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ADDITIONAL ADVANTAGES OF THE CONTACTLESS ELECTROMAGNETIC RESONANCE SPECTROSCOPY METHOD IN MEASUREMENTS IN THE SMART FAMILY PHYSICIAN'S OFFICE (Additional advantages in the smart family physician's office when using the contactless electromagnetic resonance spectroscopy method for measurement and online integrative analysis of the state of viral infection in the body of the measurement subject, as well as for continuous monitoring of the stages and phases of viral infection development under real-world complex conditions inherent to the measurement subject's body)

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Abstract

This article examines the additional advantages of the contactless electromagnetic resonance spectroscopy method for measurement, online integrative analysis of viral infection, and continuous monitoring of its development under real-world conditions. Particular attention is paid to the method's extremely low energy consumption, which significantly reduces electronic noise while improving the sensitivity and accuracy of measurements.

The article also discusses the design features of the sensor module, including the use of planar and three-dimensional coils, and highlights the potential of the technology for detecting viral infections, assessing antibody activity, and monitoring biological, chemical, and physical parameters in medical and laboratory applications.

The proposed approach combines high sensitivity, contactless measurement, and real-time monitoring, providing a foundation for next-generation intelligent diagnostic systems with broad applications in medicine, biotechnology, and continuous monitoring.

Keywords: *Smart family physician's office; Contactless electromagnetic resonance spectroscopy method; Measurements in the smart family physician's office; Additional advantages in the smart family physician's office when using the contactless electromagnetic*

resonance spectroscopy method for measurement; Additional advantages in the smart family physician's office when using the contactless electromagnetic resonance spectroscopy method for measurement and online integrative analysis of the state of viral infection in the body of the measurement subject, as well as for continuous monitoring of the stages and phases of viral infection development under the real-world complex conditions of the smart family physician's office

Additional advantages of the contactless electromagnetic resonance spectroscopy method in measurement and online integrative analysis of the state of viral infection in the body of the measurement subject, as well as in the continuous monitoring of the stages and phases of viral infection development under the real-world complex conditions inherent to the body of the measurement subject.

As indicated in the description of the contactless electromagnetic resonance spectroscopy method, one of the most important distinguishing characteristics of the proposed method is its extremely low energy consumption during the measurement process – approximately 1,000 times lower than that of contact-based methods.

As a result, the generation of electronic noise is virtually eliminated, thereby increasing both the sensitivity of the measurement process and the accuracy of the measurement results.

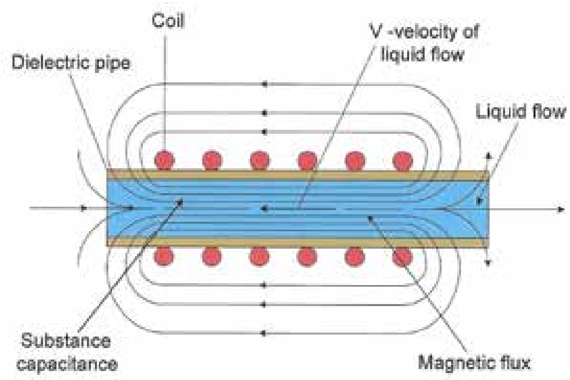
For obtaining and selectively extracting an integral measurement parameter, the above-mentioned advantages make it possible to perform approximately 1,000 input signal variations during the measurement process, differing in both frequency and amplitude (see the appendices for examples).

The design of the sensor in the form of a planar coil with different numbers of active layers has a significant influence on the accuracy and sensitivity of the measurement process. The penetration depth of the probing signal depends on the number of active layers (for example, one layer – penetration depth of 2 millimeters, two layers – penetration depth of 10 millimeters, and so on).

In addition, the proposed method makes it possible to combine different coil configurations within the sensor module – using both a three-dimensional coil and a planar coil in the same sensor, which significantly expands the functional range of monitoring and analytical processing of the measurement results.

Thus, the proposed method makes it possible to measure both the presence of a viral infection and the occurrence and level of antibody activity.

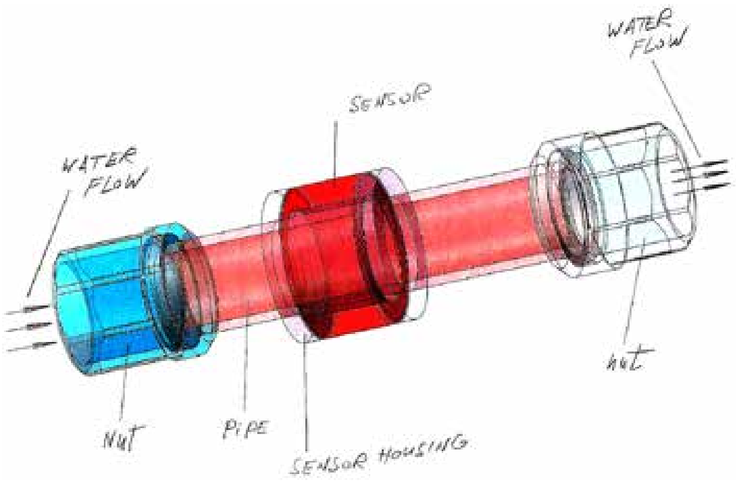
Figure 1.



