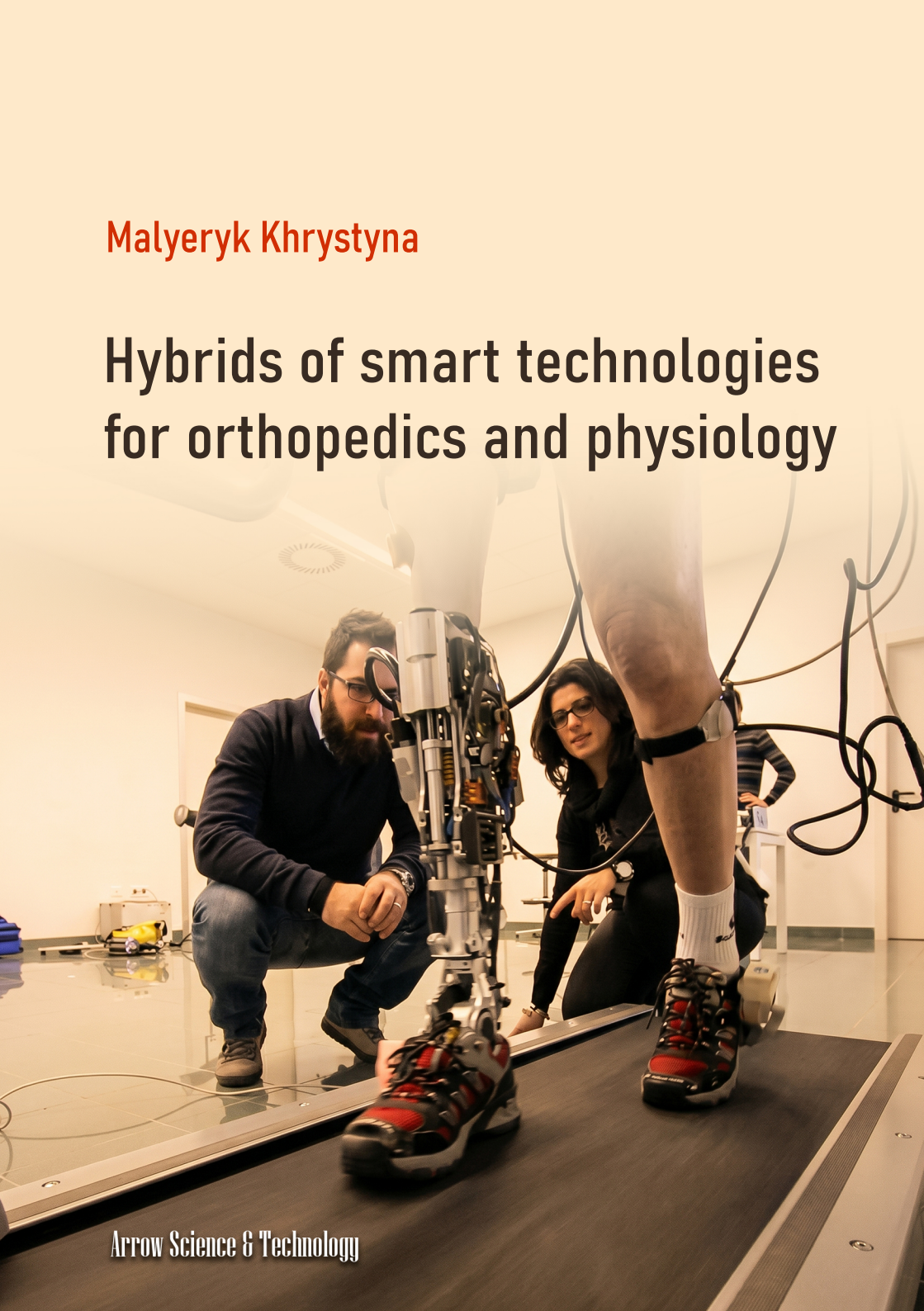
Malyeryk Khrystyna

Hybrids of smart technologies for orthopedics and physiology



Arrow Science & Technology

Malyeryk Khrystyna

HYBRIDS OF SMART TECHNOLOGIES FOR ORTHOPEDICS AND PHYSIOLOGY

Hybrids of smart technologies and intelligent design for orthopedics and physiology

2026

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Malyeryk Khrystyna
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The book examines hybrid technical and technological solutions for the development of intelligent footwear and orthopedic accessories based on the principles of electromagnetic resonance spectroscopy, artificial intelligence, and artificial neural networks. Particular attention is given to smart insoles and sensor systems incorporating carbon-carbon composite materials, shape-memory materials, magnetic resonance sensors, and microelectronic modules manufactured using RITM technology. The study explores non-contact monitoring of physiological conditions, including blood parameter assessment, diagnostics of bone and muscle tissue, early disease detection, fracture healing monitoring, and vascular condition evaluation. Special emphasis is placed on the integration of laser, fiber-optic, and magnetic resonance technologies for therapeutic and preventive effects on the human body without invasive procedures. The book also presents the design features of sensor modules, composite materials, and electronic control systems that provide high sensitivity, safety, and continuous real-time monitoring. It is concluded that hybrid intelligent technologies have significant potential for advancing modern orthopedics, physiotherapy, preventive diagnostics, and personalized medicine.

Keywords: *Smart footwear concept; Non-contact monitoring; Laser and fiber-optic system; Non-contact interaction system; Magnetic resonance early diagnosis system; Preventive diagnostic system*

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Hybrids of smart technologies and intelligent design for orthopedics and physiology.

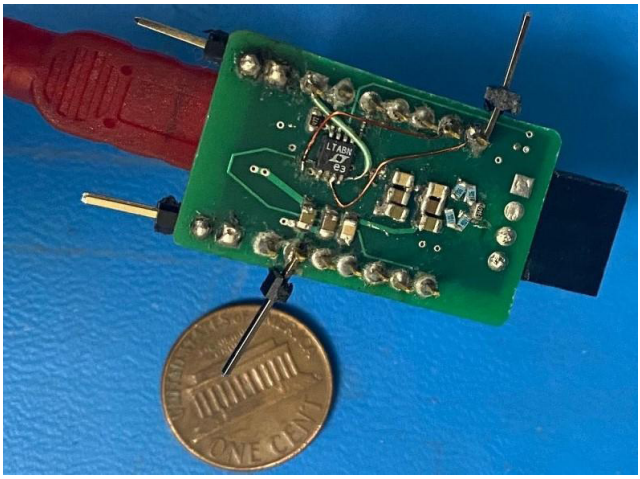
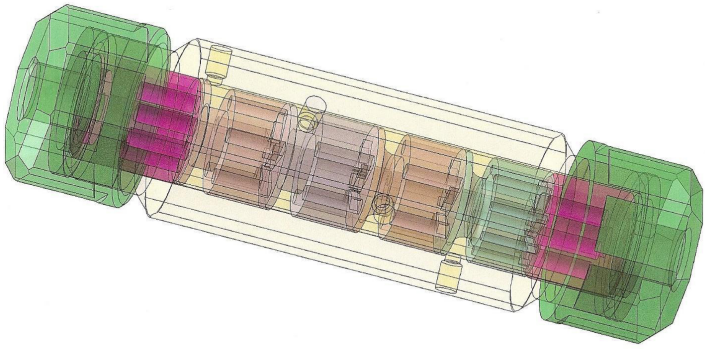


Figure 1.



