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DIGITAL TECHNOLOGIES WITH ELEMENTS OF ARTIFICIAL INTELLIGENCE AND ARTIFICIAL NEURAL NETWORKS

Summary. Nuances and aspects of marketing products created based on and in the development of digital technologies in their interaction with TRIZ.

Key words: Development of digital technologies, Development of digital technologies in their interaction with TRIZ, Complex innovation process, Technological breakthrough, Criteria and signs of smart production, Expressed innovative character, Fundamental spheres of human life, Compositional design solutions, Tools and methodology of industrial design.

Annotation. The introduction of new so-called smart technologies, the application of new so-called smart materials and composites, the replacement of traditionally accepted production methods with unusual ones that help and represent a continuous technological leap or breakthrough, increasing production efficiency, which begins to meet the criteria and signs of smart production, is now commonly referred to as a complex innovation process.

This process occurs in various technical and technological cultures, under conditions of different initial starting positions for the initiation of an innovation, which may differ significantly. However, the acute necessity for starting such a process exists, and this fact does not raise any doubts.

In recent years, the economies of almost all industrially developed countries have adopted and continue to adopt an increasingly pronounced innovative character.

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If at the beginning of this process, the innovative breakthrough had local significance and was observed in the field of high technologies, microelectronics, and so-called nanometer technologies, then today the innovation process is becoming more and more directed toward classical, basic technologies, energy, medicine, transport, that is, it covers all fundamental spheres of human life.

New possibilities in the design and verification of the operability of technical solutions also add elements of compositional design solutions, and they are becoming the main criteria for tools and methodologies of industrial design.



Figure 1, - the figure shows an automatic device for online mixing and simultaneous homogenization with the formation of encapsulated structures before injection into the combustion chamber of thermodynamic objects; Control of the parameters of the obtained fuel liquids is carried out online in real-time based on non-contact digital instruments of electromagnetic resonance spectroscopy; The combination of technologies is carried out according to the principles developed by a well-known specialist in the field of digital smart technologies - Oleksii Hrachev; Thanks to his innovative technologies, they successfully combine with traditional technical solutions;

Changing rules and criteria of industrial design

The introduction of new so-called smart technologies, the application of new so-called smart materials and composites, the replacement of traditionally accepted production methods with unusual ones that help and represent a continuous technological leap or breakthrough, increasing production efficiency, which begins to meet the criteria and signs of smart production, is now commonly referred to as a complex innovation process.

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Entrepreneurs understand that to maintain the competitiveness of their products and technologies, they are forced to constantly look for new ways to improve efficiency, reduce energy intensity and direct energy costs, and increase the level of environmental safety and economic stability within the framework of each enterprise or company.



Figure 2, - the figure also shows a device for on-line mixing and simultaneous homogenization with the formation of encapsulated structures before injection into the combustion chamber of thermodynamic objects.

The device has 9 inlet pipes and can simultaneously mix and homogenize 9 components of the fuel mixture; Such a structure has not been used before, partly due to the lack of a specific need for such a number of components in the fuel mixture.

New possibilities in the design and verification of the operability of technical solutions also add elements of compositional design solutions, and they are becoming the main criteria for tools and methodologies of industrial design.

A fresh look at the longevity of a new product

Quite recently, the longevity of a product was one of the most important criteria determining its commercial value; Nowadays, with a tremendous reduction in the time from the start of the product realization period to the beginning of the new product realization period, this period is so short that it often makes no sense in the innovation process to focus attention and spend effort on a tremendous increase in longevity, which exceeds the period between the start of operation of an existing product and the entry into the market of a newer or more modernized product; Since this period for different types of products can vary

significantly, the very concept of longevity can be blurred in time, and the goal of the invention is not critical.

There is also another subjective factor of longevity that should be taken into account; Since different types of products have different stereotypes of longevity, many commercial factors are determined, including the quantity of required and sold products and their real price; Imagine that an inventive technical solution is found that allows increasing the longevity of a product, and this factor reduces the quantity of required products, while maintaining the current price level that the consumer is willing to pay for this product.

