Технічні науки

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CONCEPT OF AN OPTICAL INFORMATION STORAGE DEVICE WITH A CODING ELEMENT

Optical Multilayer Information Storage Device with a Coding Element Operating on the Principles of Electromagnetic Resonance Spectroscopy

Summary. *In this publication, the author would like to focus in more detail on analyzing the conceptual foundation for innovative information carriers that include a system of contactless encoding and decoding, operating based on the principles of electromagnetic resonance spectroscopy.*

Considering the need for consultations from leading specialists in this field, the author turned to integrative specialist Dmytro Sumtsov, who proposed a scheme and sequence for comprehensive analysis followed by experimental verification, which made it possible to intensify the project as efficiently as possible and achieve significant progress.

Key words: *Innovative information storage device, Electromagnetic spectroscopy, Resonance spectroscopy, Contactless encoding and decoding, Initial, intermediate, and final phases of the process, Structural materials and alloys, Final recording phase, Integral complex indicator, Concentration and conductivity levels, Resonance sensor calibration systems, Selectively extracted indicators.*

In this publication, the author would like to take a closer look at analyzing the conceptual framework for innovative information carriers, which include a

contactless encoding and decoding system operating on the principles of electromagnetic resonance spectroscopy.

Given the need for consultation from leading experts in this field, the author turned to integrative specialist Dmytro Sumtsov, who proposed a scheme and sequence for comprehensive analysis followed by experimental verification, which allowed the project to be intensified and achieve significant progress.

CONCLUSIONS FROM SYSTEMIC ANALYSIS AND PRELIMINARY EXPERIMENTAL TESTING

1. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of various encoding variants.
2. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of encoding variants and can distinguish those same samples that have different storage durations at room temperature.
3. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of encoding in the initial, intermediate, and final phases of the process, and can distinguish those same samples that have different storage durations at room temperature and into which certain doses of other structural materials have been additionally introduced.
4. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of the encoding ring in the intermediate and final phases of the recording process, and can distinguish those same samples that have different storage durations at room temperature and into which certain doses of coating materials have been additionally introduced.

5. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of encoding ring materials in the initial, intermediate, and final phases of the measurement and identification process, and can distinguish those same samples that have different storage durations at room temperature and into which certain doses of insulating materials have been additionally introduced.
6. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of encoding rings in the initial, intermediate, and final phases of the recording and reading process, and can distinguish those same samples that have different storage durations at room temperature and into which certain concentrations of dielectrics have been additionally introduced.
7. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of encoding rings in the initial, intermediate, and final phases of the measurement and control process, which have different levels of concentration and conductivity, and can distinguish those same samples that have different storage durations at room temperature.
8. The resonance control technology is capable of distinguishing with the required accuracy, based on the integral complex indicator, samples of encoding ring materials in the initial, intermediate, and final phases of the identification process, which have different levels of concentration, and can distinguish those same samples that have different storage durations at room temperature, and can simultaneously evaluate and distinguish the level of electrical conductivity of those same samples.
9. The experiments confirmed the correctness of the selected strategy for preliminary testing, which involves at least a two-step calibration system for

the resonance sensor — at the first step, at the level of the integral signal based on the characteristics of resonance phenomena in the encoding ring, and at the second step — at the level of a selectively extracted combination of resonances of the most prominently manifested frequency–capacitance and amplitude complex characteristics in the studied samples, characteristic for each of the controlled parameters and characteristics.

10. Overall, the system demonstrated high sensitivity to incoming signals, high selectivity in signal separation and comparison, sufficient repeatability of results, stable operation according to the adopted methodology, sufficient accuracy in determining the integral components of signals, sufficient autonomy and resistance to external influences and interference, and the capability for both the operator and artificial intelligence to confidently and stably control the system without formal specialized professional training.
11. The results of the preliminary studies justify moving to the next phase of the project — toward the application of selective control for all necessary encoding and decoding parameters and to the fundamental design of all necessary applications for resonance sensors.
12. The results of tuning and changing the operating parameters of the sensors, the general nature of the control and digital testing process of the sensor and its entire infrastructure, allow us to conclude the possibility of confident and guaranteed remote control of sensor operation — both individual and grouped — with synchronization of their primary measurement and analytical functions, as well as the possibility of adapting the sensors in accordance with the specifics and varying conditions at industrial enterprises.

To enable the integration of such an information storage device into a system, the capacity of the storage medium must be significantly increased.

A preliminary analysis of such a universal-type system is proposed.

The first and most important control and management sector is the control and analysis of all materials entering the process and their combinations.

As is well known, in the input stage of processes (for example, in energy equipment), the following working parameters are regulated and monitored:

- fuel consumption
- fuel injection pressure
- specific fuel consumption
- the stoichiometric ratio of air to fuel consumption
- the additional amount of air relative to total fuel consumption

Since the amount of air directly affects the efficiency of energy equipment, this dependence is monitored and precisely adjusted throughout the entire operating cycle, requiring significant processing power from control processors and computers.

Let's now turn to the principles of constructing multilayer information storage disks with a full cycle of encoding and decoding.

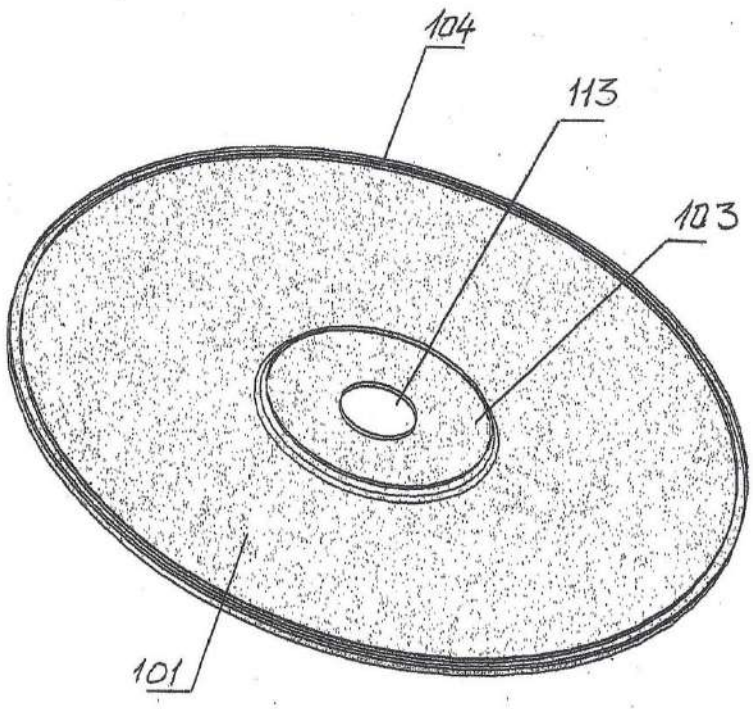


FIG.1A

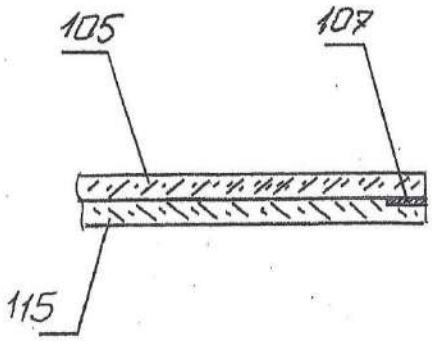


FIG.1B

As can be seen from the model, the disc has practically the same dimensions and elements as a standard disc, with the key difference being the presence of an encoding ring 107 located along the disc's perimeter.