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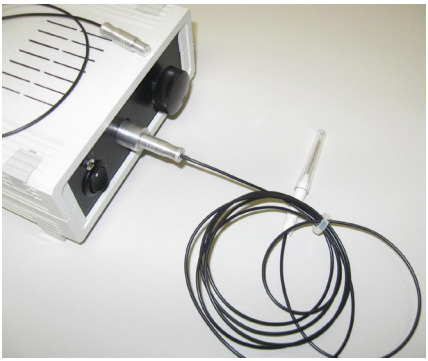

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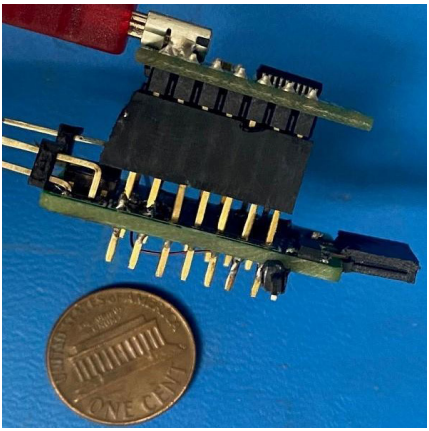

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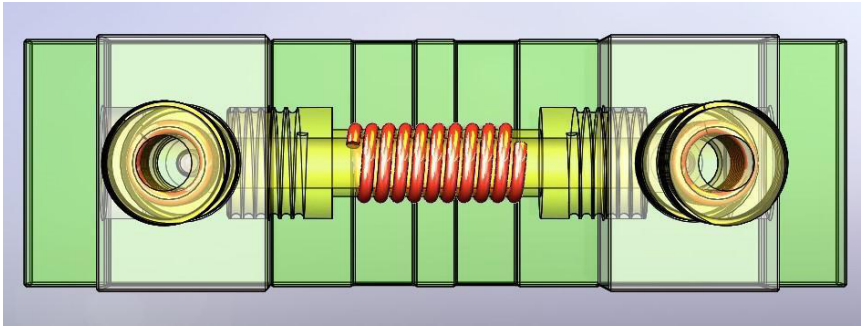

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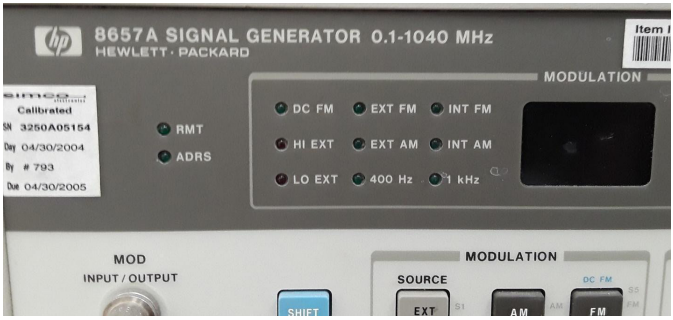

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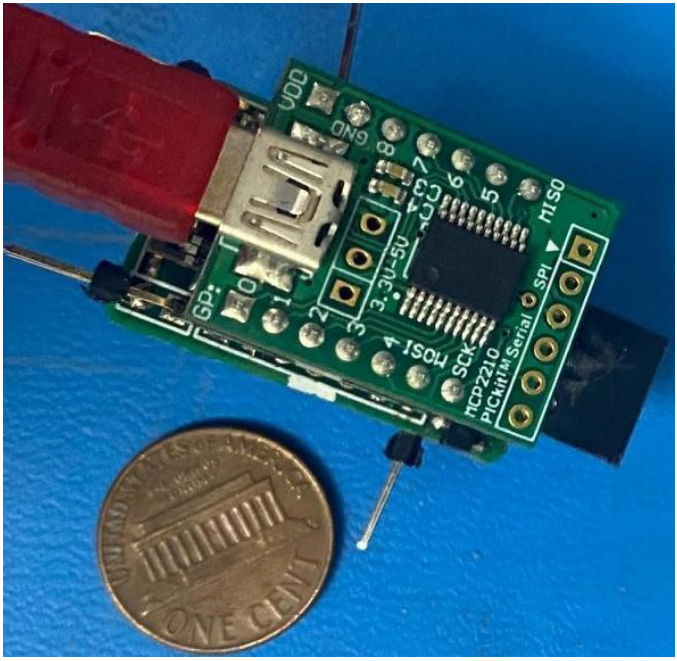

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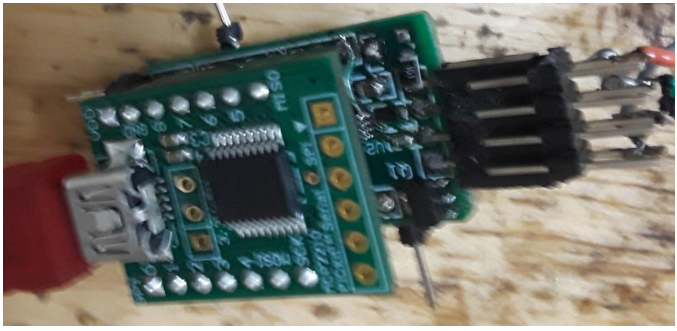


Figure 7.

Introduction: Current state of the art and technology of intelligent non-contact monitoring and control methods based on the fundamental principles of electromagnetic resonance spectroscopy.

Principle of measurement (electromagnetic coupling with object under test).

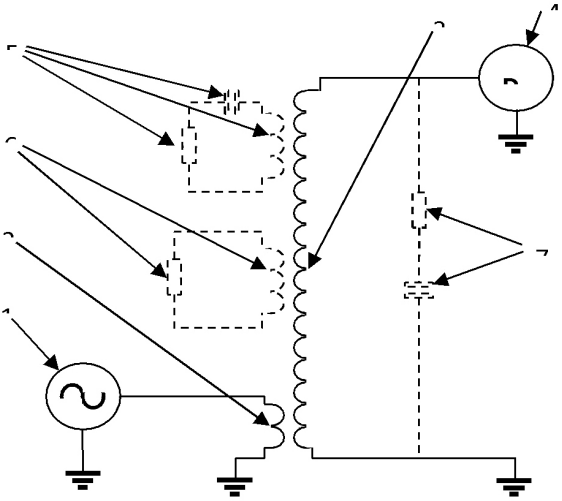


Figure 9. Equivalent circuitry of RIST-sensor illustrates an electromagnetic coupling with analyte

Schematic of RIST-sensor (depicted with solid line).

1 – source of an alternating electric field with frequency sweep (sweep generator)

2 – excitation coil

3 – sensing coil

4 – data acquisition system

Electromagnetic response of object under test (depicted with dash line).

5 – vortical displacement currents (dielectric polarization)

6 – vortical ionic currents and eddy currents

7 – linear conductance, displacement and ionic currents caused by difference in electrical potential spread along of the sensing coil.

These and equivalent variations of these principles are used in all high-technology fields and are continuously optimized with the emergence of new software solutions and new engineering developments.

For these purposes, a system of elastic composite solenoids is also proposed. In addition to their primary functions, these solenoids serve as water-repellent bandages and, because they are made of carbon-carbon composite fabric, they can also function as disposable sorbent dressings. This provides a significant therapeutic effect confirmed by testing in leading clinics around the world, as well as in Russia and Kazakhstan.