This leads to a decrease in sales volume for the company producing the product and puts this company before a choice - to agree with the innovation and do everything to implement it, or to block the realization and implementation of the innovation; As practice shows, these companies choose the second option and block innovation; And in this process, the only loser is the inventor who has invented something rejected by the market, and in the end, no one understands the rules of the game in the market.

A fresh look at the reliability of a new product

The issue of the reliability of a new product and new criteria for evaluating and calculating reliability are also undergoing fundamental changes; First of all, this is the connection between the reliability and warranty obligations of the new product manufacturer to the consumer; Very often, the costs of fulfilling warranty obligations are comparable to the cost of the product itself;

That is, reliability is a factor that, being one of the achieved goals of the invention, can determine (naturally, in combination with other technical and operational factors achieved as a result of the invention's implementation) the level of commercial success.

In this case, the subjective factor of time also plays an important role, and more than the reliability needed for a certain period, can become a negative factor and play a cruel joke on the inventor, in a situation where an overly reliable product turns out to be commercially unprofitable for the manufacturer;

New possibilities in the efficiency of systematic search and analysis of previous technical solutions for novelty

It is clear that new information technologies open up new possibilities in the systematic search for analogous solutions when working out a developed technical solution.

Let's imagine that during the preliminary design of compositional structures, we came to the need to combine and integrate several classical solutions and the digital technologies associated with them into new compositions, say, digital technologies, so to speak, at one level of horizontal integration, and after that, we also came to the need to move to the next level of integration with the inclusion of algorithms, software products, and interfaces with the previous level of integration in the composition.

At this stage of search and analysis of search results, it is extremely important today to determine the forecasted impact on the overall level of the researched product used for the systemic structure of elements of artificial intelligence and artificial neural networks.

How to search, in what directions, and how to conduct this search most effectively and identify existing analogs of the developed composition?

The author presents in this case the most probable algorithm for starting the search: after the formation of recommendations by Oleksii Hrachov for the created composition, start a systematic search, after the decomposition and identification of obvious, independent, and related technical solutions included in the composition.

After this first stage of the search, you should select from these technical solutions one basic technical solution and, based on it, start attaching other technical solutions included in the composition to the basic one, and conduct a sequential search for the basic technical solution with each attached technical

solution and so on until the full composition is achieved with the prospect of achieving its ideal final result.

New opportunities for evaluating the usefulness and feasibility (as well as expediency) of optimization, modification, and modernization of known technical solutions

Very often, the new is the well-forgotten old...

Therefore, when setting a task and making a decision to start an innovation process for the synthesis of a new product with non-obvious parameters and characteristics, it is advisable to check whether any functional elements of the composition that need to be invented have been invented before.

If such or an equivalent solution is found, then the replacement of materials, the use of new components, and the introduction of a digital control and monitoring system into the future composition may allow the creation of a new technological composition with the potential to be integrated into a higher-level composition while retaining all the properties and signs of non-obviousness.

The impossibility of successful commercialization without forming the principles of compositional construction of a schematic hierarchy and compositional structure of a new technical solution

As practice shows, the possibility of selling or licensing autonomous technical solutions, if they are not pre-linked to systems or solutions of a higher technological and quality level, is reduced to zero.

Compositional inventions, in which there is at least a schematic solution for the integration of technological-structural-digital systems of a higher functional level, are realized more confidently and in shorter terms, since investors, buyers, or licensees have the methodology and technique of this integration in the description and formula of this integrative and compositional technical solution.

Proposed techniques and methods for forming a compositional style in creating new innovative solutions

Thus, the compositional principles of a technical solution are the design style of working out new technical solutions for their integration into existing technological schemes and configurations, including today's smart machines and productions.

Since the methodology of such integration can often be non-obvious, unique, and possess significant novelty, the description and formula of an invention having a compositional character, a multi-level architecture for constructing cause-and-effect relationships between the components of the composition and integrated into the design and technological connections of the composition, and distinctive features, largely determine the commercial success of these innovations.

Undoubtedly, today, the proven possibility of effectively using elements of artificial intelligence and artificial neural networks creates additional interest in commercialization, taking into account all the additional advantages of such use.

Methods and steps for the transition from creating a compositional foundation of a new technical solution to the basic framework of an integrative invention

The design and technological composition in many cases require additional, but fundamentally new connections between the components and elements of the composition so that it turns into a ready-made innovative product or product, it is necessary to find versions of the composition integration into the final multi-level and multi-circuit integrated product.