This placement of the encoding element offers several significant advantages:

First of all, it presents no technological challenges during production, since the standard disc manufacturing process involves bonding two disc halves together. This makes it possible to embed ring 107 into the disc without changing the process or equipment, using the standard production technology and tooling.

There are many technological options for producing and attaching ring 107, so modifying discs only requires choosing the most optimal existing method.

Additionally, integrating this system into multilayer disc production should not encounter any serious technological obstacles.

Let's assume that the outer diameter of the disc remains unchanged.

The placement and geometry of encoding ring 104 also remain essentially unchanged, which allows for the potential integration of a method known as layer-by-layer polymerization and formatting into the disc manufacturing process.

But the effect can be multiplied many times if, after polymerizing each layer, the formatting is done via pressing.

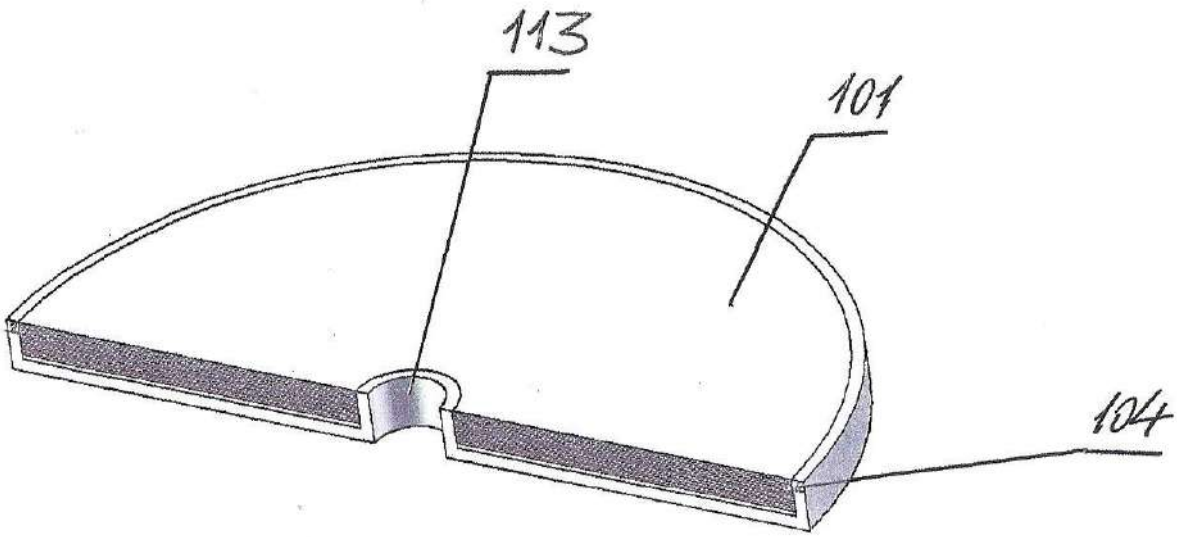


FIG.1C

This could reduce formatting time by approximately a factor of 1000 and dramatically increase formatting precision.

Such experimental discs have already been produced and tested in Japan.

In the experimental models, 100 layers were created, and the test results exceeded all expectations.

Since multilayer discs made from monolithic optical material require high-powered laser diodes for formatting and subsequent use, the layer-by-layer

polymerized discs require no optical formatting at all and can operate using lower-power diodes.

Reducing the required laser diode power drastically reduces thermal loads on the system — which in turn greatly improves reliability and durability.