One of the least explored areas is the technological field associated with designers, developers, manufacturers, and service centers involved in the production and distribution of footwear.

The author of this publication offers readers several comments and examples of positive experience in applying electromagnetic resonance spectroscopy techniques and technologies within service and retail centers engaged in the sale and distribution of all types of footwear.

The concept of smart footwear and smart accessories

As of today, there are no established standards for smart footwear or its associated smart accessories.

Based on the experience accumulated by the author of this book, the main characteristics of smart footwear can be represented by the following integrative invention concept:

1. A device, manufacturing system, software, and associated method for using a combined smart insole in footwear, possessing electrical conductivity and volumetric saturation with a carbon-carbon composite, connected to a power source, a micro-pulse generator, and a micro-analytical module, and based on the characteristics of an electromagnetic resonance spectrometry system with control and monitoring functions utilizing elements of artificial intelligence and artificial neural networks. In addition, the active surface of the smart insole contains distributed system elements providing various forms of interaction with the foot and manufactured from shape-memory materials.

2. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from a single layer of viscose fabric saturated under vacuum with carbon-carbon composite atoms.

3. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical

conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms.

4. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms, with at least one layer of carbon-carbon wool positioned between them.

5. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from at least one layer of viscose fabric saturated under vacuum with carbon-carbon composite atoms, and elements manufactured from an elastic shape-memory material are uniformly distributed across the surface of the insole facing the foot.

6. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from at least one layer of viscose fabric saturated under vacuum with carbon-carbon composite atoms, and elements manufactured from an elastic shape-memory material are uniformly distributed across the surface of the insole parallel to the surface facing the foot.

7. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical

conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from at least one layer of viscose fabric saturated under vacuum with carbon-carbon composite atoms, and elements manufactured from an elastic shape-memory material are uniformly distributed on both surfaces of the insole, namely the surface facing the foot and the surface parallel to it.

8. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms, and shape-memory elements are uniformly distributed on at least one of these layers.

9. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms, and shape-memory elements are uniformly distributed on at least two of these layers.

10. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms, and shape-memory elements are uniformly distributed on all layers.

11. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical con-

ductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms, with at least one layer of carbon-carbon wool positioned between them, and shape-memory elements are uniformly distributed on one of the layers.

12. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite according to Claim 1, wherein the smart insole is made from several layers of viscose fabric saturated under vacuum with carbon-carbon composite atoms, with at least one layer of carbon-carbon wool positioned between them, and shape-memory elements are uniformly distributed between the layers separated by the carbon-carbon wool layer.

13. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity and volumetric saturation with a carbon-carbon composite, wherein the insole material is hydrophobic.

14. A device, manufacturing system, software, and associated method for using a combined smart insole with electrical conductivity, volumetric saturation with a carbon-carbon composite, and hydrophobic properties, wherein flat coils in the form of flexible printed circuit boards are mounted at specific locations on the surface of the insole opposite the surface in contact with the foot.

15. A device, manufacturing system, software, and associated method according to the previous claim, wherein the flat coils in the form of flexible printed circuit boards are manufactured using dimensional selective metal etching technology.

16. A device, manufacturing system, software, and associated method according to the previous claim, wherein the flat coils in the form of flexible printed circuit boards are manufactured using dimensional selective metal etching technology, and the base material for the flat coils is aluminum-containing steel.

17. A device, manufacturing system, software, and associated method according to the previous claim, wherein the flat coils in the form of flexible multilayer printed circuit boards are manufactured using dimensional selective metal etching technology, and the base material for the flat coils is steel containing aluminum, chromium, and molybdenum with a carbon concentration of 38–42%.

18. A device, manufacturing system, software, and associated method for using a combined smart insole connected to a power source, a micro-pulse generator, and a micro-analytical module according to Claim 1, wherein the power source, micro-pulse generator, and micro-analytical module are located within the heels of the smart footwear and communicate with the smart insole through a non-contact connection.

19. A device, manufacturing system, software, and associated method for using a combined smart insole connected to a power source, a micro-pulse generator, and a micro-analytical module according to Claim 1, wherein the power source, micro-pulse generator, and micro-analytical module are located in a mobile phone and are controlled together with the smart insoles through a mobile application installed on the mobile phone.

20. A device, manufacturing system, software, and associated method according to Claim 1, wherein the active surface

of the smart insole contains distributed system elements manufactured from shape-memory materials for various forms of interaction with the foot, and these elements are initially configured as discs with spherical protrusions.

21. A device, manufacturing system, software, and associated method according to Claim 1, wherein the active surface of the smart insole contains distributed system elements manufactured from shape-memory materials for various forms of interaction with the foot, these elements being initially configured as discs with spherical protrusions, and the material receives a command to restore its memorized shape at the normal temperature of the foot.

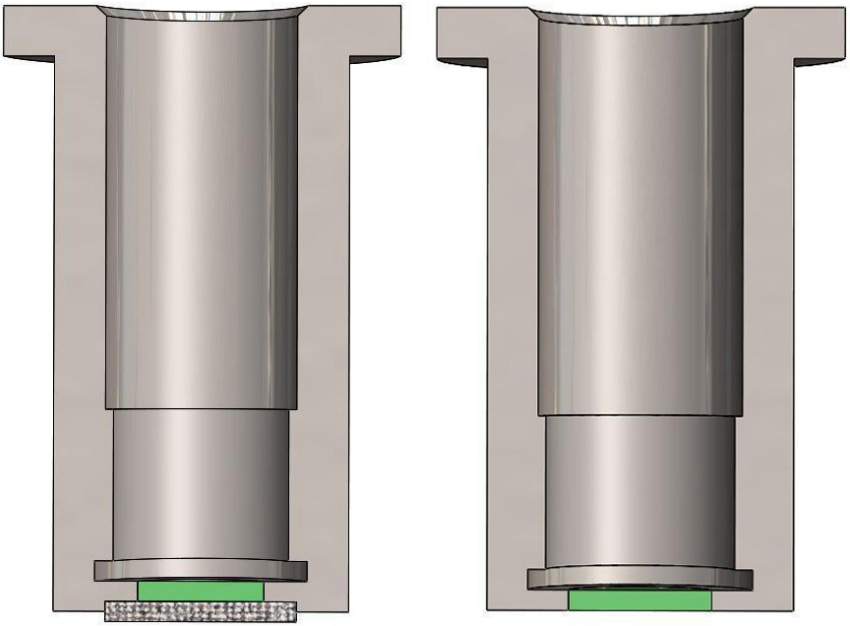
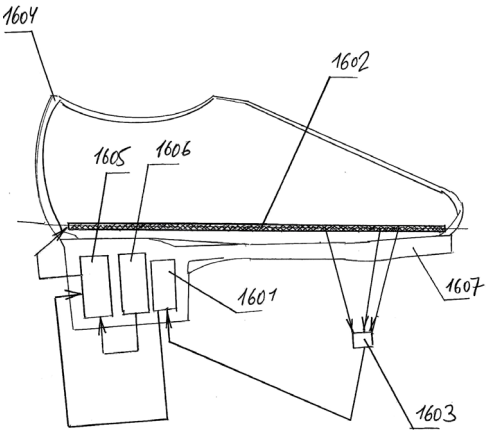
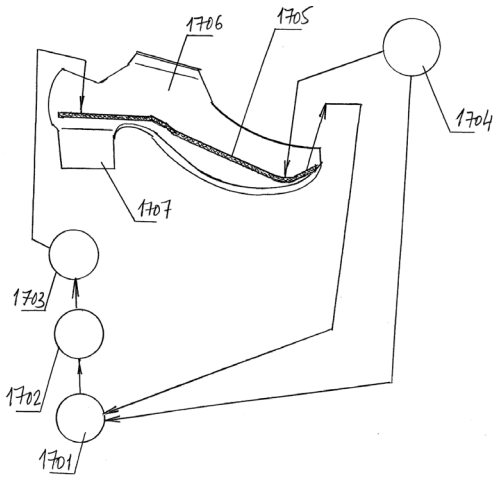


Figure 10.



