Technical Sciences

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APPLICATION OF COMBINATORIAL DESIGN PRINCIPLES

The Use of Combinatorial Design Principles in Ecosystem and Infrastructure-Based Technical Solutions and Their Role in Achieving the Ideal Final Result

Summary. *The field of all types of innovation is typically saturated with a wide range of conventionally applied technical solutions and materials. Therefore, the implementation of innovative changes must be adapted to and integrated with traditional technologies and materials.*

In general, innovation is not a goal in itself. The central objective of the entire innovation process is to achieve a final result that leads to a qualitative improvement of all parameters of the therapeutic process, while ensuring the continuity of technologies, engineering solutions, and materials — including consumables.

Developers have presented their first quantum computer and joined the global race for "quantum supremacy." The first 20-qubit computer employs modern superconducting technology.

Key words: *Design, Combinatorial Design, Ecosystem Technical Solutions, Infrastructure Technical Solutions, All Types of Innovation, Ideal Final Result, Preservation of Continuity in Technology, Engineering, and Materials, Quantum Computer, Quantum Supremacy, Modern Superconducting Technology, Power of Conventional Supercomputers.*

"Quantum supremacy" refers to the performance level of a quantum computer that enables it to solve tasks requiring virtually unattainable processing power from conventional supercomputers.

At present, quantum supremacy is achieved only for selected model tasks by a few quantum computers, but the development of quantum computing is advancing globally. **All developed countries participate in this global competition, with the United States currently leading the race.** The development of quantum computing involves not only the creation of quantum computers but also the establishment of access infrastructure for computational resources, the development of software, and the integration of quantum computers with conventional supercomputing systems. In recent years, the global race for *quantum supremacy* has significantly accelerated due to groundbreaking discoveries in this field. Today, several leading nations have emerged as developers of quantum infrastructures and computers that promise to revolutionize computational research, defense, industry, and other high-impact sectors.

Achieving the Ideal Final Result
The use of natural materials such as **zeolite** and **activated carbon–carbon fabrics**, as well as their innovative modifications in modern therapeutic processes and medical equipment—including integrative solutions—is one example of an innovative approach to combinatorial design.

In the field of medically oriented technologies, the innovation implementation process is significantly constrained due to the necessity of obtaining regulatory approval for the clinical use of any fundamentally new technical or technological solutions, as well as new composite and nanomaterials.

The **QTM microscope** may become one of the key instruments for the study of quantum materials.

Its unique ability to explore both electronic states and collective excitations will help advance multiple areas of science related to quantum computing, sensor technology, and next-generation quantum electronic devices.

Scientists from several leading laboratories around the world have developed a powerful tool for studying quantum phenomena — the **cryogenic quantum-twisting microscope (QTM)**.

The research has been published in the journals of the world's leading academies of sciences.

The fundamental properties of materials are determined by their basic particles: the flow of electrons governs electrical resistance, while lattice vibrations—known as **phonons**—determine thermal conductivity. Phonons are quasiparticles that physically represent lattice vibrations but can also be described similarly to photons. However, observing phonons is much more difficult.

Materials may also contain other types of collective excitations, such as **phasons**—quasiparticles that emerge in aperiodic crystal structures.

When electrons and quasiparticles interact, unexpected phenomena can occur.

For example, during the study of **graphene**—a one-atom-thick carbon lattice—an extraordinary effect was discovered: if two layers of graphene are stacked and twisted relative to each other by an angle of **1.1 degrees**, the electrical resistance of the bilayer system drops to zero, indicating the onset of **superconductivity**.

This surprising behavior led scientists to refer to the **1.1-degree angle as "magic"**, though the cause of superconductivity in bilayer graphene remained unclear for a long time. The new **QTM microscope** enables direct observation of **phonons and phasons** within the material. By observing bilayer graphene twisted at the magic angle, physicists identified a phason whose interaction with electrons grew stronger as the twist angle approached 1.1 degrees.

This phenomenon had **never been observed before** and suggests that **phasons may play a critical role in the emergence of superconductivity** in twisted bilayer graphene.

"Our method goes far beyond phonon observation," says one of the co-authors.

"It can detect **any excitation related to tunneling electrons**, opening up exciting possibilities for exploring other collective excitations such as **plasmons, magnons, spinons**, and more."

The microscope's **unique capability** to probe both electronic states and collective excitations will greatly advance diverse areas of science related to **quantum computing, sensor technologies, and future quantum electronic devices**.