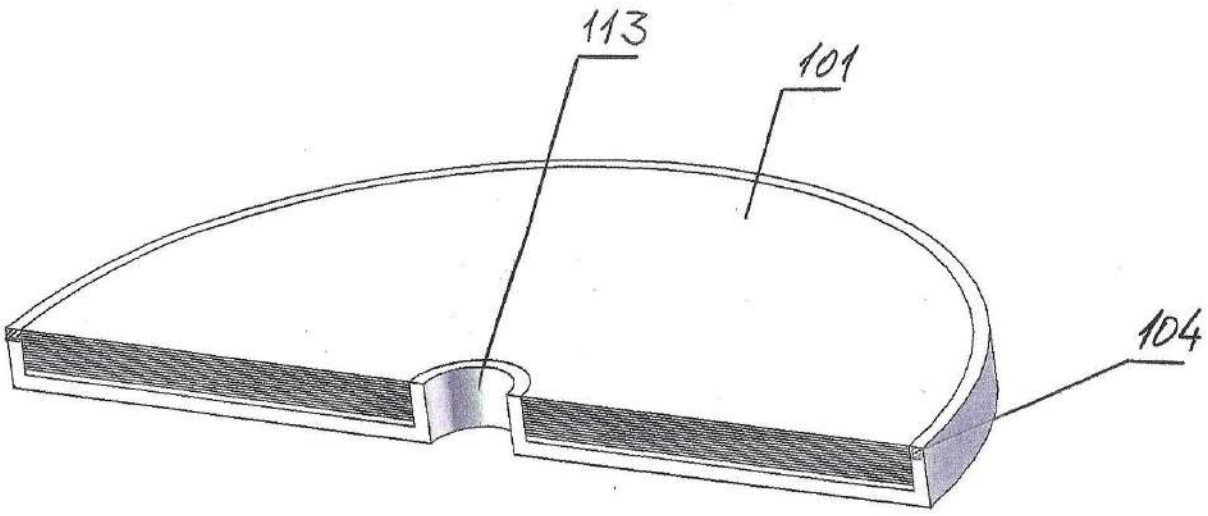


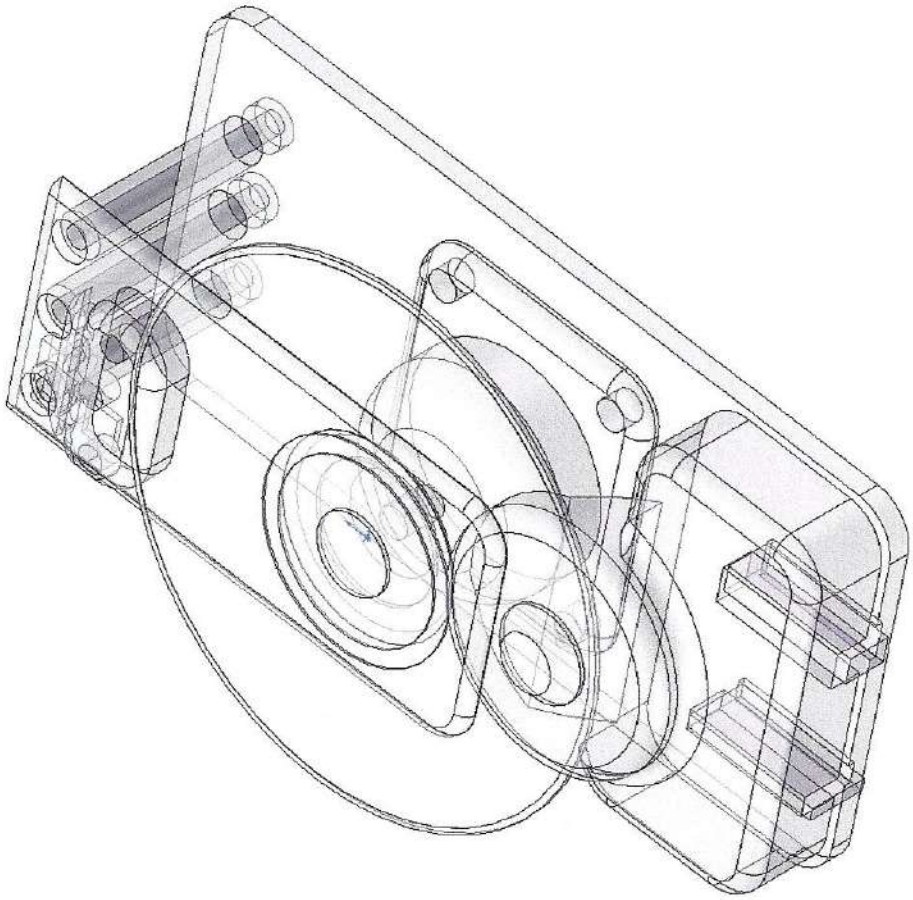
FIG.1D

Many cases have been documented where standard discs deform and fail due to mechanical damage or thermal stress.

The press-based formatting process used in the new design allows for the introduction of mechanical stress into the disc, which improves its geometry and overall structural strength. This has a positive effect on the precision of information reading.

Of course, during the formatting processes, many characteristics and technical parameters are monitored — especially their real-time interdependencies. The precision of laser diode beam geometry plays a crucial role in forming the overall

technical characteristics of subsystems and their compatibility with the parameters expected by higher-level systems.



Based on the overall information encoding–decoding concept embedded in the encoding rings of the discs, the processor and computer drive should include sensor systems for reading encoding signals, tightly integrated with the data reading systems.

To ensure full stability of the process, these systems must be both statically and dynamically balanced and reliable.

However, the structure of industrial energy companies (especially smaller ones) often does not allow for maintaining specialized departments to service processors and related systems within power generation infrastructure.

This becomes even more critical considering that these departments, while responsible for cybersecurity, must also ensure the general operability of the equipment and its components — including the encoding and decoding mechanisms for the storage devices.

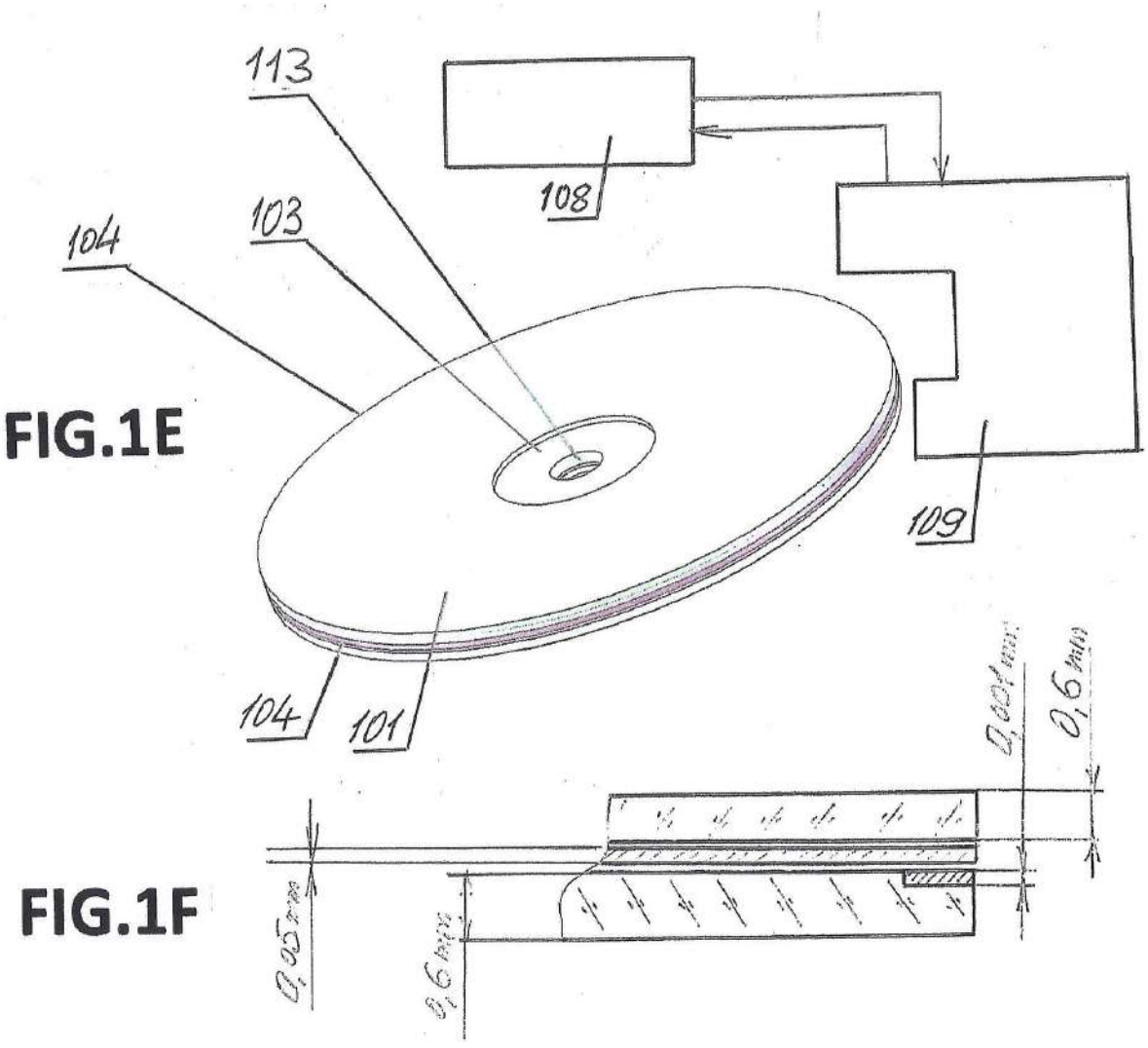


FIG.1E

FIG.1F

The presented model shows the calculated geometric and dimensional characteristics of a system potentially capable of operating with discs holding up to 1 terabit of data.