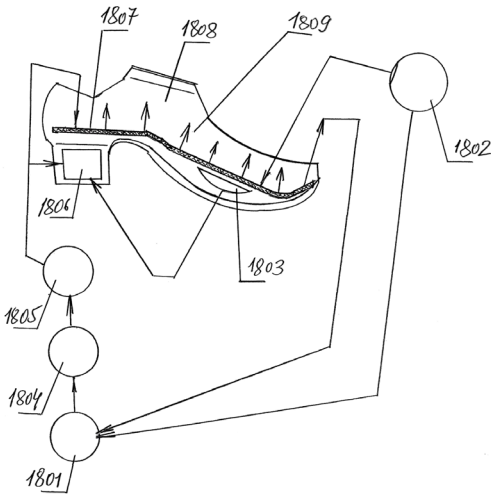
1601 – Part of the sensor module.
1602 – Smart insole.
1603 – Part of the sensor module.
1604 – Part of the shoe upper.
1605 – Part of the sensor module.
1606 – Part of the sensor module
1607 – Shoe outsole

Figure 11. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, with all system components housed within the cavity of the shoe heel



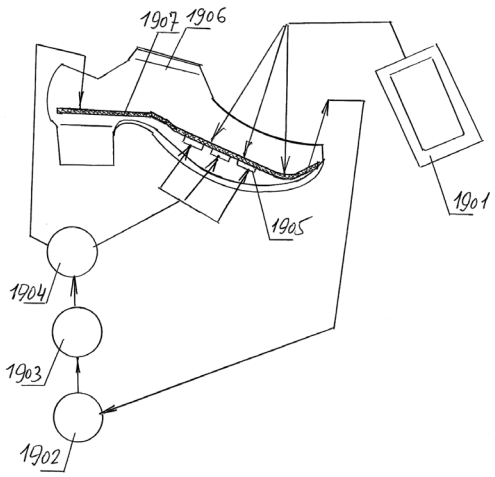
1707 – Shoe heel, which may be used to house a micro power source, a micro-pulse generator, and a micro-analytical module

Figure 12. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, with all system components controlled and monitored through a mobile application



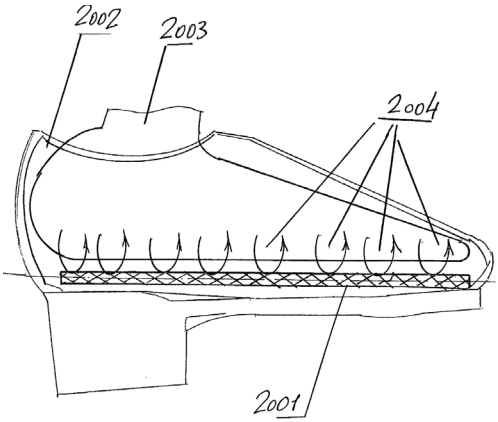
1809 – Direction of impulse transmission from the insole to the foot.

Figure 13. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, with all system components controlled and monitored through a mobile application, wherein sensors for real-time monitoring and control of the insole are integrated beneath the insole within the footwear



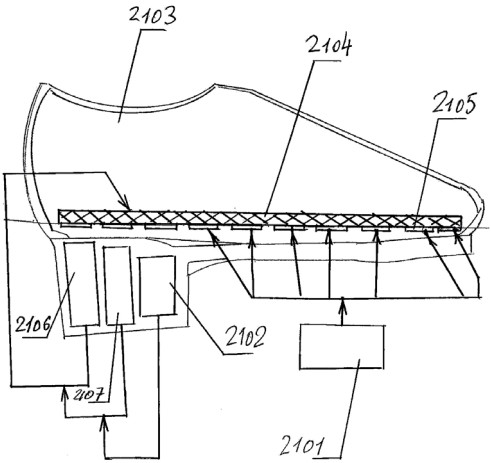
1901 – Mobile phone with a mobile application. 1905 – Micro-sensor modules.

Figure 14. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, with all system components controlled and monitored through a mobile application, wherein sensors for real-time monitoring and control of the insole are integrated beneath the insole within the footwear



2003 – Foot (conventional designation of the leg). 2004 – Direction of the return flow of liquid initiated by the hydrophobic properties of the carbon-carbon composite material.

Figure 15. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, utilizing the hydrophobic properties of the insole



2105 – Elastic micro-sensor modules.

Figure 16. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, incorporating sensors in the form of flexible flat coils installed on the side opposite to the surface in contact with the foot

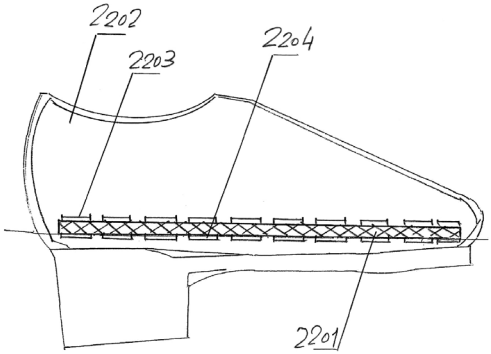


Figure 17. Example of footwear with an insole made from viscose fabric vacuum-saturated through a sequential pyrolysis process with a carbon-carbon composite, incorporating sensors in the form of flexible flat coils installed both on the side opposite the surface in contact with the foot and on the side in direct contact with the skin of the foot

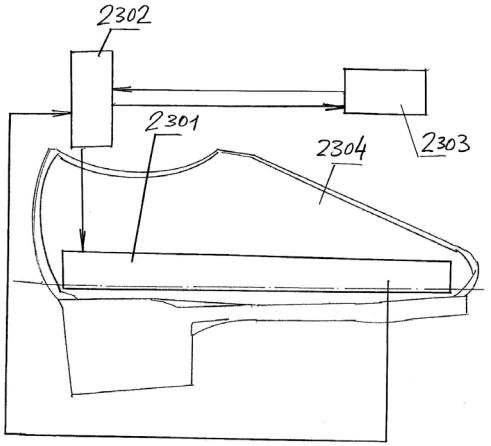


Figure 18. Example of a digital control and monitoring module for a smart insole utilizing elements of artificial intelligence and artificial neural networks

The author of this publication further presents examples of the application of hybrid combinations of the technologies and integrative complex engineering solutions described above.

All examples incorporate applications of non-contact monitoring, measurement, and analytical functions based on the principles of electromagnetic resonance spectroscopy.

Techniques and technologies for non-contact monitoring and analytical assessment of blood condition using elements of artificial intelligence and artificial neural networks

Techniques and technologies for non-contact monitoring and analytical assessment of blood condition using elements of artificial intelligence and artificial neural networks.