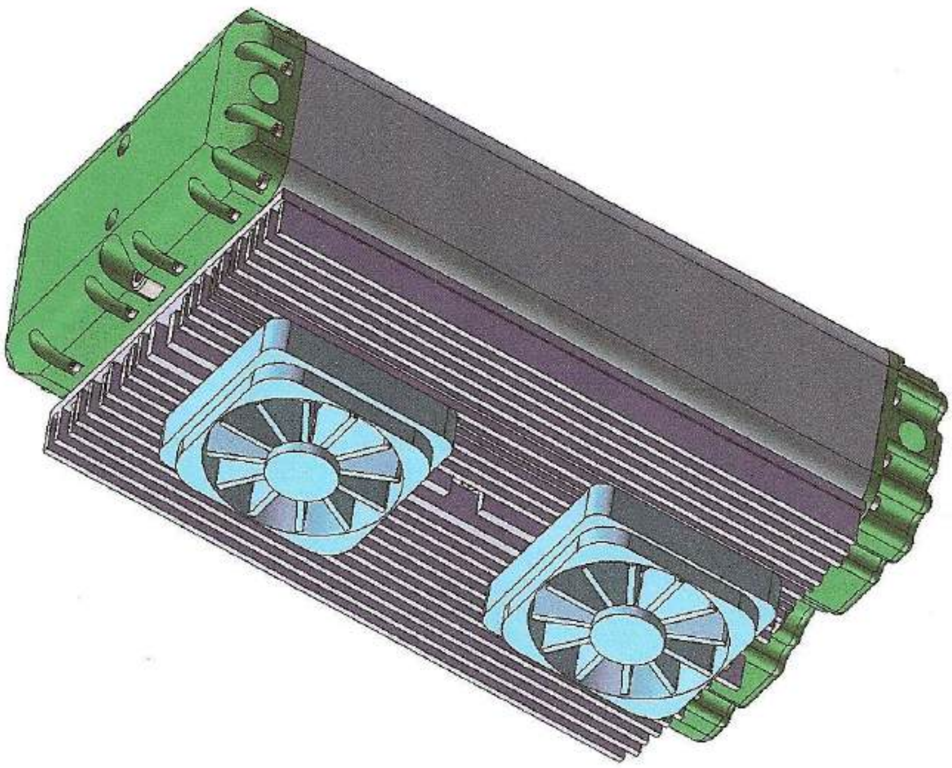

Fig. 1. The illustration shows a device that utilizes granulated natural ion-exchange aluminosilicate for water regeneration in arid regions

The field of innovation is typically saturated with a wide variety of traditionally employed technical solutions and materials, which means that any type of innovative modification, by the conditions of implementation, must be adaptable to and compatible with existing technologies and materials.

Controlling gadgets with the power of thought is on the verge of becoming reality.

Apple is planning to integrate neural interface support into its operating systems — as early as 2025.
The focus is on Stentrode technology, developed by the American startup Synchron. This is a miniature implant inserted into the brain through a blood vessel, eliminating the need for complex surgical procedures.
The device reads motor cortex signals and transmits them to an iPhone, iPad, or Vision Pro headset, effectively transforming thoughts into actions.

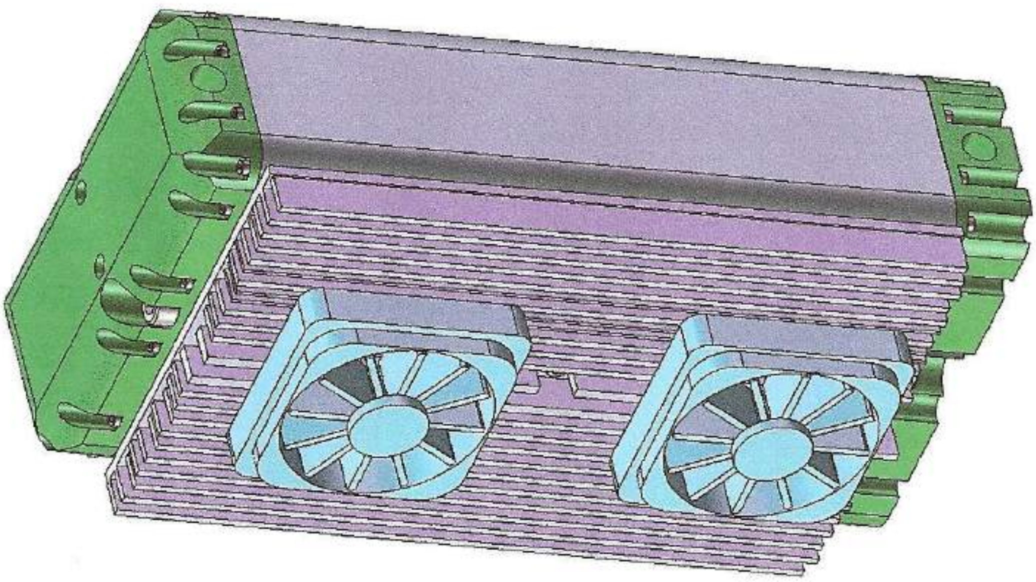

Fig. 2. The illustration also shows a device utilizing granulated natural ion-exchange aluminosilicate for water regeneration in desert regions

In infrastructural and foundational solutions, including those with auxiliary purposes, the correct and harmoniously coordinated combinations between system elements at all levels fundamentally determine the success of the innovation process, in alignment with the entire infrastructure and the design architecture of equipment and specialized tools.

A paperclip-sized implant with 16 electrodes is inserted through the jugular vein and captures brain activity.

It recognizes the user's intentions, translates them into digital commands, and enables control over various devices. Already today, patients with amyotrophic lateral sclerosis (ALS) who have lost motor function are using Stentrode to operate applications, view content on Vision Pro, and perform other tasks — using only the power of thought.