As seen in the cross-section, the disc's dimensions remain within those of a standard optical disc, but it includes an encoding ring with a thickness of just 1 micron.

Since the encoding ring can be manufactured using electrolytically deposited metal (e.g., nickel), it also plays a significant role in strengthening the disc structure.

This mechanical strength is especially important to prevent geometric deformation.

Because the information is distributed across 100 or more layers, even a micron-scale distortion can cause read errors or at least inaccuracies in retrieving the data.

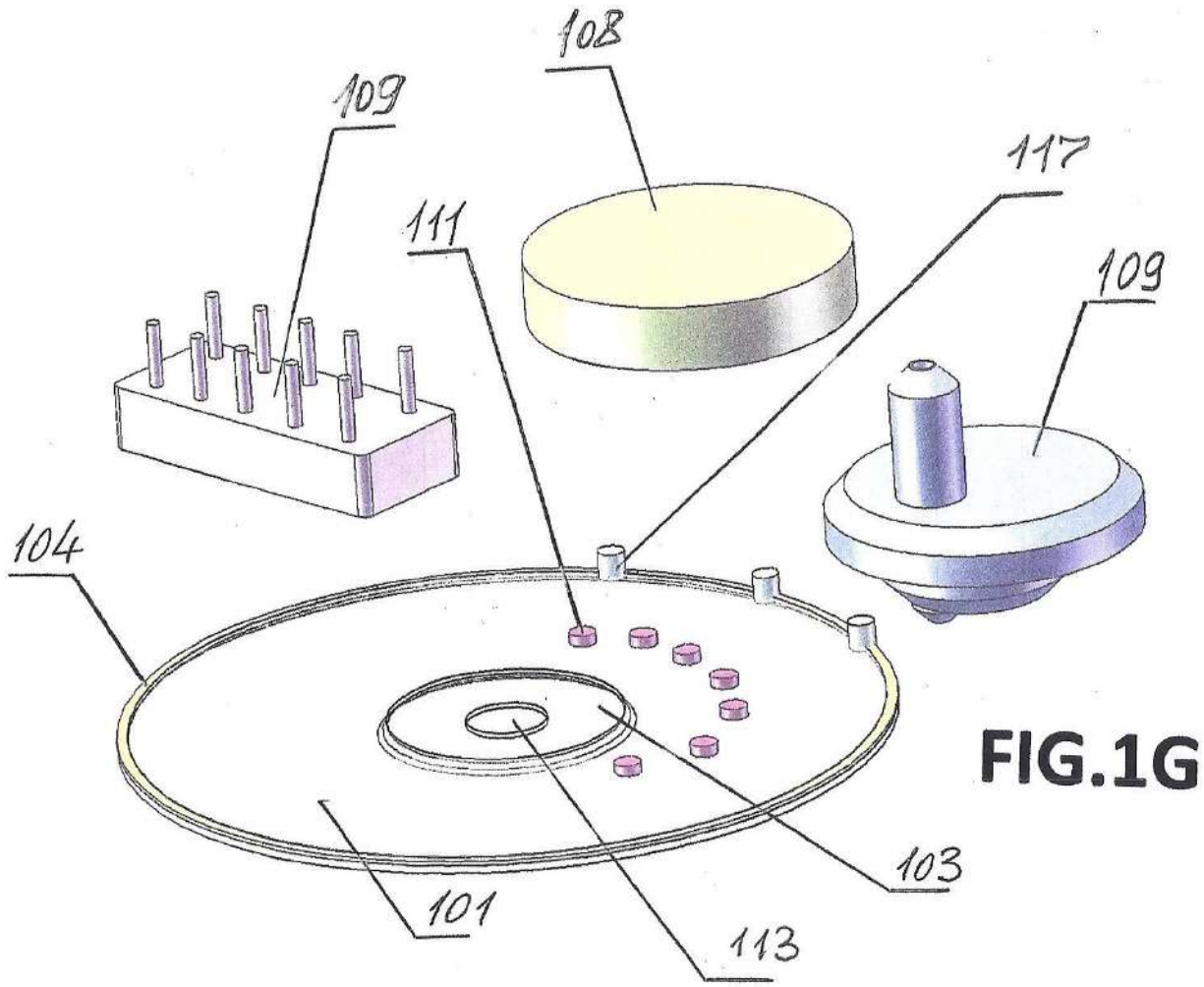


FIG.1G

For standard discs, which don't affect high-precision processes, minor geometric deviations usually don't matter much. But in industrial energy systems, where even slight delays in control and monitoring systems can lead to accidents or major financial losses, this becomes critical.

Since the mini-solenoid acting as a sensor is relatively inexpensive, it was decided that the reading system should include at least three sensors.

This configuration significantly enhances reliability and — crucial for energy systems — provides faster response times and increased reactivity to even the smallest changes in all input and output factors considered when forming control and monitoring algorithms for energy equipment.