In this project, the fundamental technological principle is based on the sensitivity of a magnetic resonance sensor to any changes in the properties of a liquid.

The methodology of this technological approach was developed through experiments involving the assessment of water into which pre-weighed elements were introduced. During these experiments, the sensor responded with high accuracy to microscopic changes in composition and identified the nature of the changes occurring throughout the mixture.

The sensor is designed in the form of a ring-shaped solenoid into which a finger is inserted for measurement purposes (as one possible embodiment).

Prior to testing, the sensor processor is supplied with statistical information describing the sensor response to blood composition that fully corresponds to a reference standard and is adjusted to the individual characteristics of the person undergoing the test.

If the sensor signal coincides with the shape, amplitude, resonance frequency characteristics, dielectric permittivity, conductivity, and acidity parameters of the reference signal, a green

LED indicator illuminates on the device display, indicating that the blood condition corresponds to the reference standard.

If deviations from the norm are detected, with a sensitivity equivalent to the introduction of as little as 0.000001 grams of, for example, table salt into the control volume, a red LED indicator illuminates. This indicates that changes have been detected in the composition and condition of the blood, after which a laboratory blood analysis is required.

Project title for Technical and Technological Solution, Variant 1: **MOBILE NON-CONTACT DEVICE FOR MONITORING AND COMPARATIVE ASSESSMENT OF OVERALL BLOOD CONDITION.**

Possible organizational format for project development: Research and Development (R&D) Project.

By its format and innovative nature, this project may serve as the technological foundation of a research startup, with the ultimate objective of creating a new innovative product whose key operating parameters define the unique and non-obvious characteristics of both the technology itself and the device designed for its implementation.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The project is intended for the comprehensive investigation of the technological capabilities of comparative remote assessment and identification of the overall condition of blood without taking a blood sample and without any penetration into the circulatory system or the functional support systems of the human body.

The project allows for the evaluation of the functional capabilities of several types of sensor modules, including both conventional three-dimensional coils and innovative flat coils manufactured using RITM technology.

The second stage of the project should be dedicated to experimental design and engineering development and should culminate in the creation of a prototype device intended for mass use. Upon completion, the project should result in a device with operational characteristics suitable for conducting a full cycle of clinical trials.

KEY DISTINGUISHING FEATURES OF THE PROJECT:.

As a result of the project implementation, a device intended for mass-market use will be created, possessing a level of accuracy comparable to that of expensive laboratory instruments.

The device has the potential to fundamentally transform the field of personal health monitoring, and its widespread use is expected to significantly enhance the level of health protection available to citizens.

The device is based on a nanometrological technology that is currently in demand within the semiconductor manufacturing industry, has undergone extensive testing, and is fully protected by patents while possessing substantial licensing potential.

ADVANTAGES OF THE DEVELOPED TECHNOLOGY:.

The technology under development opens a new medical technological and metrological field in which the extremely high sensitivity of the sensors is achieved through the principles of electromagnetic resonance.

This principle makes it possible to detect changes in the overall concentrations of blood components at a sensitivity level of 0.000001 milligrams, while monitoring can be performed remotely and without any physical contact with the subject being examined.

Since the cost of the device falls within the range of mass-market consumer products, its implementation is expected to provide a significant social benefit.

Laser and fiber-optic system for blood treatment aimed at increasing hemoglobin concentration

The system utilizes the methods and technologies of electromagnetic resonance spectroscopy for online monitoring and comprehensive assessment of blood condition during the exposure process, in order to prevent the exceedance of permissible exposure parameters that could otherwise lead to unintended irreversible destructive processes within the blood.

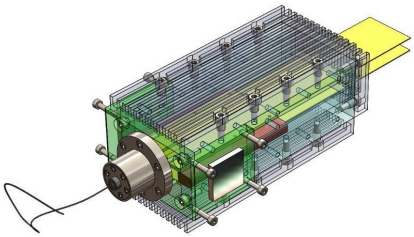


Figure 19.

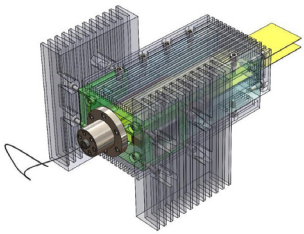


Figure 20.

In all other respects, the treatment technology falls within the field of concentrated light-processing techniques operating within a specified spectrum and wavelength range, with a defined frequency and a particular combination of pulses characterized by peak optical power at the pulse maxima.

Project Title: **DEVICE WITH SINGLE-USE INSTRUMENTATION FOR SPECTRAL LIGHT TREATMENT OF BLOOD AIMED AT INCREASING HEMOGLOBIN CONCENTRATION.**

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The objective of the project is to develop a mobile medical device based on modern nanometrological principles and advances in spectral-optical technologies for rapid blood treatment while ensuring 100% monitoring of blood condition throughout the treatment process.

The combination of rapid spectral-optical treatment functions with magnetic resonance monitoring of blood condition in real time makes it possible to achieve a stable, safe, and consequently highly effective process for restoring vital blood parameters.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The distinguishing features of the project, as well as of the device and technology developed within its framework, include:

The structural simplicity and reliability of the device and its instrumentation, making it possible to achieve an exceptional positive outcome through the application of high-tech solutions that were previously used for industrial purposes in large-scale semiconductor manufacturing processes operating within the dimensional range of nanometrology.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The proposed technology and the means for its instrumental implementation are characterized by the following advantages and features:

– Use of a proven core technological platform.

– Application of technology and device components that have counterparts already in mass production.

– Full patentability of the technology and its constituent elements.

– Ease of device operation and accessibility of its application principles for a mid-level specialist without specialized training.

Non-contact system for the treatment of subcutaneous fat tissue aimed at its non-surgical reduction

The system operates according to a specially developed algorithm.

Within this system, the functions of magnetic resonance technology include three-dimensional monitoring of the location of thermal воздействие on the subcutaneous fat layer that is most sensitive to this type of treatment.

Monitoring and maintenance of the treatment temperature are also performed in this application through the capabilities of magnetic resonance technology.

Project Title: **DEVICE WITH INSTRUMENTATION AND A MAGNETIC RESONANCE ACTIVE ONLINE MONITORING SYSTEM FOR NON-CONTACT TREATMENT OF SUBCUTANEOUS FAT TISSUE AIMED AT ITS NON-SURGICAL REDUCTION.**

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The project is intended for the development of technology and equipment for the non-surgical reduction of subcutaneous fat tissue using technologies based on the physical principles of magnetic resonance and modern nanometrology.

The objective of the project is to create a device and a comprehensive application technology that enable localized precision treatment of subcutaneous fat tissue without complex surgical procedures and without causing any adverse side effects.

The essence of the project is to conduct the necessary range of scientific research activities followed by the experimental design and engineering implementation of the results obtained from these studies.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The key distinguishing features of the project are the proposed methods of applying magnetic resonance nanometrology for precision, localized, controlled, and monitored thermal treatment of subcutaneous fat tissue.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The principal advantage of the proposed technology is the precision control of all process parameters, making it possible to achieve satisfactory treatment results while completely avoiding damage or injury to surrounding untreated tissues, thereby ensuring the full safety of the procedure.

Magnetic resonance system for the early detection of malignant neoplasm development.

The system has several embodiments.