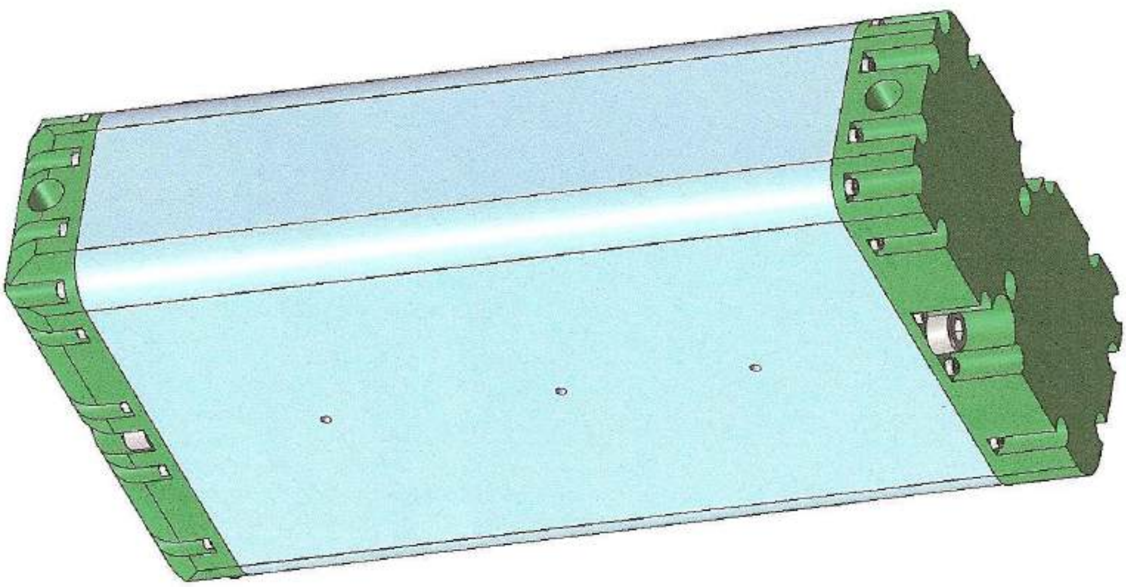

Fig. 3. The illustration also depicts a device utilizing granulated natural ion-exchange aluminosilicate for water regeneration in desert regions

While Apple is working with the brain, startups are helping the blind "see" the world.

One such device — a miniature camera mounted on glasses — recognizes text, faces, currency denominations, and reads the information aloud without requiring an internet connection. For visually impaired individuals, this has become a form of "auditory vision", unlocking new possibilities.

Future technologies: from functionality to empathy
Neurointerfaces, smart glasses, eye-tracking control — these developments are blurring the line between human and machine.
As Apple demonstrates, inclusive technologies are no longer niche products — they are becoming drivers of progress.

If today an iPhone is learning to read your thoughts, tomorrow it may learn to recognize your emotions — and perhaps even offer help upon detecting irritation or distress.

The main trend is not just smart devices, but technology that understands the human being. And this is no longer science fiction.

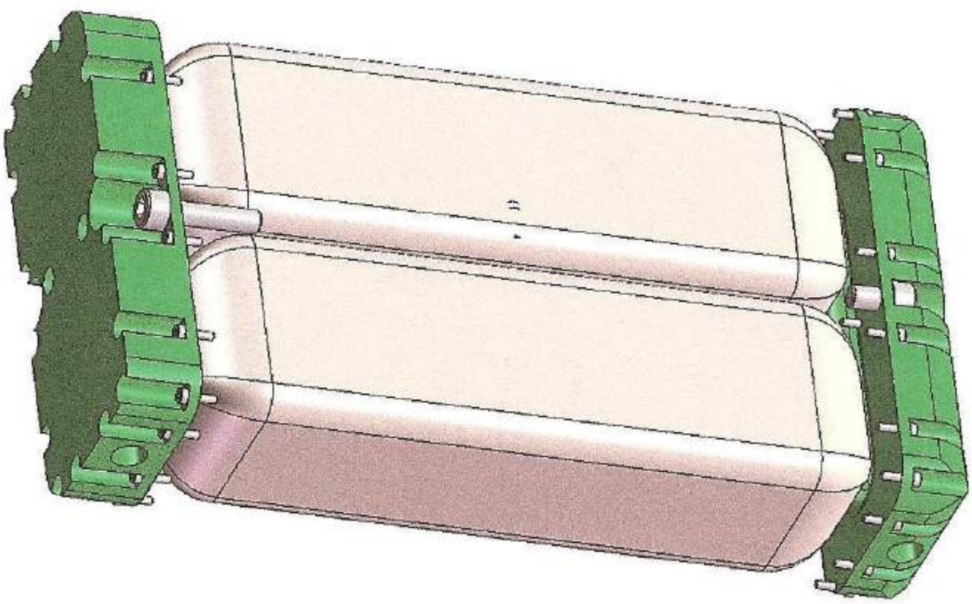

Fig. 4. The illustration also shows a device utilizing granulated natural ion-exchange aluminosilicate for water regeneration in arid regions

In general, innovation is not an end in itself. The central goal of the entire innovation process is to achieve a final outcome from the implementation of innovative ideas at a level that ensures qualitative improvement in all parameters of the therapeutic process, while preserving continuity of equipment, technologies, and materials, including consumables.

