# DESIGN AND TECHNOLOGIES WITH ELEMENTS OF ARTIFICIAL INTELLIGENCE

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## Abstract

This article analyzes modern approaches to the development of innovative technical solutions that integrate principles of engineering design, digital technologies, TRIZ methodology, and elements of artificial intelligence. Examples of solutions with a high degree of non-obviousness, protected by patents and implemented in software, are considered.

## Keywords

Design, artificial intelligence, neural networks, TRIZ, innovation, patenting, digital technologies, engineering

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## Introduction

The emergence of information technologies and the sharp reduction in the time cycle intended for the development and transformation of an inventive idea into a truly necessary, market-demanded, and implementable product—along with the increasing complexity of the technical and technological components of new products, which proportionally raises the cost of manufacturing and testing prototypes—forces us to reconsider the possibility of creating technical solutions with auxiliary innovative functions that are absolutely non-obvious.

Now, if a designer-inventor wants their innovative ideas to be used, they must be more versatile and possess not only foresight techniques, intuition, and a well-developed imagination to some extent, but also be practically a multidisciplinary specialist. At the very least, they must sense—and preferably understand well—the commercial and consumer demands of the market, regardless of stereotypes and the psychological barriers associated with them, which often stem from the apparent obviousness of the paths for implementing synthesized ideas.

There are several fundamental directions that, under today's conditions, have a decisive influence on the fate of new ideas. Taking these into account may ensure a real and high level of commercial success, while neglecting them may permanently close the door to the implementation of the idea in any commercial form.

Modern design and multidisciplinary digital technologies with elements of artificial intelligence and artificial neural networks, the psychological nuances of forming an innovative comprehensive solution and design, and the future aspects of marketing products and items created and developed based on these technologies in interaction with TRIZ and ARIZ—all these play a significant role.

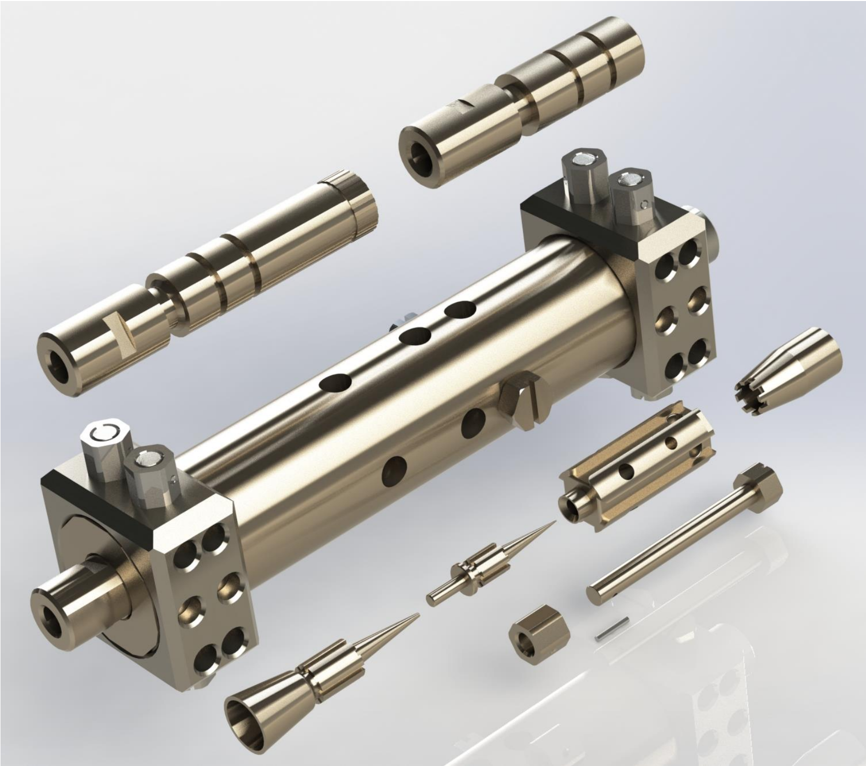

**Figure 1.** *An example of modern innovative design with full simulation of the used structural materials and their properties and performance characteristics, including the type of mechanical processing and type of surface finish.*

All inventors know that sometimes technical solutions are created that work effectively under real conditions and solve numerous tasks, which initially prompted the inventor to perform innovative analysis and triggered their targeted creative activity. On the other hand, there are contrived, obvious technical solutions that are created detached from reality and solve absolutely nothing, except for fulfilling ambitious claims to some kind of (often useless) idea in the field of technology and engineering.