The most innovative foundational element of the system is specially designed monitoring garments individually tailored to the patient's size and manufactured from carbon-carbon composite fabric. This material is electrically conductive and, due to a specialized textile structure of the warp and weft, functions as a planar or three-dimensional solenoid.

The examination is carried out by dividing the entire surface area of the patient's body into monitored zones. The reflected signal from each zone is compared with a reference statistical signal obtained from a verified healthy individual wearing the same clothing size.

Due to the properties of the composite fabric, sterilization can be performed in autoclaves or by means of microwave treatment.

A second embodiment of the system has a localized configuration in which the sensor assembly is designed to conform to a specific body surface geometry corresponding as closely as possible to the organ under examination.

Comparison of the signal from a healthy reference organ with that of the monitored organ makes it possible to assess the potential presence or development of malignant neoplasms.

Project Title: **DEVICE WITH INSTRUMENTATION FOR NON-CONTACT RESONANCE MONITORING AND COMPREHENSIVE DIAGNOSTICS OF THE EARLY DEVELOPMENT OF MALIGNANT NEOPLASMS IN THE HUMAN BODY**.

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The project is intended for the development of a technology and device capable of providing early dimensional diagnostics of the emergence of malignant neoplasms within the human body.

The objective of the project is to create a device and a methodology for its application based on a modern group of non-contact nanometrological and magnetic resonance technologies, possessing a sensitivity sufficient to detect and identify neoplasms with dimensions of 100 angstroms and a mass of 0.000001 milligrams.

Such a level of sensitivity makes it possible to detect neoplasms at the earliest stages of their development and to initiate treatment before irreversible consequences occur.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The project is distinguished by the fundamental novelty of its core and auxiliary technical solutions.

The technical solutions underlying the project are entirely innovative, capable of further development, and have no known counterparts in global practice.

The project utilizes technical solutions that can be implemented using commercially available components and materials manufactured on a serial-production basis, without requiring the development of specialized production technologies.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The principal advantage of the proposed technology is its unique level of sensitivity, which determines its effectiveness.

Magnetic resonance system for the early detection of reduced calcium concentration in bones.

The system is similar in its sensor-garment design to the system for the early detection of malignant neoplasms, with the difference that the statistical reference database used for comparison consists of analytical information obtained from the monitoring of bone tissue with a normal calcium concentration.

Project Title: **DEVICE WITH INSTRUMENTATION FOR PREVENTIVE DIAGNOSTICS AND ASSESSMENT OF CALCIUM CONCENTRATION LEVELS IN BONES.**

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The project is intended to investigate the fundamental principles and develop a technology for the preventive diagnosis of changes in calcium concentration within bone tissue.

The objective of the project is to create a universal device capable of detecting concentration changes as small as 0.000001 milligrams.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The project is distinguished by its core technological principle, whereby methods and systems of magnetic resonance nanometrology are used to determine changes in calcium concentration within the volume of bone tissue.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The proposed technology and its implementation method offer significant advantages over existing technologies. These advantages are reflected in their high accuracy and sensitivity, making it possible to detect even minimal deviations under outpatient monitoring conditions at a stage when the processes of regulation or correction remain manageable and controllable.

Real-time magnetic resonance system for diagnosing the condition of bone fractures during the healing process

The system incorporates a flexible and elastic solenoid manufactured from electrically conductive carbon-carbon composite fabrics produced through the pyrolysis of viscose textile substrates.

A localized bandage is formed from the fabric solenoid and applied at the fracture site. The bandage remains continuously connected to a processor containing statistical information regarding the characteristics and parameter levels of signals obtained from normal tissue in areas where no fracture is present.

This reference information is obtained through a control installation of the system on, for example, a limb that contains a fracture, but at a location where no fracture is present.

The signal is transmitted to the processor in real time, where it is identified and amplified. It is then directed to a specially programmed analytical coprocessor and its analytical processing unit, which, through complex interpretation of the signal parameters, generates an integrated assessment of the healing process.

The system utilizes a unique capability to concentrate the resonance signal precisely at the fracture site and, consequently, to receive the reflected signal specifically from that location, thereby providing the most complete and timely characterization of the condition of the healing bone tissue.

Project Title: **REAL-TIME MONITORING EQUIPMENT COMPLEX FOR ACTIVE DIAGNOSTICS OF**

BONE FRACTURE CONDITIONS DURING TREATMENT AND REHABILITATION.

Project Classification: RESEARCH AND DEVELOPMENT (R&D) PROJECT.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The purpose of the project is to conduct the necessary scientific research and experimental engineering development of a technology and equipment system for therapeutic monitoring performed in real time, enabling active influence on the processes of recovery and rehabilitation during their active phases.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The key distinguishing features of the project include:

– The use of the physical principles of magnetic resonance to determine differences and changes in the condition of bone tissue within the fracture zone, with the complete absence of any form of physical contact during monitoring.

– The possibility of continuous remote monitoring of the condition of the monitored object.

– High accuracy and sensitivity of the monitoring process.

– Clear identification and interpretation of monitoring results.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The advantages of the proposed technology are reflected in its high accuracy and sensitivity combined with the remote transmission and identification of monitoring results. This enables rapid decision-making in real time, thereby increasing the effectiveness of treatment.

Magnetic resonance therapy system for the destruction of cholesterol plaques in arteries

The system is based on the capability of the resonance method to distinguish between muscle tissue and fluid. By comparing signal characteristics, the system accurately determines the boundary between tissue and fluid, which corresponds to the arterial wall, and applies treatment to the arterial wall where cholesterol plaques have accumulated. The treatment is performed through thermal exposure with a controlled temperature level and precisely defined three-dimensional coordinates of the points at which the temperature is generated. Under the influence of the thermal field, the plaque material undergoes degradation and is gradually removed from the artery through the body's complex biological metabolic processes.

The treatment methodology is intended to have a preventive character, and the arterial cleansing process should be performed periodically in order to prevent the growth of abnormal cholesterol formations.

Structurally, the system consists of magnetic resonance sensors and pulse generators of thermal radiation interconnected by a flexible adjustment and mounting mechanism.

The same structural configuration and the same magnetic resonance-based identification and positioning capabilities may also be used with various treatment methods that differ in their physical nature, including radiological and laser-based techniques in cases involving superficial treatment applications.

Project Title: **DEVICE WITH MAGNETIC RESONANCE MONITORING AND ANALYTICAL INSTRUMENTATION FOR THE DETECTION AND DESTRUCTION OF CHOLESTEROL PLAQUES IN ARTERIES.**

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The purpose of the project is to develop equipment and technology for the non-surgical detection and non-surgical removal of cholesterol plaques in arteries.

The objective of the project is to conduct a comprehensive program of scientific research and experiments aimed at establishing the necessary scientific and experimental foundation for the engineering development and testing of the proposed system, as well as the development of the device itself and the methodology for its application.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

Among the key distinguishing features of the project is the use of magnetic resonance technology in combination with directed induction-heating techniques for the detection, destruction, and subsequent elimination from the body of cholesterol plaques and the products of their decomposition and degradation.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The principal advantage of the proposed technology lies in the high accuracy and sensitivity of the magnetic resonance

sensor modules employed, as well as their potential capability to detect the early formation of cholesterol plaques and to facilitate their destruction at a stage when their elimination from the body presents no significant difficulty.