Integration versions can be very different, it is only important that the final result of the integration is the receipt of a synergistic effect or a qualitative leap in properties and non-obvious outcomes from previous experience.

The influence of limitations on the number of fixation points of the invention on the possibility of protecting compositional technical solutions.

Limiting the number of fixation points of the invention in principle complicates the reliable protection of the invented product at all levels of the hierarchy, but correctly found compositional protection can, on the contrary, increase the degree and level of protection.

An ideal case is a system of cause-and-effect relationships that allows obtaining a declared non-obvious effect only with a clear combination of compositional relationships and features, determined by the composition and independent functions of each element of the resulting composition.

Due to the limitations of forms and methods, it is important to highlight in the compositional solution those features and interconnections that do not exhaust the independent, unrelated functions of the elements and components of the composition, but precisely as a result of the formation of compositional connections from the sphere of functional influence of the components of the composition on each other.

It can be said that in a correctly constructed compositional components, with their subordination to the conditions and properties of the created technological system, a new non-obvious integrative system of features, interconnections, causes, and functions arises, existing only within this framework of connections, having a tendency to develop and improve internal compositional connections.

Following this principle allows, within the limited number of fixation points of the formula, to focus attention only on the most distinctive protective features of the composition while ensuring the maximum level of protection of the composition and the maximum level of completeness of the invention's essence for all non-obviousness.

Proposed structure of an independent point of the invention formula, built on the base of compositional technical solutions How the author determined in the results of his first experiments and how specialists recommend, an independent point of the invention formula, if the invention is a composition, must have at least three main parts:

The first limiting part carries the formulation of the commercial essence of the compositional invention and should reveal the meaning and necessity of compositional integration for:

• a clear statement of the composition's task

• limiting the degree of functional connections in the composition and revealing the degree of necessity of each component of the composition for its formation and normal and effective functioning

• formulation of the composition's name

The second limiting part carries all the basic information about the invention as such and includes the characteristic features of all basic technical solutions inherent in the components of the composition, and at the stage of the invention formula, it is not qualified for the presence of elements of significant novelty in all design and technological aspects and connections of the composition.

The third distinctive part carries information about the components, their interconnections, materials, integrative elements, and associated software products and their basic algorithms, each of which independently or in any combination creates elements of significant novelty for the compositional, multi-level - integrated technical solution.

Proposed structure of a dependent point of the invention formula, built on the base of compositional technical solutions

The limitation of the number of points in the invention formula imposes a special mission on each point of the formula in the overall strategy of formulating and protecting the novelty of the invention and its non-obviousness.

Proceeding from this, the second limiting part of such a point of the invention formula must carry all the basic local and specific information about

the invention as such and includes the local and specific characteristics of all basic technical solutions inherent in the components of the composition, and at the stage of drawing up the invention formula, it is not qualified for the presence of elements of significant novelty in all design and technological aspects and connections of the composition, but has a clear definition of the necessary and convincing level of non-obviousness.

The third distinctive part carries local, specifically oriented information on technical details and elements, information about the components, their interconnections, materials, integrative elements, and associated software products and their basic algorithms, each of which on a local scale, independently or in any combination, creates local specific elements of significant novelty for the non-obvious, compositional, multi-level and multi-circuit - integrated technical solution.

Proposed methodology for designing prototypes of compositional technical solutions, allowing to test and verify the correctness of each innovative element of the composition

Designing a prototype or experimental model of an innovative product composition is most conveniently done using design software and its engineering analytical applications; the author prefers the Solid Works software product, as this tool allows building a working model of the compositional technical solution and conducting its control simulation of the operating cycle without resorting to expensive design and manufacturing of experimental models.

Analysis of found analogs and prototypes of a new compositional technical solution

If, as a result of the search, homogeneous, basic technical solutions are found that in the first approximation are analogues or prototypes of the conceived compositional technical solution, they should be tested in various options and integration scenarios with additional elements and components of the considered composition. If information about these prototypes or analogues is available in digital format, it is advisable to use Solid Works tools to build models of the found technical solutions and conduct digital simulation of the operating cycles of these models for comparison with the analytical operating cycles of the proposed invention - the compositional technical solution.