Moreover, technical solutions arising in a specific localized field inevitably directly or indirectly affect established technical stereotypes and the resulting psychological barriers, which hinder overcoming technical and technological contradictions based on and reinforcing those stereotypes.

Twenty years ago, the necessity of the second group of inventions and the equally important need to account for psychological barriers could still be justified by their auxiliary role—as a basis for selective filtering of the vast array of initiated technical and creative ideas to identify the most effective and non-obvious technical solutions.

The emergence of information technologies and the drastic reduction in the innovation cycle forces a re-evaluation of the possibility to create technical solutions that include auxiliary innovative functions but remain entirely non-obvious.

If an inventor now wants their innovative ideas to be used, they must be versatile—not only possessing foresight and intuition but also being a practically multidisciplinary expert who senses (and preferably understands) the commercial and consumer needs of the market, beyond stereotypes and the associated psychological barriers based on the apparent obviousness of the synthesized ideas' implementation paths.

There are several fundamental areas that, under current conditions, decisively influence the fate of new ideas. Acknowledging these can lead to real commercial success, while ignoring them can forever prevent their implementation in any commercial form.

The author proposes to consider some of these fundamental directions (naturally, the format of this article allows only a brief, thesis-level outline):

The technical, compositional, and technological solutions that have emerged and continue to emerge are evaluated through the lens of industrial development laws—laws that were formulated based on practices of building machines and technologies mostly from the previous century, during times when none of today's materials, components, or electronic and laser technologies were known.

Additionally, the integration of elements of artificial intelligence and artificial neural networks into the infrastructure of new technical systems significantly complicates the processes of design and formation of technical and technological characteristics of innovative products.

This situation is further aggravated by the fact that, as noted earlier in this article, recognition of a technical solution as an invention is based—in the U.S. and most other countries—on several criteria: four in the U.S., and three elsewhere.

The fourth criterion in the U.S. is precisely the subjective factor in evaluating a technical solution, which leads to the gradual development and entrenchment of a psychological stereotype that divides new technical solutions into "obvious" and "non-obvious" categories.

The presence of a clearly expressed subjective factor introduces comparison with known structural or technological elements and their combinations from existing developments into the evaluation process.

The familiarity of a solution or its implementation nuances cannot be considered an objective factor, because whether a solution is deemed obvious or non-obvious depends fundamentally on the knowledge and professional competence of the experts making the judgment.

In modern designs and technological solutions, novelty is not simply a reflection of one technical discipline but a combination of integrated fields such as electronics, microelectronics, advanced materials science, fiber optics, and laser technology. This requires assessment from multiple perspectives of obviousness and non-obviousness—something that only narrow specialists in collaboration with integration experts can effectively evaluate.

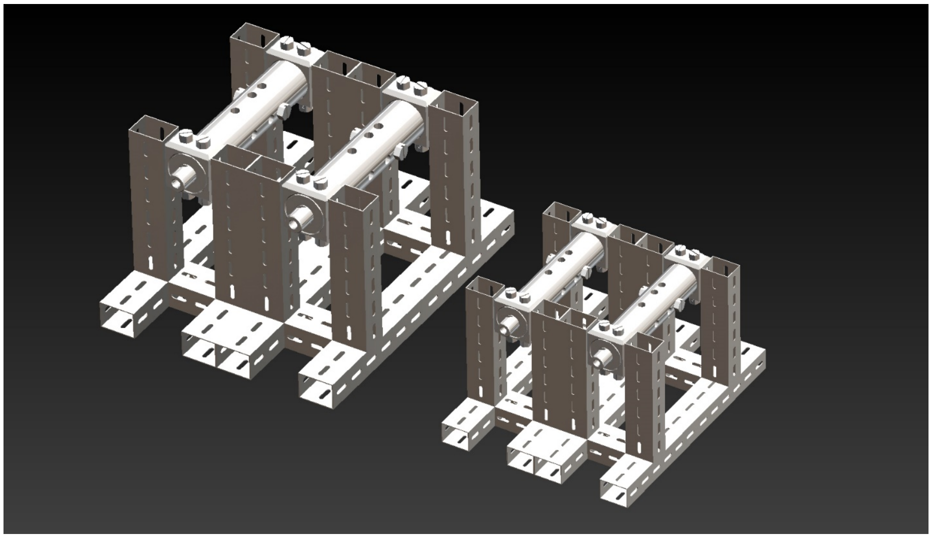

**Figure 1.1.** *Variants of industrial configurations of the devices presented in Figure 1, with three-dimensional analysis of the scaling factor, as well as parallel analysis of the level of non-obviousness across the entire set of solutions related to this innovative product.*