Preventive diagnostic system for assessing the condition of muscle tissue using a magnetic resonance scanning sensor

The system consists of a magnetic resonance scanning module that moves across the surface of the body and includes at least two sensors whose magnetic field vectors intersect. The three-dimensional geometry of these intersections is adjustable and may be modified depending on the specific objectives.

The system also includes a reference sensor that determines and controls the depth of examination.

The physical operating principles of the system remain the same across all applications; therefore, it is unnecessary to provide a separate description of these principles for each individual application.

Project Title: **DEVICE WITH AN INSTRUMENTATION SYSTEM FOR NON-CONTACT PREVENTIVE DIAGNOSTICS OF MUSCLE TISSUE CONDITION.**

Project Classification: RESEARCH AND DEVELOPMENT (R&D) PROJECT.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The purpose of the project is to conduct fundamental scientific research related to the preparation of the initial technical requirements for the engineering development of the device.

The objective of the project is to develop the necessary documentation, manufacture a prototype device, and carry out the full range of preliminary prototype testing.

The essence of the project is to obtain, upon completion of all project stages, a prototype device capable of performing preventive diagnostics of muscle tissue condition on the basis of technological solutions founded on the effects and principles of magnetic resonance.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The project has the following distinguishing features:

– The condition of muscle tissue is diagnosed through the identification and interpretation of signals generated by resonance sensors.

– The resonance sensor modules record combined reflected signals that represent an integrated characterization of the condition of muscle tissue, including its energetic state.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The project and the technology on which it is based make it possible to perform layer-by-layer assessment of muscle tissue condition without direct physical contact and to obtain a three-dimensional representation of the overall condition of the muscle tissue.

Preventive diagnostic system for detecting the presence of sputum in the bronchi and lungs using a magnetic resonance scanning sensor.

The system consists of a sensor assembly and sensor-positioning mechanisms used during examinations. The system

is based on a method of comparing signals obtained from reference examinations of healthy patients with the signals received from the resonance sensors of the patient under examination.

The sensor assembly includes a processor and an analytical comparison coprocessor, for which the software must be developed as part of the project implementation.

The system determines only the presence of signal differences indicating a deviation from the norm; the magnitude of the deviation reflects the level of sputum accumulation.

The system is intended for preventive use and, in many clinical applications, may serve as an alternative to X-ray-based monitoring and diagnostic methods.

Project Title: **DEVICE WITH INSTRUMENTATION FOR PREVENTIVE EARLY DIAGNOSTICS OF SPUTUM ACCUMULATION IN THE BRONCHI**.

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The objective of the project is to create a highly effective device, together with the techniques and technology for its application, capable of improving the effectiveness of preventive examinations for the early detection of diseases.

The use of electromagnetic resonance phenomena and effects for preventive diagnostic applications has no precedent in global practice.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

– High accuracy and effectiveness.
– Potential for widespread use in medical practice.
– Relatively low equipment and operating costs.
– Significant social benefits through improved detection of diseases at earlier stages of development.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The advantages of the proposed technology include the following:

– The technology is completely safe and produces no adverse effects during or after use.
– The technology is simple to apply and does not require specialized training for the user.
– The cost of the device is relatively low in relation to the results achieved.
– The technology has the potential to fundamentally improve the effectiveness of preventive diagnostic procedures.

Preventive monitoring system for blood flow velocity in arteries using a magnetic resonance sensor

The system incorporates flexible sensor solenoids manufactured from carbon-carbon textile composites, which are positioned at designated monitoring points or localized monitoring zones on the patient's body.

During examination, maximum conformity of the sensor solenoids to the skin surface is ensured, after which the sensor signals are used to interpret the blood flow velocity within the arteries.

The method is based exclusively on the comparison of statistical reference values of blood flow velocity with the values obtained from the subject under examination.

Project Title: **DEVICE WITH INSTRUMENTATION FOR MONITORING AND NON-CONTACT ASSESSMENT OF BLOOD VESSEL CONDITION THROUGH A MAGNETIC RESONANCE SENSOR SYSTEM FOR REAL-TIME TRACKING OF BLOOD FLOW VELOCITY IN ARTERIES.**

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The objective of the project is to create a non-contact device for the preventive examination of the vascular system without any surgical or invasive intervention.

The project includes a complete cycle of scientific research and experimental engineering development activities leading to the creation of the proposed device.

The core inventions underlying the project have no known global counterparts in terms of measurement accuracy and the analysis of measurement results.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

The principal distinguishing features of the project consist in creating practical conditions for the application of the phenomenon of magnetic resonance probing for measurement and identification of measurement results, capabilities that have no known counterparts in global practice.

Both measurement and diagnostic procedures are performed without physical contact and produce no effect on the human body.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The primary advantage of the proposed technology lies in its simplicity of implementation and relatively low cost, combined with high accuracy in both measurements and the identification of measurement results.

Magnetic resonance system for relaxing treatment of muscle tissue aimed at restoring and enhancing its energetic activity

The system can operate in combination with both thermal contrast therapy devices and individual devices for localized heating or cooling. Through the use of a tandem of magnetic resonance oscillation exciters acting at different tissue levels, together with a magnetic resonance level-control system capable of shifting the oscillation depth by less than one millimeter and monitoring this depth or level during scanning or oscillation, the system can perform layer-by-layer magnetic resonance treatment of muscle tissues either in conjunction with or independently of contrast therapy methods.

For patients suffering from arthritis and other similar disorders, the treatment completely relieves pain sensations through directed and controlled action throughout the entire volume of the muscle tissue.

The proposed system also provides a unique opportunity to perform contrast therapy in precisely defined local areas affected by arthritis, fundamentally increasing the effectiveness of contrast therapy.

Project Title: **DEVICE WITH INSTRUMENTATION AND NON-CONTACT TREATMENT ELEMENTS FOR COMPREHENSIVE MAGNETIC RESONANCE RELAXATION THERAPY OF MUSCLE TISSUES, INCLUDING**

THOSE OF INTERNAL ORGANS, AIMED AT RESTORING THEIR ENERGETIC ACTIVITY.

Project Classification: Research and Development (R&D) Project.

PURPOSE, OBJECTIVE, AND ESSENCE OF THE PROJECT:

The purpose of the project is to create, on the basis of advanced nanotechnologies, a device capable of performing therapeutic and restorative procedures in outpatient settings without dependence on specially equipped medical centers.

The project is based on established physical principles of electromagnetic resonance and relies on a group of inventions that fully protect the structural and technological principles of the proposed device.

The project includes the implementation of a complete cycle of research and experimental engineering development activities required for the creation of the device.

KEY DISTINGUISHING FEATURES OF THE PROJECT:

– Performance of all procedures without direct physical contact with the patient's body.

– Utilization of the practical advantages and precision of magnetic resonance technologies.

– Application of unique natural materials, deposits of which are predominantly located in Russia.

– Development of a device suitable for use in outpatient settings.

ADVANTAGES OF THE PROPOSED TECHNOLOGY:

The proposed technology has no equal worldwide in terms of the precision with which it determines the location for therapy and maintains the coordinates required for therapeutic intervention.

Its high level of precision directly determines the effectiveness of the therapeutic and preventive process and of the treatment performed using the device.