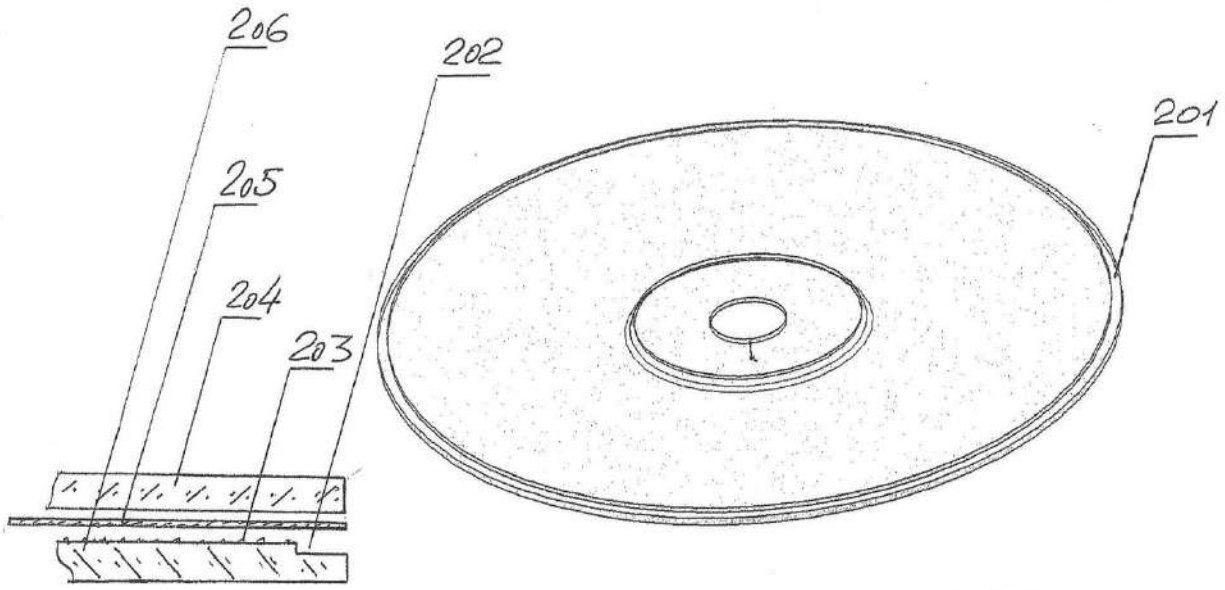


FIG.2A

FIG.2B

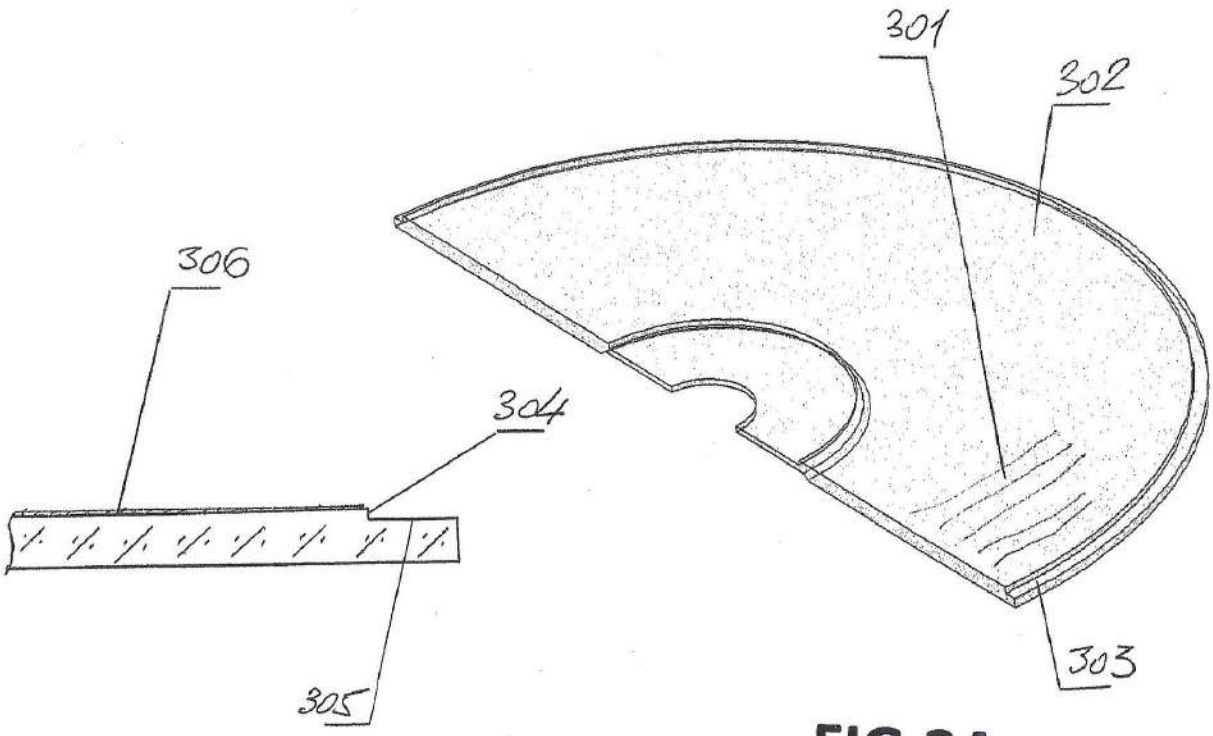
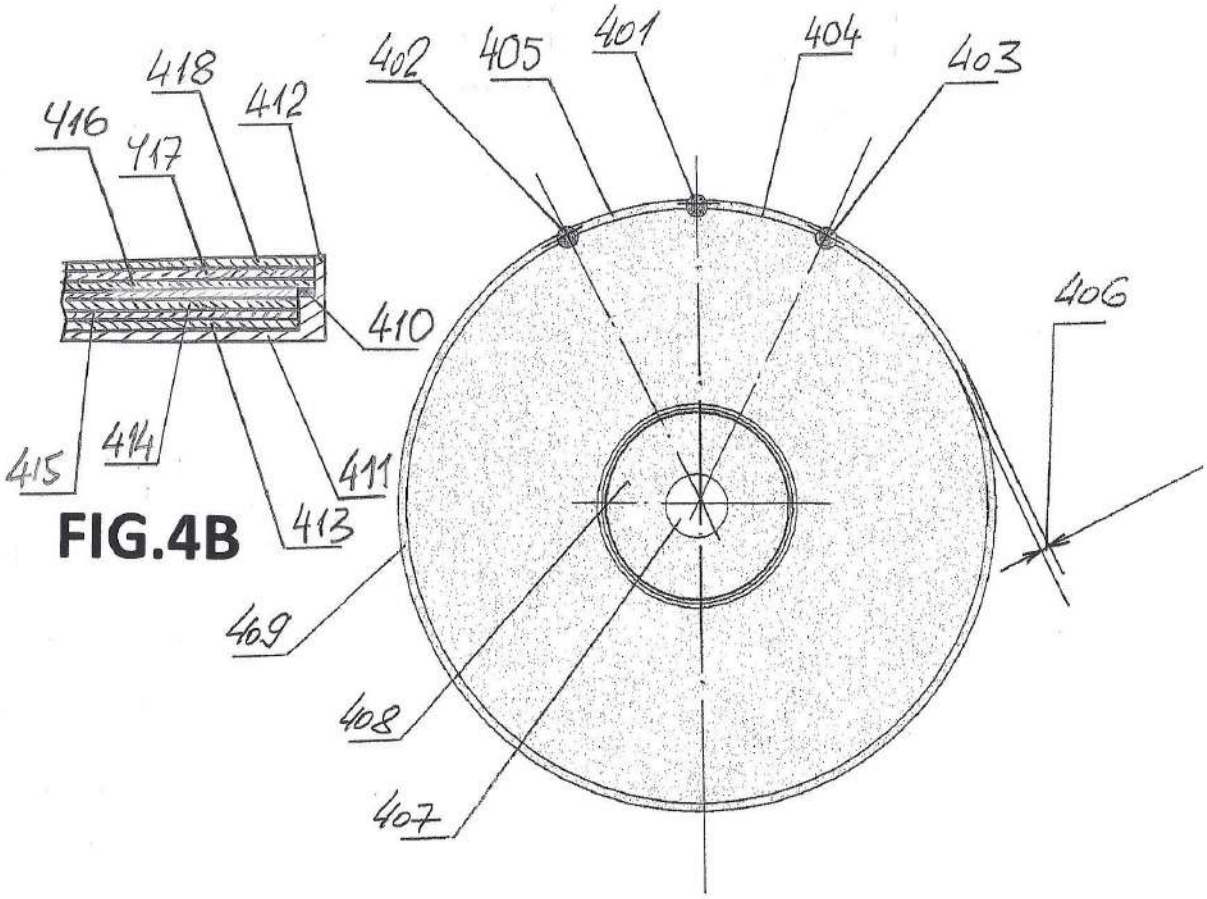


FIG.3A

FIG.3B

Energy equipment, due to its high cost, has a much longer operational lifespan compared to that of computer and processor-based systems.