Fundamentally, the author of this publication proposes to examine certain real interdependencies between these elements and to conduct an analysis of fundamental methods and frameworks for adapting innovative solutions and materials within the structure and interrelations of traditionally used technologies, techniques, and materials.

Until recently, the innovation process was largely conducted by specialists in medical technologies and materials who lacked specific experience and lacked specific experience in computer modeling and process simulation, and the implementation was carried out based solely on positive test and research results.

For quite a long time, and not always successfully, a dialogue was taking place between conservative specialists and innovators, and not always in favor of the innovators.

Practitioners remained in a state of expectation, awaiting solutions that could clearly demonstrate realistically achievable and effective methods for implementing innovations without causing any significant disruption to the stability of technological processes.

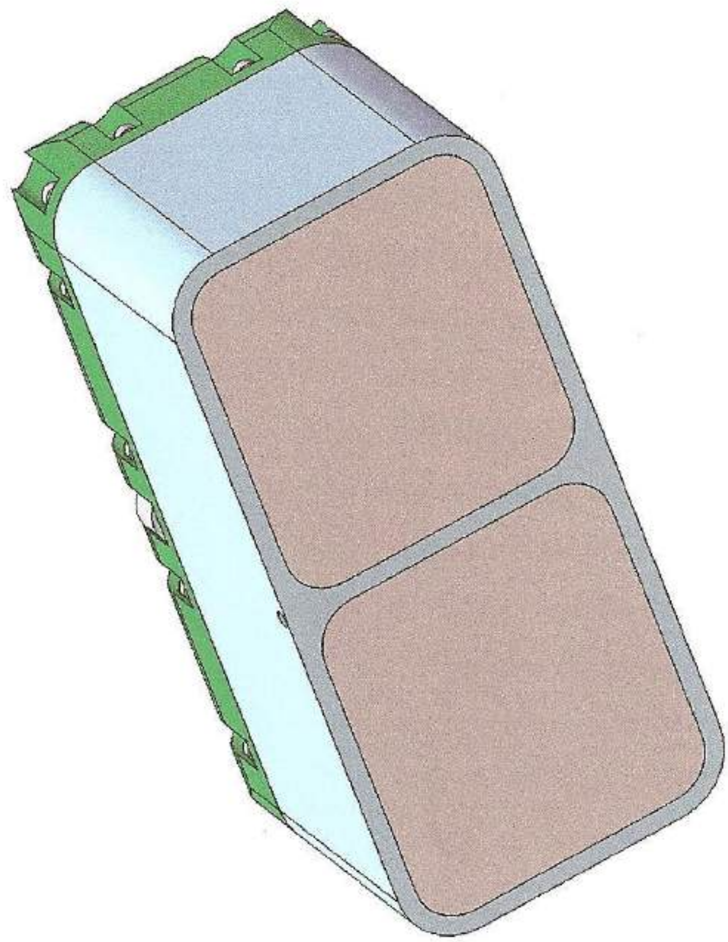

Fig. 5. The figure also shows a device that utilizes granulated natural ion-exchange aluminosilicate for water regeneration in desert areas

To the credit of proponents of innovative technological transformation, it should be noted that in recent times several comprehensive solutions have emerged that allow for the smooth implementation of innovative technologies under the real-world conditions and circumstances of modern medical — and not only medical — science and practice.

The author of this publication considers the most acceptable to be comprehensive integrative solutions, as outlined in the scientific and technological publications of Dmytro Pastukh.

What distinguishes Dmytro Pastukh's proposals and developments from similar suggestions by other authors is, first and foremost, the broad platform for experimental computer modeling. This platform has emerged due to Dmytro Pastukh's versatile and in-depth knowledge of the fundamental techniques and methods of systemic and combinatorial computer modeling, particularly within interdisciplinary innovation processes, including at the intersection of foundational scientific disciplines.