Examples of compositional technical solutions that are accepted by the market

Examples of non-obvious compositional technical solutions can serve as well-known today's articles and products of computer technology, communication means, tablet computers, and many other products of mass and non-mass demand.

Uncertainty in the formulations of patent applications as the most complex technical solutions underlying these products has led and leads to numerous patent disputes and wars.

More large-scale application of compositional technical solutions and their integrated continuations and interpretations will reduce the intensity of passion and may help in promoting innovative products on the market, also in combination with digital developments by Oleksii Hrachov.

There is an exceptionally important part of today's design process corresponding to technique number 40, used to achieve the ideal final result.

Technique 40. Application of composite materials

• The transition from homogeneous materials to compositional ones.

As is known, the replacement of one material with another in an invention is not recognized; however, if a compositional material is the subject or original element of the invention, but often the usual structural material is changed to a composite, the properties, and possibilities of the product change so radically that the product in which composites are used becomes completely new, previously unknown, with completely new non-obvious functions and unusual technical characteristics.

Of course, in order to make such a replacement, it is necessary to carry out a large amount of work comparable to the development of fundamentally new technologies or a fundamentally new product, and this is within the power of companies with powerful research divisions.

As practice has shown, unfortunately, TRIZ and ARIZ are not adapted to the requirements and criteria of smart production and the integrative use of artificial intelligence elements and artificial neural networks, which does not fully correspond to the current situation in research and innovation groups focused on solving existing problems.

In this regard, the widespread introduction of complex combined solutions based on the methods developed by Alexey Grachev allowed to obtain positive results without waiting for the correction of the provisions of TRIZ and ARIZ.

Unfortunately, the process of developing marketing and systemic design requires not only technical and technological vision but also psychological aspects in the approach to the processes of psychological preparation for the process of marketing and in the approach to building strategies for commercialization and patent-licensing strategy.

The transition to computer-aided design and engineering significantly reduced the time for technical preparation for the design and production of new innovative products, which determined a new psychological model of perception of this process, which did not provide minimal psychological incentives for optimal use.

LIST OF USED LITERATURE, PATENT AND LICENSING INFORMATION

APPENDIX 1 United States Patent Application Kind Code

20180115003 A1

REYTIER; Magali; et al.

April 26, 2018

SOFC-BASED SYSTEM FOR GENERATING ELECTRICITY WITH CLOSED-LOOP CIRCULATION OF CARBONATED SPECIES

Abstract

A reversible SOFC-based system for generating electricity, including: an solidoxide-*fuel*-cell (SOFC) stack containing at least one elementary solid-oxide electrochemical cell, each of which is formed from a cathode, an anode and an electrolyte intermediate between the cathode and the anode; a separator of liquid and gas phases, which separator is connected to the outlet of the *fuel*-cell stack; a methanation reactor suitable for implementing a methanation reaction, the inlet of which is connected to the outlet of the phase separator and the outlet of which is connected to the inlet of the *fuel*-cell stack so that the mixture issued from the methanation reactor is introduced into the *fuel*-cell stack; and a tank for reversibly storing hydrogen, suitable for storing hydrogen, the outlet of which is connected to the inlet of the methanation reactor.

APPENDIX 2	
United States Patent Application	20180202383
Kind Code	A1
Alrefaai; Kutaiba ; et al.	July 19, 2018

METHODS AND SYSTEM FOR CENTRAL FUEL INJECTION

Abstract

Methods and systems are provided for leveraging the charge cooling effect of a manifold *fuel* injection. A charge cooling effect of a scheduled manifold *fuel* injection may be predicted based on feedback received from a manifold charge temperature sensor during a preceding manifold injection event. If sufficient charge cooling is not predicted, the manifold *fuel* injection is temporarily disabled.