Therefore, the longevity of such digital systems becomes one of the most critical factors considered when analyzing the need for modernization of the core technological equipment used in power plants.

All design decisions made for optical discs with information encoding do not reduce the overall durability of control and monitoring systems. However, the need for redundancy in durability applies to the reading devices as well, which in turn requires a rethinking of the design and fundamental schematic-kinematic solutions of the drive units — incorporating potential for further upgrades and modernization, especially in connection with the introduction of multilayer optical discs with capacities of 1 terabit or more.

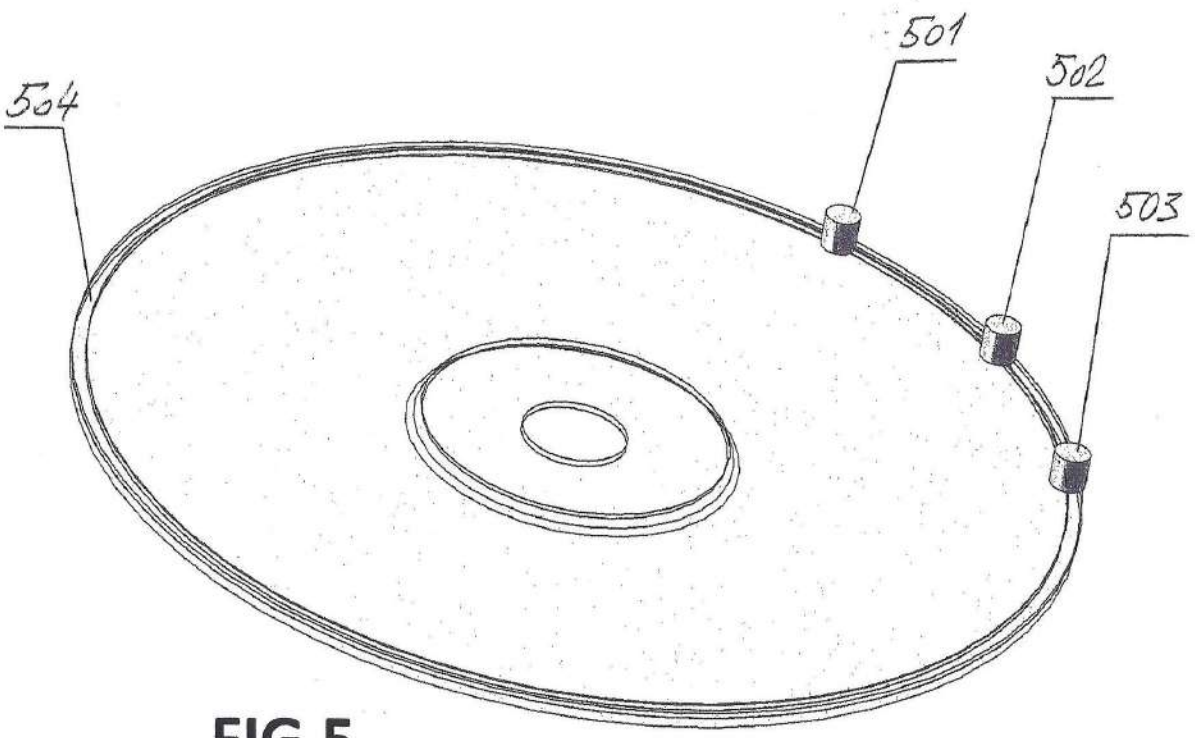


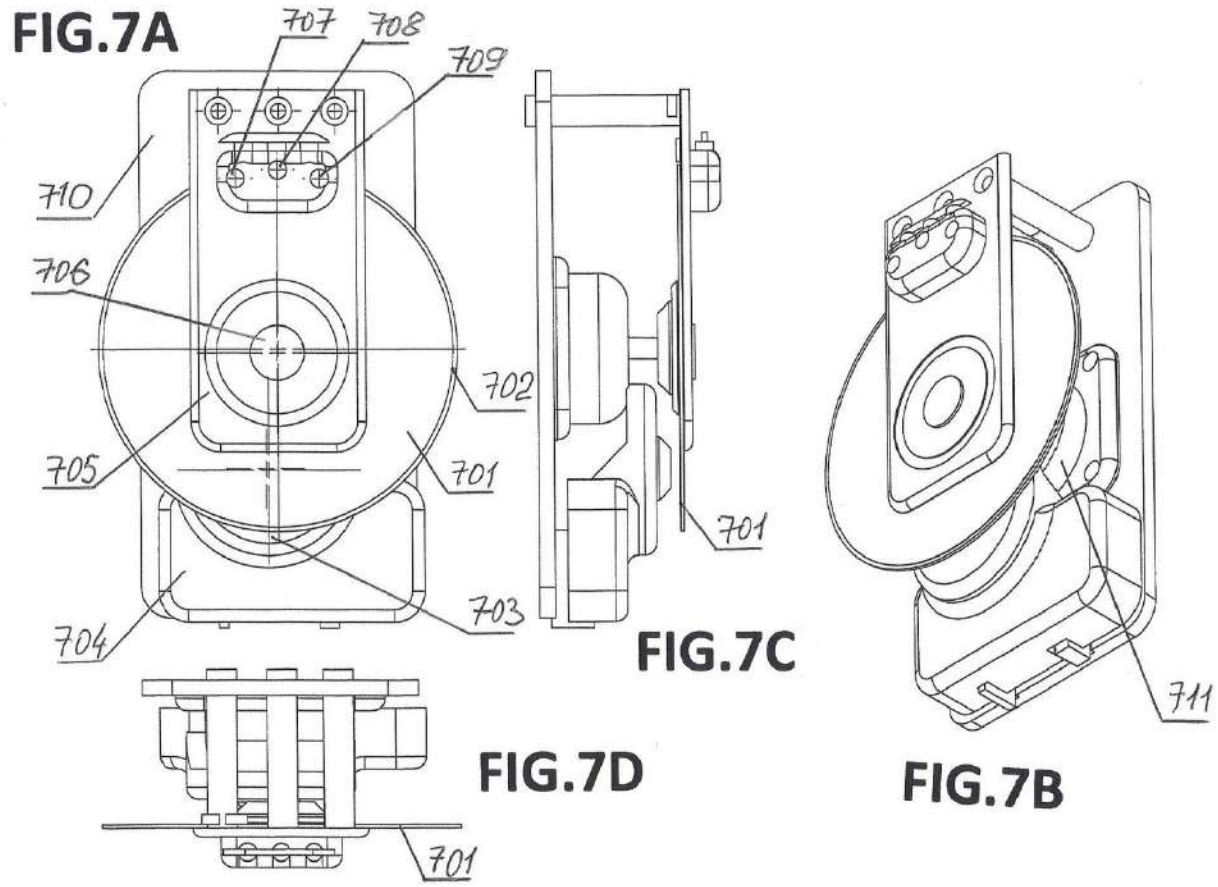
FIG.5

The decision to use a system of three resonance sensors — 501, 502, 503 — for reading the thickness of the encoding ring (504) significantly improves reliability and speed. When combined with dynamic and kinematic stability, this ensures high integrated commercial efficiency for the upgraded energy system — all with minimal additional maintenance costs.

Yet, despite the commercial potential, this solution — in its simplicity — enables a fundamental transformation in how all components of the system interact, while maintaining elegant design, strengthening all operational characteristics, and especially enhancing — reliability, stability, and operational precision.

As a result of the decision to modernize the system, it becomes necessary to systemically modernize the drive units as well. This involves applying state-of-the-art reading methods under conditions of extremely high data density, including in three-dimensional optical disc structures.