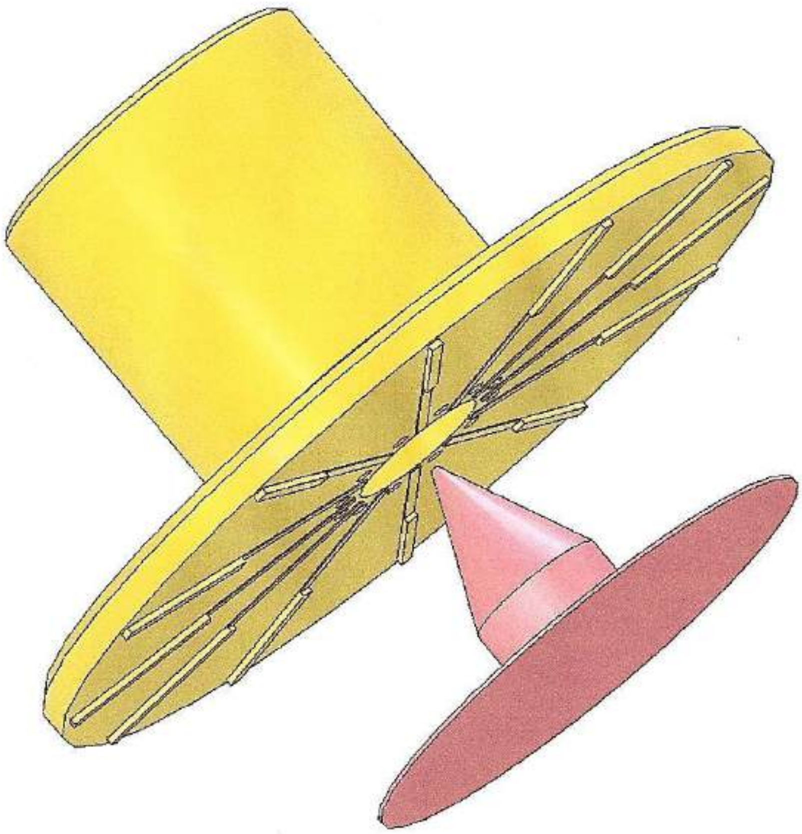

Fig. 6. The figure shows a disassembled view of a vacuum gripper that also functions as a foam generator and flow former

This combined device, thanks to its operational characteristics, can perform multiple functions, including pulsating impact actions.

In analyzing all 11 innovative medical technologies proposed in his publications, Dmytro Pastukh advances a critically important thesis for solving systemic issues: the combinatorial structure of each solution — meaning the harmonious integration and mutual enhancement of traditional technologies and materials with innovative ones, primarily composite-based.

Among Dmytro Pastukh's proposals, it is particularly important to emphasize the trend toward integration and extensive adaptation of new materials and technological methods within the environment and framework of existing and proven technologies and materials, which are already prepared for a transformation of properties and capabilities at a new, innovative level.

Embracing these trends has made it possible to account for the development potential of materials, structures, and technologies — enabling a smooth transition, for example, from flexible and permeable, volumetric-porous systems to chemically and functionally similar materials, but in solid-state form.

One unexpected conclusion of all related studies is how large mammals, such as whales, exhibit significantly lower cancer rates, despite having vastly more cells than smaller animals. The research showed that certain post-translational modifications (PTMs) found in whales likely play protective roles.

"Our findings open a promising pathway to understanding how protein modifications protect against age-related diseases and support longevity and healthy aging," the study's co-authors claim. By identifying PTMs associated with longevity, we can begin developing therapeutic strategies that mimic these evolutionarily established mechanisms.

The results outline a roadmap for targeted protein therapy research associated with healthy aging. Scientists believe that leveraging nature's embedded strategies may offer a way to slow down the aging process.

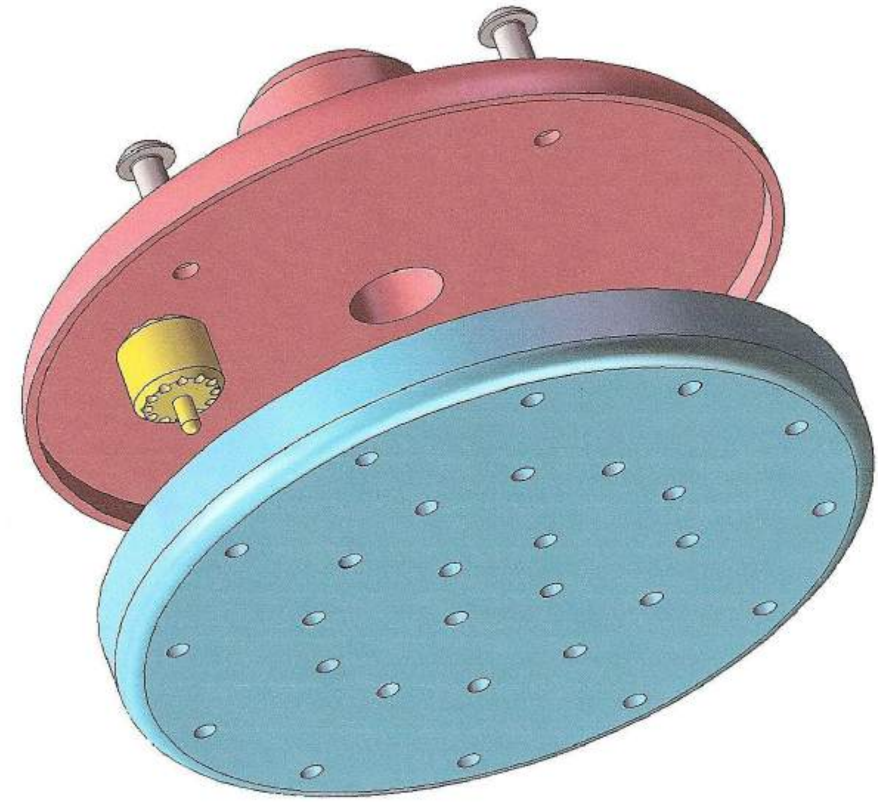

Fig. 7. The figure shows a massage module designed for pulsating massage, achieved through pneumatic pulsations

Moreover, this fundamental approach to the use of new composite materials in novel applications with extraordinary properties and characteristics enables the creation of new medical devices and instruments that meet the advanced performance requirements of modern medical technologies.

If we take into account that, in addition to the latest composite materials, nature offers exceptionally valuable natural materials, then applying the principles outlined in Dmytro Pastukh's publications also makes it possible to create a harmonious synergy a harmonious synergy between well-known natural materials and time-tested engineering and technological methods.