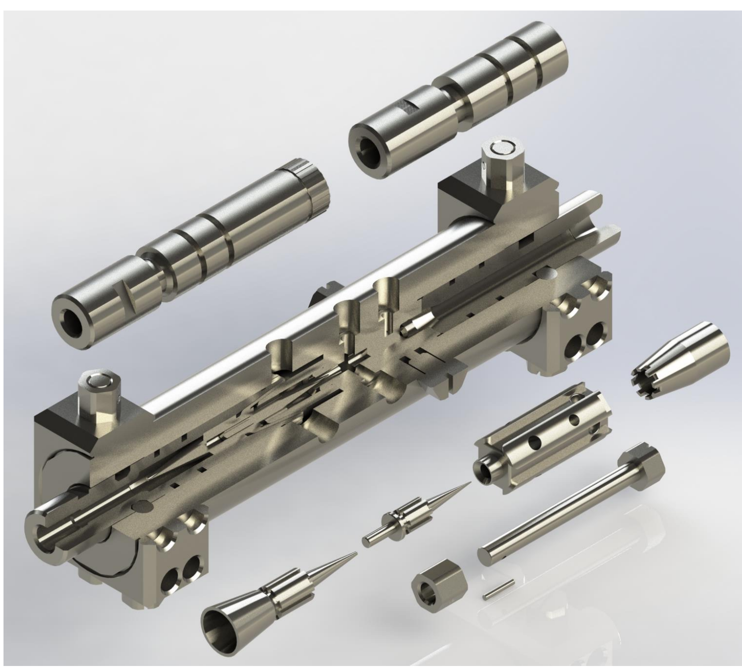

**Figure 2.** *An example of modern innovative design using sectional cuts and providing technical and innovative analysis of the credibility and qualification of non-obviousness levels for all device details, as well as the non-obviousness level of functional characteristics of assembly associations and their subsequent commercial advantages.*

In each technical discipline, over time, certain typical solutions become deeply ingrained and gradually evolve into stereotypes familiar to virtually all practicing specialists.

Such stereotypes take root in daily practice, and any change in design or technology inevitably encounters a certain barrier, which, over time, turns into a well-formed technogenic psychological barrier.

In this situation, even effective participation in the synthesis of innovative ideas—through brainstorming, refinement of these ideas, and their innovative combinations toward the borderline ideal final result—may encounter and often does encounter stereotypical psychological barriers. Even if a working group generates technically sound suggestions that are non-obvious to an average specialist in the specific field, such ideas are usually not accepted and may be rejected outright, especially in the early stages.

If we turn to the Theory of Inventive Problem Solving (TRIZ) and its methods for achieving the ideal final result, it becomes evident that this theory is not fully adequate for the realities of today's integrative and complex technical solutions.

Even during its prime, TRIZ had significant flaws, which likely led to stagnation after the death of its founder and to serious difficulties in its practical application.

TRIZ, at the technological level of its time, attempted to formulate laws for the development of technical systems, intended to form the foundation of TRIZ and its overall problem-solving methodology.

These foundations remained relevant until the emergence of processor-based technologies and the adaptation of classical ideal results to new conceptual solutions. The effectiveness of such new solutions was not only in their structural and technological sophistication but also in the software implementations that gave inventions fundamentally new commercial characteristics.

However, most of the principles and laws formulated over 70 years ago are no longer applicable today due to the widespread introduction of digital technologies.

These are more accurately referred to as tendencies or patterns of technical development—yet they are far from complete. As a result, a coherent methodology for solving inventive problems based on these “laws” never truly emerged.

The formulated laws were mainly used as methodological justifications for the invention examples presented. Commercial feasibility factors were entirely excluded and their influence on the use of constantly evolving laws for technical system development was not considered. This limited the ability to modernize, optimize, and adapt inventions to become non-obvious, market-demanded, and fully viable innovative products.