To support this, two conceptual designs and configurations of the drive are considered — based both on existing kinematic principles and on innovative technical solutions.



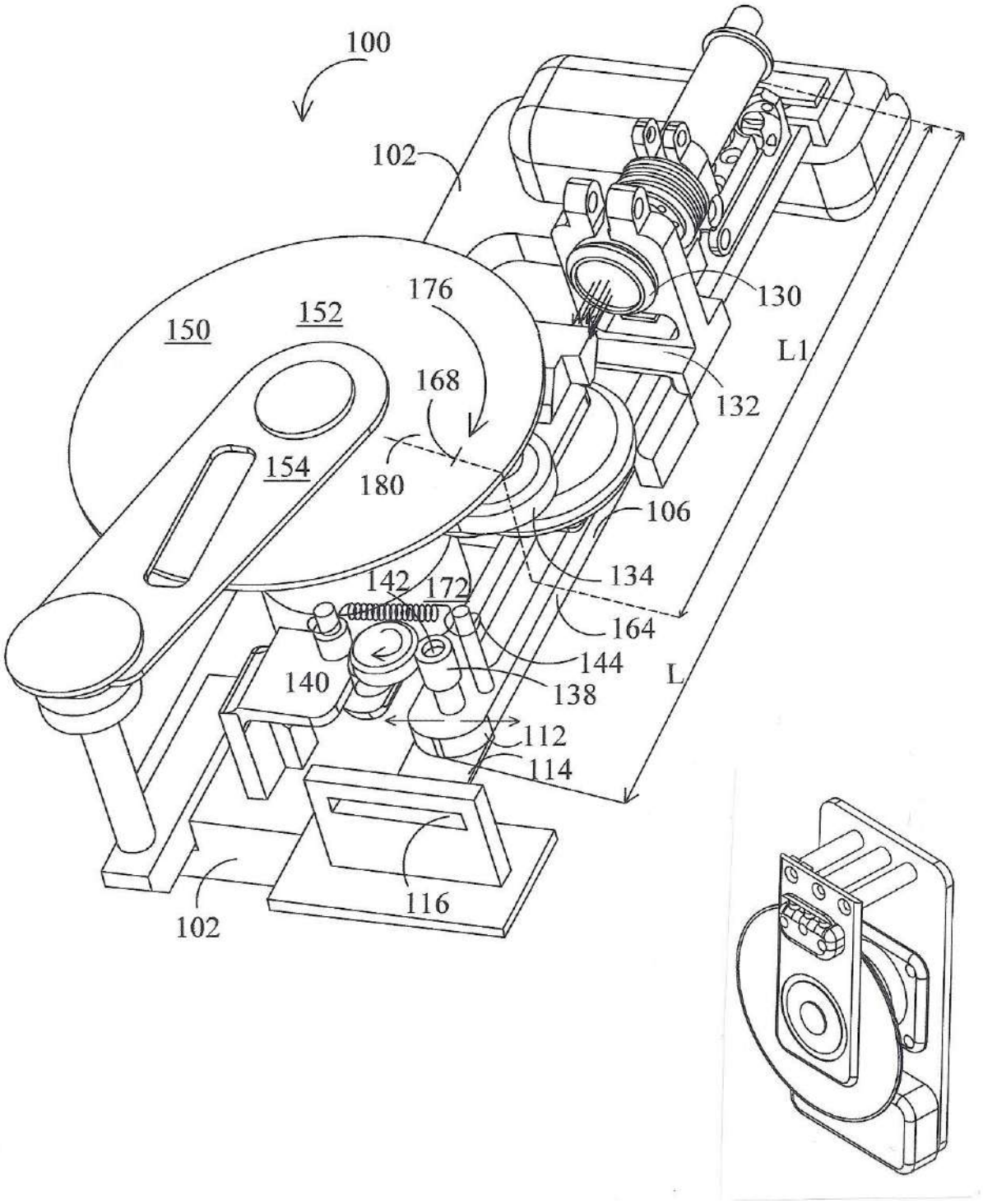
In the traditional version, it is critically important to define the positioning and placement of the three electromagnetic resonance sensors — numbered 707, 708, and 709.

As shown in the diagrams, symmetrical placement of these sensors allows for maintaining the current level of complexity while achieving a much higher degree of symmetry in the primary mechanisms of the drive. Ultimately, this should result in improved reliability and durability, simplified mechanical and schematic design solutions.

The use of multilayer discs, regardless of their manufacturing method — whether it's a monolithic disc formatted by a high-powered laser diode, or a layer-by-layer polymerized disc where formatting marks and optical tags are printed on each layer — leads to the necessity of deep modifications to the drive. Most importantly, this involves reworking the kinematic principles of how the main mechanisms function, particularly the positioning system of the laser head, and the synchronous rotation mechanism of the multilayer disc.

The models shown in the following sections illustrate a drive design that includes a swinging mechanism for positioning the laser diode into the active zone, along with its stabilization and synchronization systems. These demonstrate the practical feasibility of such a modernization for integration into energy equipment.

Drive model for the proposed version of the information storage device. The drive concept was proposed by Dmytro Sumtsov, based on his positive experience and expertise in this field.