The photo at the beginning of this publication illustrates exactly such an application of natural aluminosilicate — zeolite — in a laboratory-based water preparation system, for example, for cleansing patients' skin prior to therapeutic procedures.

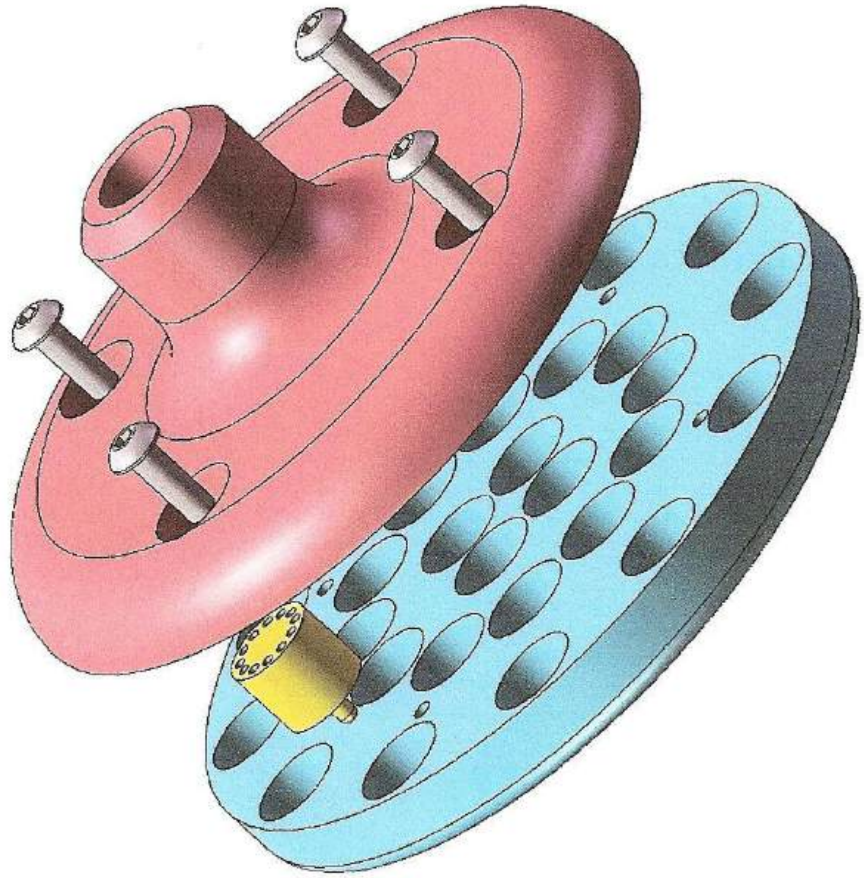

Fig. 8. The figure also shows a massage module designed for pulsating massage, as a result of pneumatic pulsations

The presented models demonstrate that, based on the general principles of innovative design proposed by Dmytro Pastukh, it is possible—within the framework of traditional shapes and constructions (e.g., an ion-exchange filter)—to achieve an almost ideal end result with unusual parameters and properties by using natural and completely safe materials, such as:

- complete absence of chemical reagents in the process,
- use of natural ion-exchange properties of zeolite,

- tremendous potential of zeolite's unique exchange capacity, including for the purification of radioactively contaminated liquids.

These design trends fundamentally shift the requirements for design itself, enabling the broad implementation of computer modeling methods and techniques in the development process.

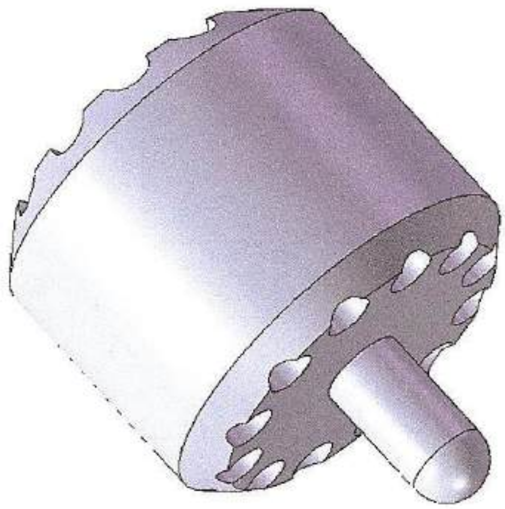

Fig. 9. The figure shows the design of a massaging head

The conceptual solutions proposed by Dmytro Pastukh enable further development of materials—for example, carbon-carbon composites in textile form—into solid compressed components made from such fabrics, possessing completely unique properties and opening new innovative possibilities in therapeutic and related processes. For such materials, the novelty and advantage lie in their exceptionally high thermal resistance, with operating capability at ambient temperatures up to 4000°C.

Disinfection at such high temperatures provides an absolute guarantee of eliminating all bacteria, viral agents, and other forms of instrument contamination.

The following models depict massaging heads, in which all components, including the massage plungers, are made of compressed carbon-carbon fabric.

This design trend of the device and its method of application is defined by the potential to leverage the combined properties and qualities of new materials and their derivatives, in synergy with traditional materials and application techniques within a systemic design framework.