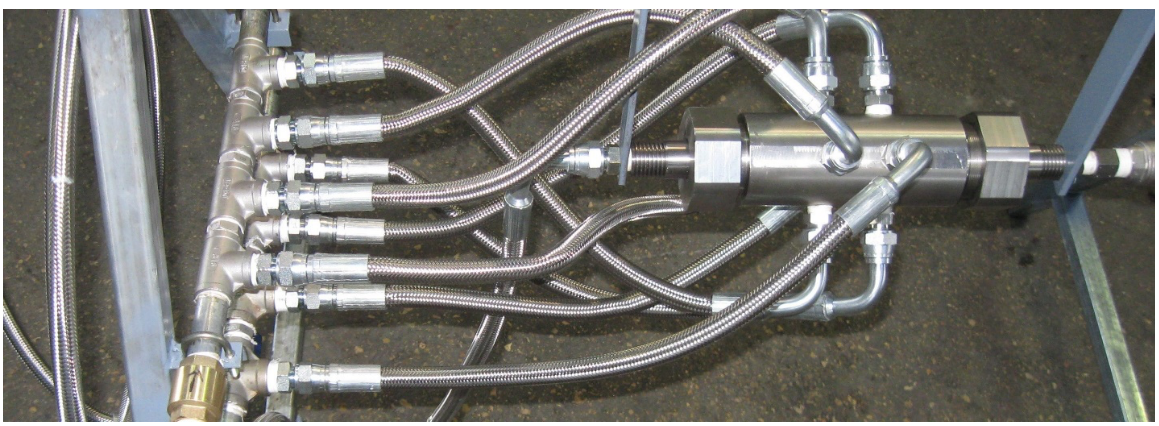

**Figure 3.** *An example of combinatorial innovative design based on principles for overcoming technogenic stereotypes.*

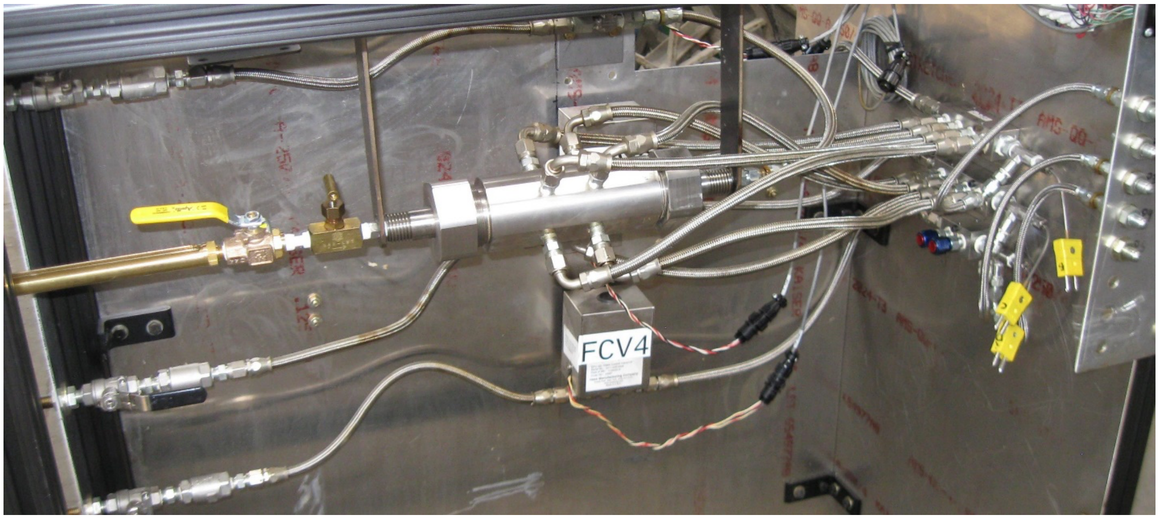


**Figure 4.** *Another example of combinatorial innovative design based on principles for overcoming technogenic stereotypes.*

Recent patent disputes among the world's largest technology companies demonstrate that the laws of technical system evolution formulated in TRIZ cannot reflect the full variety of tasks, functions, and features present in modern multifunctional objects with non-obvious structural characteristics.

Given the constant emergence of new factors characterizing innovative objects, it is necessary to reformulate these laws—now in connection with the laws of commercial system evolution and the commercialization of innovative ideas within the framework of the modern innovation economy and the practical globalization of the innovation process.