100
102
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L1
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180
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112
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116
102

Fig. 8.

References, patent and licensing information

APPENDIX 1-1

United States Patent Application	**20220209868**
Kind Code	**A1**
Frankel; Michael Y. ; et al.	**June 30, 2022**

Software programmable flexible and dynamic optical transceivers

Abstract

An optical transceiver includes an electro***-optic*** front end; a digital-to-analog converter (DAC) and an analog-to-digital converter (ADC) connected to the electro***-optic*** front end; and one or more Field Programmable Gate Arrays (FPGAs) connected to the DAC and the ADC, wherein the one or more FPGAs are connected to one or more of a local memory and a remote storage for loading FPGA bit files, and wherein the one or more FPGAs are loaded with a forward error correction (FEC) encoding app and a FEC decoding app. The FEC encoding app and the FEC decoding app can be selected based on any of an optical application and a standard compliance requirement.

APPENDIX 1-2

United States Patent Application	**20220200699**
Kind Code	**A1**
Heath; Jeffrey Abramson ; et al.	**June 23, 2022**

METHOD AND APPARATUS FOR THE DETECTION OF DISTORTION OR CORRUPTION OF CELLULAR COMMUNICATION SIGNALS

Abstract

A system for troubleshooting signals in a cellular communications network, and in particular, for determining the cause of distortion or corruption of such signals, includes a robotic or other type of switch. The robotic switch can tap into selected uplink fiber***-optic*** lines and selected downlink fiber***-optic*** lines between radio equipment and radio equipment controllers in a wireless (e.g., cellular) network to extract therefrom the I and Q data. The selected I and Q data, in an optical form, is provided to an optical-to-electrical converter forming part of the system. The system includes an FPGA (Field Programmable Gate Array) or the like, and an

analytic computer unit, or web server, and SSD (Solid State Drive) and magnetic ***disk*** storage, among other components of the system. The system analyzes the I and Q data provided to it, and determines the cause, or at least narrows the field of possible causes, of impairment to transmitted signals. The system includes a display which provides the troubleshooting information thereon for a user of the system to review, or other form of a report, and may communicate the analytical findings to a remote location over a public or private internet protocol network.

APPENDIX 1-3

United States Patent Application	**20220187357**
Kind Code	**A1**
Sinsheimer; Roger A. ; et al.	**June 16, 2022**

AUTOMATIC TEST EQUIPEMENT HAVING FIBER OPTIC CONNECTIONS TO REMOTE SERVERS

Abstract

An example test system includes a test head, and a device interface board (DIB) configured to connect to the test head. The DIB is for holding devices under test (DUTs). The DIB includes electrical conductors for transmitting electrical signals between the DUTs and the test head. Servers are programmed to function as test instruments. The servers are external to, and remote from, the test head and are configured to communicate signals over fiber ***optic*** cables with the test head. The signals include serial signals.

APPENDIX 1-4

United States Patent Application	**20220133910**
Kind Code	**A1**
Hu; Yang	**May 5, 2022**

NEUROPROTECTION OF NEURONAL SOMA AND AXON BY MODULATING ER STRESS/UPR MOLECULES

Abstract

Compositions and methods for treating a mammalian subject for an ***optic*** nerve (ON) neuropathy and/or reducing or ameliorating degeneration of axons and/or

soma of RGCs are provided. Aspects of the composition include a mammalian viral vector, comprising a murine g-synuclein promoter, or functional fragment thereof, that promotes expression of a transgene specifically in retinal ganglion cells (RGCs), said promoter in operable linkage with an expression cassette encoding the transgene, wherein the expressed transgene inhibits activity of an expression product of an endogenous pro-neurodegenerative gene involved in an ER stress and/or UPR pathway that leads to axon or soma degeneration in the RGCs. Aspects of the methods include intravitreally administering the composition to treat the subject for the ON neuropathy. A variety of ON neuropathies may be treated by practicing the methods, including retinal ganglion cell degeneration, glaucoma, ***optic*** neuritis, ON traumatic injury and other ON-related diseases.

APPENDIX 1-5

United States Patent Application	**20220034810**
Kind Code	**A1**
Park; David Jaehyun	**February 3, 2022**

DEVICE AND METHOD FOR AN INTRAOPERATIVE CANCER DETECTOR

Abstract

A device for intraoperative cancer detection includes an excitation fiber ***optic*** configured to excite a biological sample as a function of an intrinsic excitation wavelength, an emission fiber ***optic*** configured to detect an intrinsic emission of the biological sample, a tissue scanner module including a display window configured to visualize the intrinsic emission of the biological sample, wherein visualizing further comprises receiving a signal from a tissue scanner representing an intrinsic emission of the biological sample, and relaying a visual recording as a function of the signal to the display window, and a vacuum-line tip configured to remove a portion of the biological sample as a function of the visualized intrinsic emission of the biological sample and a haptic feedback controller.

APPENDIX 1-6

United States Patent Application	**20210165300**
Kind Code	**A1**
Cushing; Scott K. ; et al.	**June 3, 2021**

ENTANGLED PHOTON SOURCE THAT CAN REPLACE A PULSED LASER IN NON-ABLATIVE MULTIPHOTON AND NONLINEAR PROCESSES

Abstract

A coherent, entangled photon source which uses a continuous wave laser to replace pulsed photon excitation sources in multiphoton nonlinear processes. In various embodiments, the device comprises a continuous wave photon laser creating electromagnetic radiation at a specific frequency and narrow linewidth. The emitted beam may be conditioned by an optical fiber to allow for efficient interaction with a nonlinear crystal. The nonlinear material is designed and fabricated in a specific manner, enabling the quantum mechanical process of a single photon with well-defined energy being converted into two or more photons which display quantum correlations. The nonlinear material and subsequent fiber-***optic*** or free space components control the temporal, spatial, and polarization-related quantum correlations such that the entangled photons can create a signal in multiphoton nonlinear processes that is the same or exceeds that of a pulsed photon source but at the average and peak powers of a continuous wave laser.

APPENDIX 1-7

United States Patent Application	**20210401925**
Kind Code	**A1**
Wilson; D. Travis	**December 30, 2021**

METHODS AND COMPOSITIONS FOR PREVENTING OR TREATING DOMINANT OPTIC ATROPHY

Abstract

The disclosure generally describes methods of preventing or treating dominant ***optic*** atrophy. The methods comprise administering an effective amount of an aromatic-cationic peptide to subjects in need thereof. The present technology relates generally to the treatment or prevention of Leber's hereditary ***optic*** neuropathy (LHON) or dominant ***optic*** atrophy (DOA) in mammals through administration of therapeutically effective amounts of aromatic-cationic peptides to subjects in need thereof. In one aspect, the present disclosure provides a method of treating or preventing dominant ***optic*** atrophy in a mammalian subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of a peptide.