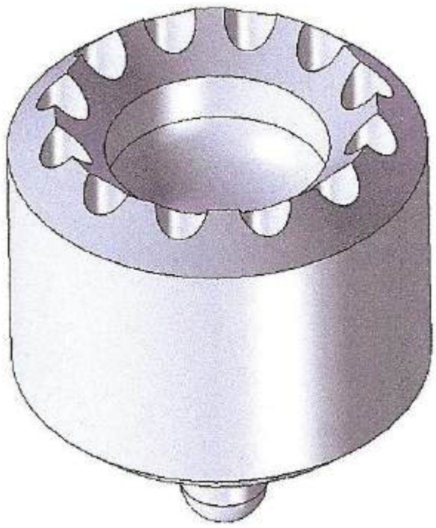

Fig. 10. The illustration also presents the design of a massage head

The very possibility of creating such technical solutions arose from basing all stages and phases of project development on the principles of combinatorial design and software-modeled selective selection of innovative materials and their integrative combinations and modifications, as declared in the publications by Dmytro Pastukh.

As an example, the author of this publication presents a design version based on Bernoulli effect methods, which enables localized vortex-based surface cleansing systems for patient body preparation prior to therapeutic intervention.

The material used for manufacturing the components of the depicted device is the same compressed carbon-carbon composite mentioned above, which enables exceptionally effective cleaning and disinfection of contact elements. Only a few examples are presented here, yet they clearly demonstrate the validity of the design trends and principles, as well as the selection of structural materials for their subsequent modification and optimization of properties and capabilities.

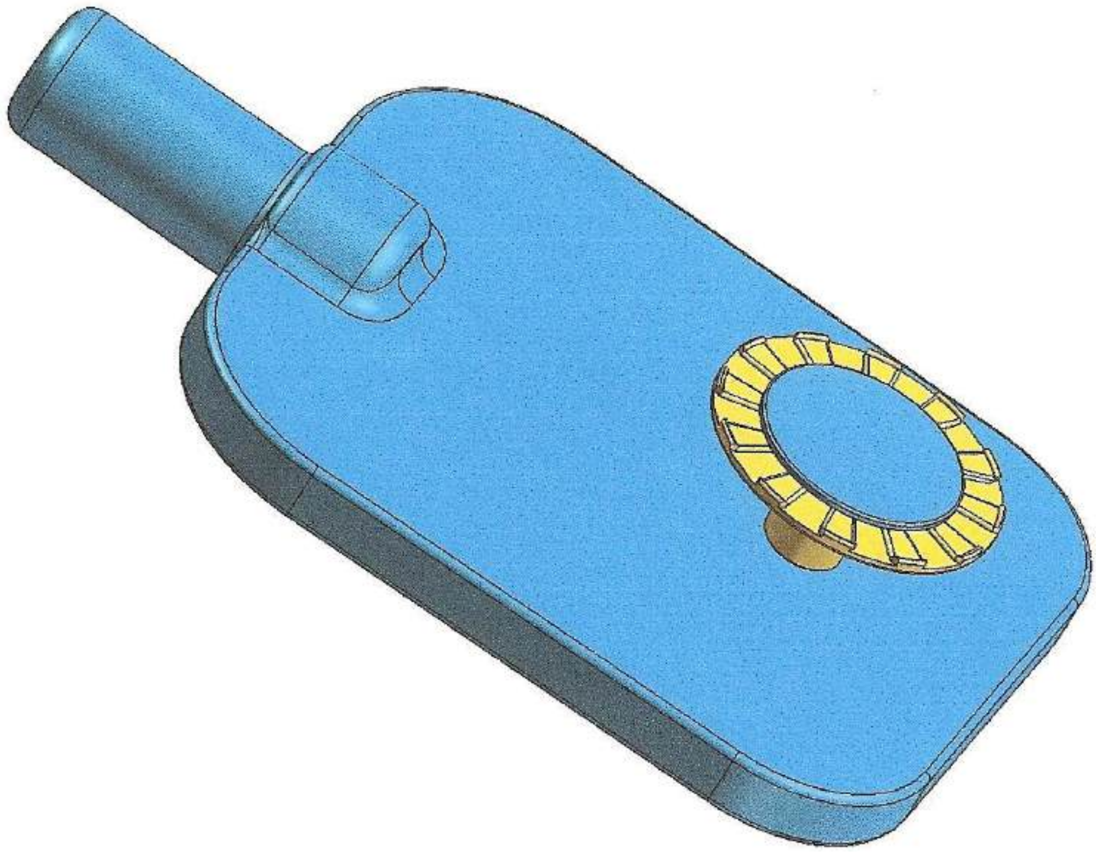

Fig. 11. The illustration shows a massage module with foam generation and formation functionality

As demonstrated by design practice for such devices, which can be classified as auxiliary medical equipment, tooling, and instruments, it is most appropriate to use modern versions of SolidWorks design software during development.

The software’s built-in capabilities for structural analysis of design quality and performance, along with its extensive data sets and parameters, allow for effective application in parallel computer modeling to verify the soundness of the adopted design solutions.

Moreover, if all the necessary technical requirements, specifications, and local standards are available at the design stage, the critical parameters embedded in SolidWorks can be leveraged to utilize the software's internal resources for more detailed modeling during the so-called late-stage design phase.