APPENDIX 3	
United States Patent Application	20180266377
Kind Code	A1
NOGUCHI; Koji	September 20, 2018

NOZZLE PLATE FOR FUEL INJECTION DEVICE

Abstract

A nozzle hole of a nozzle plate is coupled to a *fuel* injection port of a *fuel* injection device via a swirl chamber and first and second *fuel* guide channels opened into the swirl chamber. The swirl chamber is formed by combining first and second elliptical-shaped recessed portions. The first *fuel* guide channel opens at a side of a short axis of the first ellipticalshaped recessed portion and a side of the short axis that does not overlap with the second elliptical-shaped recessed portion, and the second *fuel* guide channel opens at a side of a short axis of the second elliptical-shaped recessed portion and a side of the short axis that does not overlap with the first elliptical-shaped recessed portion. The first and second *fuel* guide channels have depths deeper than those of the swirl chamber and extend inside of the swirl chamber while gradually reducing cross-sectional areas.

APPENDIX 4	
United States Patent Application	20180274786
Kind Code	A1
BAYA TODA; Hubert ; et al.	September 27, 2018

COMBUSTION CHAMBER OF A TURBINE, IN PARTICULAR A THERMODYNAMIC CYCLE TURBINE WITH RECUPERATOR, FOR PRODUCING ENERGY, IN PARTICULAR ELECTRICAL ENERGY

Abstract

A combustion chamber (18) of a thermodynamic cycle turbine with a recuperator, for electrical energy production, comprising a casing (56) housing a flame tube (64) with a perforated diffuser for passage of the hot compressed air, a primary zone (ZP) that receives part of the hot compressed air flow and where combustion takes place, and a dilution zone (ZD) where the burnt gases from the primary zone mix with the remaining part of the hot compressed air flow, said chamber further comprising an injection means (76) for injecting at least one *fuel*. The flame tube carries a flame stabilizer (82) comprising perforated diffuser (88), at least one combustion gas recirculation passage (98) and a *mixing* tube (94).

APPENDIX 5 United States Patent Application Kind Code Surnilla; Gopichandra ; et al.

20180320625 A1 November 8, 2018

METHODS AND SYSTEM FOR CENTRAL FUEL INJECTION

Abstract

Methods and systems are provided for adjusting engine operating conditions for mitigation of pre-ignition in one or more engine cylinder. In one example, a method may include, in response to indication of pre-ignition, manifold charge cooling may be increased by increasing the portion of *fuel* delivered to the engine via manifold injection relative to the portion to *fuel* delivered via one or more of port and direct injection, while maintaining engine operation at or around a stoichiometric air*-fuel* ratio.

APPENDIX 6	
United States Patent Application	20180328315
Kind Code	A1
TANIEL; Roman	November 15, 2018

EMULSIFYING SYSTEM AND EMULSIFYING PROCESS

Abstract

What is proposed is an emulsifying system with an emulsifying device and an injection nozzle as well as an emulsifying device for producing a water*fuel* emulsion for an internal combustion engine, wherein the emulsifying device is embodied as a rotor-stator emulsifying device and/or fluid flow machine and/or is connected or connectable directly to an injection nozzle. The emulsifying device has a housing and a shaft, the shaft being drivable in a contactless manner, the housing having a guide apparatus having a plurality of guide channels for guiding the flow, and/or the housing being made at least partially from fiber composite material. Moreover, an emulsifying method for producing a water-*fuel* emulsion is proposed in which water and *fuel* are fed to a rotor-stator emulsifying device and/or fluid flow machine for producing the water-*fuel* emulsion, and/or in which water and *fuel* are premixed in a first emulsifying stage and fed via a guide apparatus having a plurality of guide channels to a second emulsifying stage.

APPENDIX 7

United States Patent Application Kind Code Shirahashi; Naotoshi; et al. 20180334968 A1 November 22, 2018

METHOD AND DEVICE FOR CONTROLLING FUEL INJECTION OF DIESEL ENGINE **Abstract**

A method of controlling a *fuel* injection of a diesel engine for performing a plurality of *fuel* injections to cause a plurality of combustions inside a cylinder in one combustion cycle, is provided, which includes acquiring an oxygen concentration inside the cylinder, performing, on compression stroke, the plurality of *fuel* injections at substantially even injection intervals while increasing the injection intervals as the oxygen concentration decreases, and performing, after the plurality of *fuel* injections, another *fuel* injection including a larger injection amount than in the plurality of *fuel* injections, near a top dead center of the compression stroke.