Conclusion

This list can be further expanded to include areas related to monitoring technologies, particularly real-time monitoring of the condition of a user or patient through magnetic resonance sensors based on the principles of electromagnetic resonance spectroscopy, which do not exert any harmful effects on the human body and do not cause any side effects or degenerative-destructive processes.

These effects are achieved, among other factors, through the use of flat-coil sensors manufactured in the form of microcircuit boards using RITM technology and coated with a film of synthetic diamond.

The same technologies are also used in the production of micro-pulse generators and micro-analytical modules.

For these purposes, a system of elastic composite solenoids is also proposed. In addition to serving as monitoring elements, these solenoids function as water-repellent dressings. Since they are manufactured from carbon-carbon composite fabric, they can also serve, in disposable applications, as absorbent dressings, providing a significant therapeutic effect that has been confirmed during testing in leading clinics around the world and in Russia.

Various hybrid technological solutions may become a promising avenue for expanding the application of the medical, orthopedic, and physiotherapeutic technologies developed under the leadership of Kristina Malerik.

Additional Distinguishing Features.

For the printed circuit board module (as a device):

1. The presence of an integrated heat-exchange surface with a two-layer nickel-copper structure, representing one of the most efficient heat-transfer configurations currently known.

2. A minimal distance of only 0.15 mm between the heat-generating surface and the integrated heat-exchange surface.

3. A two-layer nickel-copper structure for all heat-conducting topological elements and pathways.

4. A sequence of materials within the heat-conducting channels consisting of copper-nickel-iron-nickel-copper, representing a highly efficient combination achieved without additional manufacturing costs. This configuration results naturally from the requirements of board fabrication using additive manufacturing methods to create the topology and maximize the thickness of the board's dual-layer conductive structures.

5. The presence of semiconductor nanostructured polycrystalline diamond films on all heat-conducting surfaces, significantly increasing the efficiency of heat dissipation and heat exchange.

6. Placement of the heat-exchange structure directly beneath each heat-generating component, enabling optimal thermodynamic stabilization of these components during operation.

7. The possibility of implementing the same system in a multilayer configuration. In such a design, each layer contains identical heat-removal elements isolated from all current-carrying structures. Heat-transfer channels interconnect the thermal elements of all layers, while diamond coatings are applied to the external elements of each layer, creating a multilayer metal-semiconductor heat-transfer system.

8. Electrical contact for all components and heat-conducting surfaces is achieved through a semiconductor, non-con-

ductive intermediate layer, thereby increasing the reliability of the module and reducing the risk of short circuits.

Manufacturing Method for a Module Intended for the Installation, Cooling, Control, and Monitoring of High-Power Optoelectronic Systems

The method includes:

– Preparation of the surface of a steel strip (coil) (the term "metal strip" may be used instead of "steel strip").

– Application of photoresist.

– Development of the photoresist.

– High-speed jet electrochemical deposition of nickel (2–3 microns thick).

– High-speed jet electrochemical deposition of copper (25–35 microns thick).

Since this technological phenomenon constitutes the principal distinguishing feature of the method and forms the basis of its significant advantages, the following explanation is provided.

High-speed jet electrochemical deposition is an electroplating process carried out in a selectively oriented directed electrolyte flow with a continuously operating electrolyte renewal and recirculation system.

The system includes:

1. An electrolyte reservoir with controlled operating parameters, including:

– Nickel and copper concentration.

– Temperature.

– Acidity or alkalinity level.

– Density.

– Electrical conductivity.

2. Owing to the advantages of the technology, there is no need to use organic activating additives.

3. A pump equipped with a filter.

4. A jet-metallization anode incorporating a component soluble in the specific electrolyte and a component insoluble in the same electrolyte.

The components are arranged sequentially along the direction of electrolyte flow, wherein:

– The insoluble component is manufactured from a composite electrically conductive carbon-graphite fabric.

– It is positioned parallel to the metallized surface and is located last in the direction of electrolyte flow and immediately before the coated surface (the cathode).

– Both components are connected to a positive electrical potential.

– Both components possess selectively adjustable permeability to the electrolyte.

The anode incorporates a system for uniform distribution of electrolyte across the plane of the soluble component. This distribution pattern is automatically reproduced on the insoluble component and consequently on the metallized cathode surface.

Subsequent process stages include:

– Removal of the photoresist.

– Etching of iron from one side to one-half of the thickness of the steel strip.

– Removal of etching products from the surface by aerodynamic treatment followed by hydrodynamic treatment.

– Encapsulation with a low-viscosity polymer composition in the following sequence:

- Filling with monomer.
- Subsequent polymerization.
- Thermal stabilization.

– Etching of iron from the second side (using the same process variations).

– Encapsulation from the second side (using the same process variations).

– Application of a protective coating to the electrically conductive structures.

– Vacuum coating of all heat-conducting structures with a multilayer system composed of semiconductor nanostructured polycrystalline diamond films.

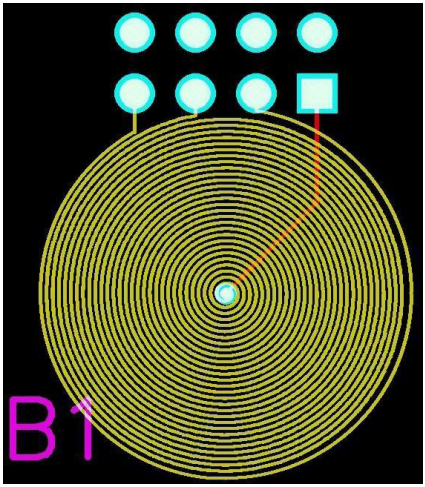


Figure 21. Achievement of the required level of quality and efficiency is ensured through the use of flat coils as electromagnetic resonance sensors, manufactured in the form of microcircuit boards using RITM technology and coated with a film of synthetic diamond

Continuation of this list may be developed in areas related to monitoring technologies, including real-time monitoring of the condition of the smart footwear user, as well as the condition of the user's foot, through magnetic resonance sensors based on the principles of electromagnetic resonance spectroscopy.

The same technologies are also employed in the production of micro-pulse generators and micro-analytical modules.

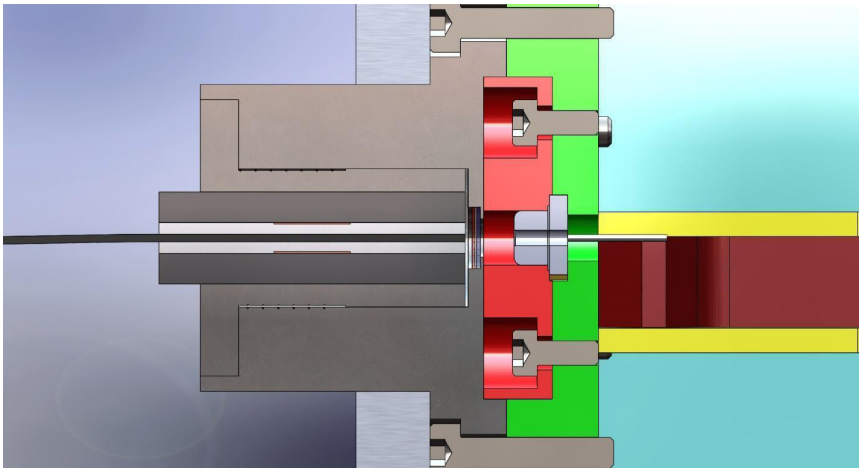


Figure 22.

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