These new concepts have changed the nature of dialectical contradictions as formulated in dialectical logic. This, in turn, has made it more difficult to identify contradictions when attempting to solve real inventive problems using ARIZ, and it has not provided an adequate qualification for the level of non-obviousness in technical solutions—especially when they involve elements of artificial intelligence and neural networks.

This is where we should focus attention: What can truly be considered an inventive problem today? How can we harmoniously combine the psychological evaluation perspectives of the inventor, manufacturer, and consumer?

How can correct or incorrect problem formulation affect the commercialization of the invention?

And is it even possible to reliably protect a complex technical solution from unauthorized copying?

Finding answers to these and many other questions is becoming a key part of the dialectics in forming patenting and licensing strategies for inventions—especially in relation to evaluating their degree of non-obviousness.

The refinement of ARIZ (from ARIZ-77 to ARIZ-85B) did not focus on correcting inaccuracies in identifying contradictions, but instead moved toward increasing algorithmic complexity.

As a result, the final official version—ARIZ-85B—became extremely cumbersome and poorly suited for practical use.

TRIZ never developed a clear mechanism for transitioning from a formulated contradiction to its practical resolution. This made solving real-world problems using ARIZ difficult.

Although TRIZ declared a rejection of methods that activate trial-and-error iteration, most of its so-called tools were precisely such techniques.

This kind of analysis was presented as a scientific method based on the study of structural development patterns in technical systems. However, TRIZ's allowance for using non-existent physical fields and the possibility of ambiguous interpretations of constructions and transformation rules suggests that these approaches are better described as heuristic trial-and-error methods rather than scientific analysis.

The closest TRIZ came to formalizing an inventive problem-solving procedure was the creation of a contradiction resolution table and a set of inventive principles. This approach was based on statistical analysis of invention descriptions available at that time. Despite its promise, it was never further developed within TRIZ. Due to its limitations and the outdated nature of its statistical foundations, the method has lost practical relevance.

A widespread illusion persists about the possibility of implementing TRIZ into real production environments. In essence, TRIZ is a personal tool for problem-solving, dependent on individual choice and affected by significant psychological factors. This makes it practically impossible to integrate TRIZ directly into manufacturing processes. At best, companies may offer TRIZ training to enhance the creative capacity of their staff (as is done today in the U.S.).

During its active development in the 1980s, these shortcomings were often offset by the enthusiasm of TRIZ followers. However, the unresolved flaws in TRIZ and the departure of its core developers during the industrial crisis—those capable of recognizing and addressing these flaws—ultimately led to a stagnation in the theory's evolution. In the author's opinion, this is the main reason why TRIZ has produced nothing substantially new in recent decades.

In composite technical solutions, the methods and technologies used to manufacture parts and components play a critical role in determining whether a product can realistically be implemented.

As an example, let us consider a fuel nozzle or fuel injector for an internal combustion engine.

This is one of the most mass-produced products—more than a billion such injectors are manufactured globally each year.

The consumer value of such a product is determined by several key factors: the diameter of the outlet openings and the ability to ensure tightness under high fuel pressures (up to 2000 atmospheres).

Traditional manufacturing methods determine the lower limit for the diameter of these openings. Since high-pressure applications require hole diameters measured in microns, the drilling technology must be, for example, laser-based.

In this case, the inventor of a new injector must account for the compositional aspect of the invention's novelty, expressed in compliance with the specific requirements of the equipment used for laser drilling.

Constantly changing conditions and consumer demands, when combined with local consumption standards, cultural, and national traditions (on which these local consumption standards are based), create informal but implicitly accepted consumer standards.

If the inventor's goal is to ensure commercial success for their invention, then a key element of their commercialization strategy must be a fundamental understanding of the currently existing criteria of consumer standards, as well as the technical, operational, and functional parameters of the new product.

Even if technological risk is eliminated due to successful testing of the new product, the risk of commercial failure remains real—if the inventors and their commercialization partners have not understood or accounted for the essence of the consumer standard for their product.