In cases where each component of the development plays a functional (not merely decorative) role in ensuring the proper operation of the device, tool, or instrument, SolidWorks enables detailed and localized modeling of individual parts or assemblies consisting of several functionally related components.

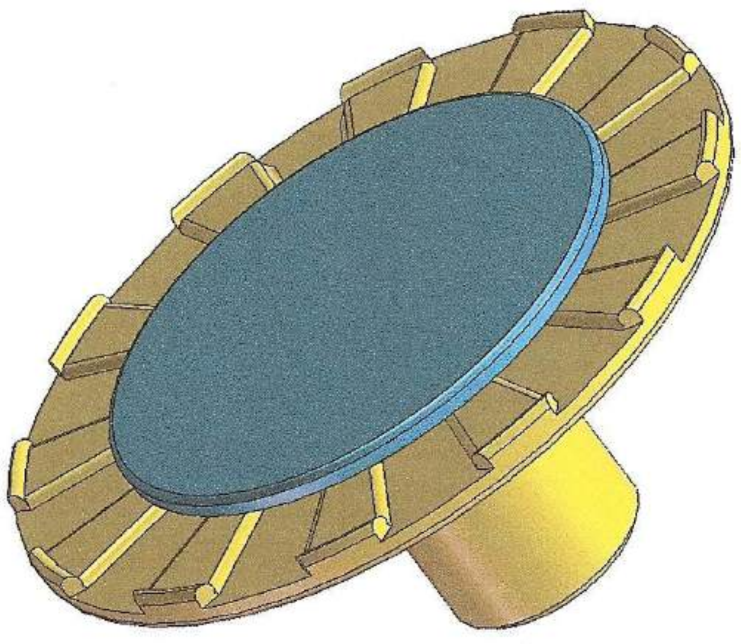

Fig. 12. The illustration shows an assembled vacuum gripper that also functions as a foam generator

This combined device, due to its operational characteristics, is capable of performing multiple functions, including pulsating action effects.

Another factor that significantly facilitates the setup and selective computer modeling process is the use of engineering design software, rather than graphic design tools, for development purposes.

The author intends to devote subsequent publications specifically to this topic.

List of References, Patent and Licensing Information:

Appendix 1

United States Patent **5,871,814**
February 16, 1999

Pneumatic grip

Abstract

A device for shaping a vacuum includes a housing having a primary passageway which includes an inlet. A fluid shaping mechanism is disposed in the primary passageway in fluid communication with the inlet for changing the shape of a fluid flow into a planar fluid flow flowing radially outwardly from a central point. The fluid shaping mechanism includes a conically-shaped portion disposed within the primary passageway, a plurality of secondary passageways extending through the housing from a periphery of the cone-shaped surface to outlets at a bottom surface of the housing, and a reflector adjacent to and spaced from the bottom surface for uniformly reflecting the fluid from the secondary passageways radially outwardly to create a vacuum adjacent thereto.

Appendix 2

United States Patent **8,871,090**
October 28, 2014

Foaming of liquids

Abstract

Methods and systems for processing of liquids using compressed gases or compressed air are disclosed. In addition, methods and systems for mixing of liquids are disclosed.

Appendix 3

United States Patent	**9,399,200**
	July 26, 2016

Foaming of liquids

Abstract

A foaming mechanism configured to receive a plurality of streams of gas and generate a foamed liquid, having an aerodynamic component and an aerodynamic housing disposed around at least a portion of the aerodynamic component. The aerodynamic housing includes a plurality of first channels and a plurality of second channels connected to the plurality of first channels at regular intervals on a distributed plane. The distributed plane is about perpendicular to the plurality of first channels, wherein the plurality of first channels and the plurality of second channels are configured to transform an axial stream of the gaseous working agent into a plurality of radial high-speed streams of the gaseous working agent by channeling the gaseous working agent through the plurality of first channels and into the plurality of second channels on the distributed plane. A hydrodynamic conical reflector and a hydrodynamic housing form a ring channel in an area between the hydrodynamic conical reflector and the hydrodynamic housing. An accumulation mechanism is configured to disperse the plurality of radial high-speed streams of the gaseous working agent into the ring channel and create turbulence to foam the liquid.

Appendix 4

United States Patent Application	**20100224506**
Kind Code	**A1**
	September 9, 2010

PROCESS AND APPARATUS FOR COMPLEX TREATMENT OF LIQUIDS

Abstract

Methods and apparatus for complex treatment of contaminated liquids are provided, by which contaminants are extracted from the liquid. The substances to be extracted may be metallic, non-metallic, organic, inorganic, dissolved, or in suspension. The treatment apparatus includes at least one mechanical filter used to filter the liquid solution, a separator device used to remove organic impurities and oils from the mechanically filtered liquid, and an electroextraction device that removes heavy metals from the separated liquid. After treatment within the treatment apparatus, metal ion concentrations within the liquid may be reduced to their residual values of less than 0.1 milligrams per liter. A Method of complex treatment of a contaminated liquid includes using the separator device to remove inorganic and non-conductive substances prior to electroextraction of metals to maximize the effectiveness of the treatment and provide a reusable liquid.