. 10,583,389, issued March 10, 2020.

Panda et al. *Economically Viable Atmospheric Water Generator*. U. S. Patent No. 10,718,101, issued July 21, 2020.

Bravo et al. *Modular Apparatus for Water Production*. U. S. Patent No. 10,422,112, issued September 24, 2019.

Bravo et al. *Water Production Apparatus for Rigorous Climates*. U. S. Patent No. 10,385,549, issued August 20, 2019.

Hering et al. *Advanced Laminar Flow Water Condensation Technology for Ultrafine Particles*. U. S. Patent No. 9,821,263, issued November 21, 2017.
Shinoda et al. *Indoor Unit of Air-Conditioning Apparatus*. U. S. Patent No. 9,976,769, issued May 22, 2018.
Vaughen. *Fresh Water Generation System Using Coastal Atmosphere and Ocean Water*. U. S. Patent No. 10,161,114, issued December 25, 2018.
Chen. *Water Generation System for Deserts*. U. S. Patent No. 10,337,175, issued July 2, 2019.
Heller. *Humidity Collector Apparatus*. U. S. Patent No. 9,758,948, issued September 12, 2017.
Elliott. *Method and Apparatus for Drying Compressed Air*. U. S. Patent No. 9,216,379, issued December 22, 2015.
Mayr et al. *Condensation Device*. U. S. Patent No. 8,967,096, issued March 3, 2015.
Claridge et al. *System and Method for Efficient Air Dehumidification and Liquid Recovery*. U. S. Patent No. 8,685,144, issued April 1, 2014.

submitted 15.06.2026;
accepted for publication 29.06.2026;
published 30.06.2026

Contact: lysenko.dmytrous@gmail.com