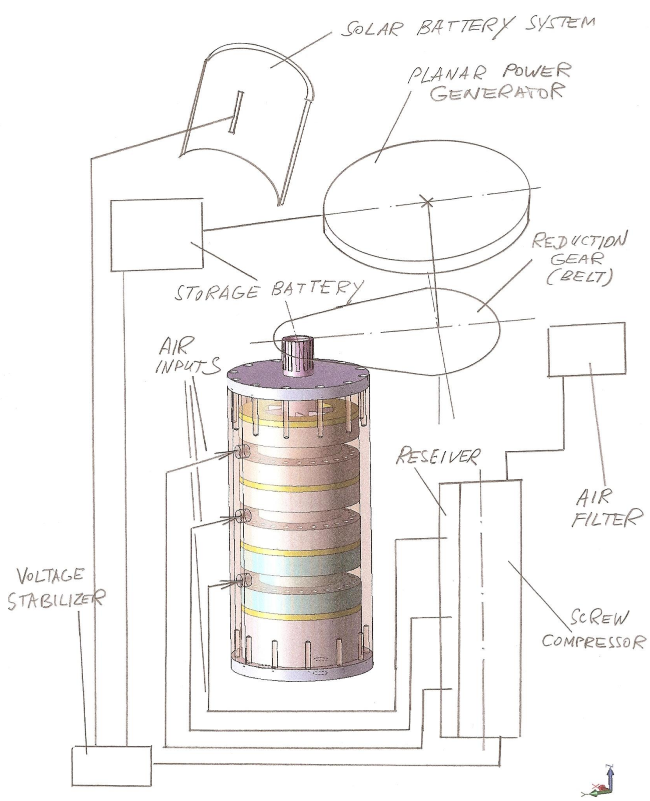


**Figure 5.** *Schematic diagram of the device, connection, and functioning of a shoulder-mounted generator for condensing drinking water from ambient air. Component labels are shown in the illustration.*

As shown in the diagram, the device receives electrical power from a miniature solar battery equipped with a voltage stabilizer, which is connected to an energy storage battery.

The battery, in turn, is connected to a planar electric generator that supplies electricity to all actuating mechanisms—most notably, dual vortex generators that form vortex tubes where accelerated condensation occurs.

Air compression is achieved using an innovative screw compressor.

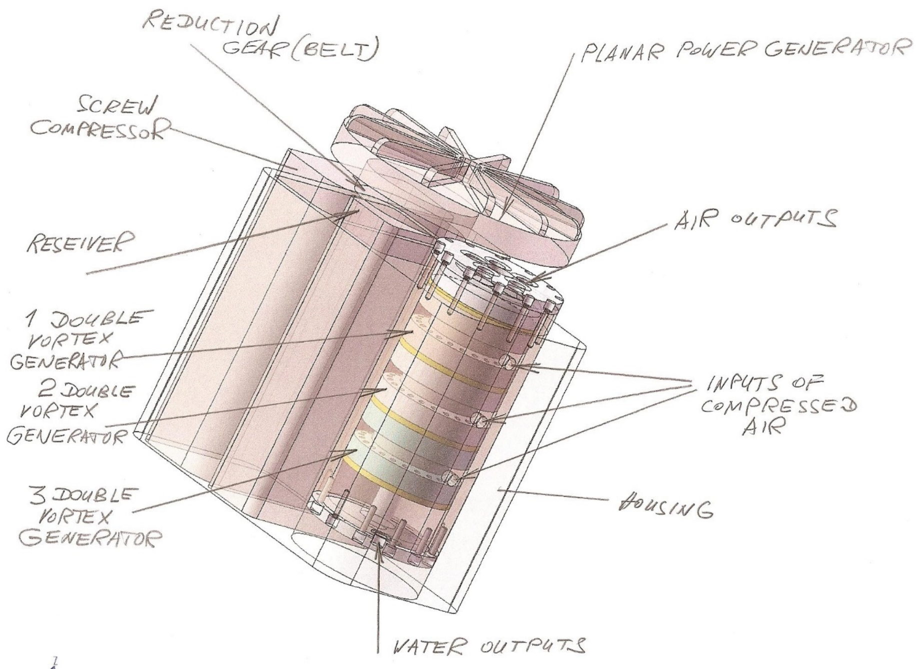


**Figure 6.** *Schematic — three-dimensional model of the device, connections, and operation of a shoulder-mounted generator for condensing drinking water from ambient air. Labels for the included units and components are shown in the illustration*

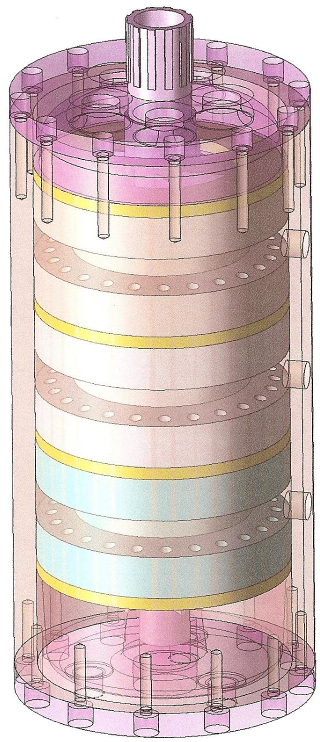

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**Figure 7.** *Three-dimensional model of the vortex generator, which serves as the main actuating mechanism of the compact shoulder-mounted generator for condensing drinking water from atmospheric air.*

The mechanism for aerodynamically forming localized vortex tubes within the main vortex tube consists of three dual local vortex generators.

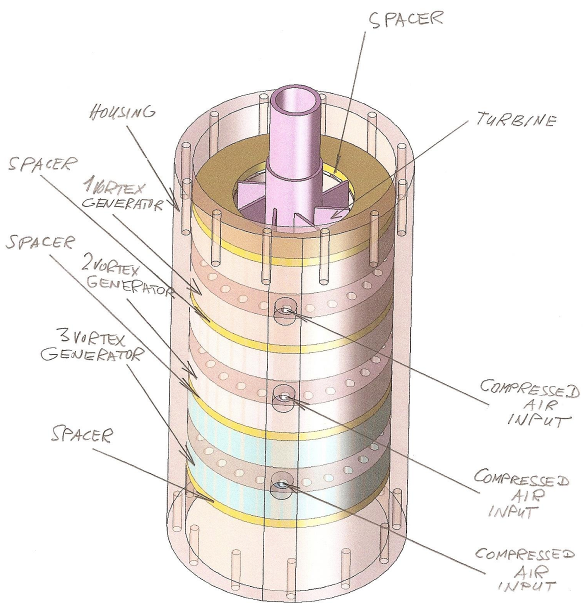


**Figure 8.** *Three-dimensional model of the central accumulating vortex generator with labeled component parts.*

Here, it makes sense to relate the description of the generator's structural properties and qualities to the features of modern innovation development, particularly as components of smart technologies.

The presence and continuous development of software products, as well as the increasing complexity of all types of equipment—especially various kinds of electronic and microelectronic devices—have fundamentally changed the principles for protecting such inventions as complex, multi-faceted, and multifunctional intellectual property.

Furthermore, the recent classification of technical solutions as *smart technologies*, *smart devices*, and *smart materials* requires additional justification for such designations.

For such objects, purely structural features, schematic decisions, and combinations of those decisions no longer fully define the invention. Today, all of these characteristics can often be implemented into a working system or prototype only under certain manufacturing and quality control conditions. Very often, the actual fabrication process, combined with the demonstrated non-obviousness of the structural solutions, determines the invention's core attributes.

The development of processor-based control systems also determines the technical solution's viability. Algorithms, software, and feedback between structural or circuit elements have already become—or are steadily becoming—an organic part of the technical solution forming the basis of the claimed invention.

To this point must be added the step-by-step analysis of the state of the innovative object in conjunction with the possibility of applying a non-obvious principle involving elements of artificial intelligence and neural networks.

he possibilities of integrative patenting in the field of information technologies affect a vast segment of modern societal activity.

Until recently, it was still possible to clearly define or limit a given technological sector. However, with the penetration of high technologies and their offshoots—information technologies—into all areas of human activity, such classification possibilities and protection mechanisms have been significantly transformed into a new system of technical, commercial, and legal interconnections that require detailed proof of non-obviousness.

In virtually all processes and devices—even relatively simple ones—the emergence of new types of technology (such as quantum computers and their equivalents) means that their structure, within both horizontal and vertical integration, becomes inherently integrative. This includes technological methods, approaches, and systems that have never been used before (i.e., non-obvious). Additionally, the integration of classical technical solutions with new capabilities offered by information technologies fundamentally changes the very concept of "invention" and forces us to view it as a complex set of interrelated technical solutions**.**

This newly emerged technological development factor—arising at the intersection of classical technologies—significantly alters our approach to formulating and protecting those elements and their combinations which, under new conditions, may be qualified as composite integrative technical solutions that meet the main criteria of an invention and are based on composite engineering-design elements.

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