Applications derived from the proposed monitoring scheme:

– Monitoring of the physical and chemical parameters of a liquid flowing through a pipeline.
– Monitoring of the biological parameters of a liquid flowing through a pipeline.
– Monitoring of the flow rate of a liquid flowing through a pipeline.
– Monitoring of the presence of heavy metal ions and their equivalents in a liquid.
– Monitoring of the presence of bacteria in a liquid.
– Monitoring of the presence of viruses in a liquid.
– Monitoring of the presence of fatty contaminants, somatic cells, and their equivalents in a liquid.
– Monitoring of the acidity levels of a liquid flowing through a pipeline.
– Monitoring of the calorimetric parameters of a liquid flowing through a pipeline.
– Monitoring of the presence of toxic substances and poisons in a liquid flowing through a pipeline.

Figure 2.



The sensor system designed according to the proposed scheme can be installed on any water supply pipeline, process pipeline, specialized technological equipment, and in testing and measurement laboratories.

The proposed sensor system can also be implemented in a portable configuration and can serve as a means for rapid local monitoring and control.

Figure 3.

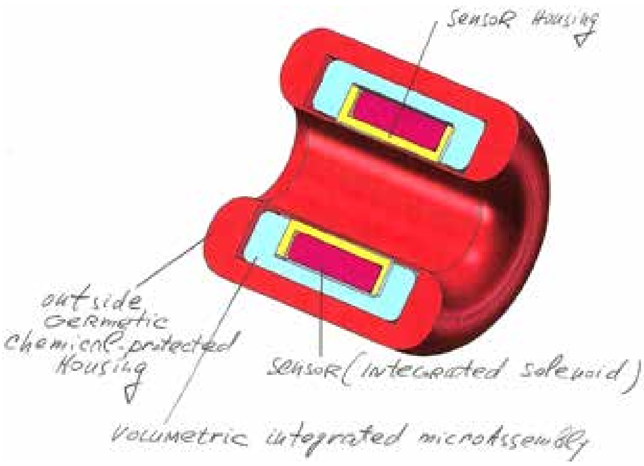
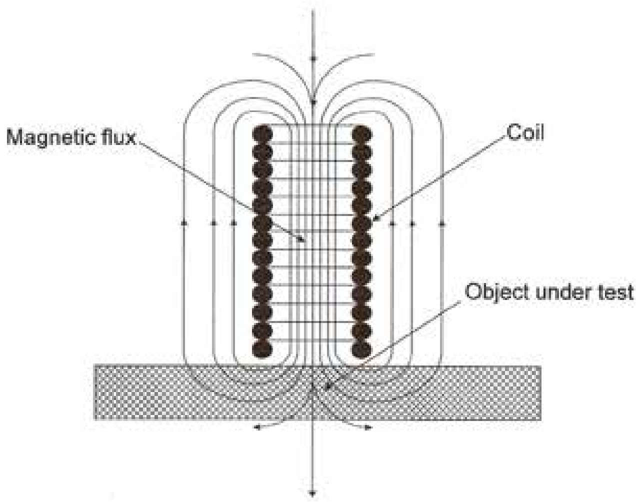


Figure 4.



The sensor system designed according to the proposed scheme can also be used in autonomous monitoring modules for online real-time monitoring and control.

These may include capsules for monitoring the parameters of gastric juice, as well as capsules intended for use in colonoscopy and endoscopy.

The same system can also be used as a technological witness in closed chemical and electrochemical processes.

The sensor system designed according to the proposed scheme, but without a central opening, can also be used in autonomous monitoring modules for online real-time monitoring and control, including applications in medicine and animal husbandry.

These may include capsules for monitoring the parameters of gastric juice, as well as capsules intended for use in colonoscopy and endoscopy.

The same system can also be used as a technological witness in closed chemical and electrochemical processes in which the central channel may be blocked by solid or amorphous particles contained in the liquid.

Figure 5.

The system shown in the model, designed according to a similar scheme, may be equipped with a dedicated battery and a radio transmitter for transmitting the measurement results and system analysis data to a mobile phone or a processor.

Figure 6.

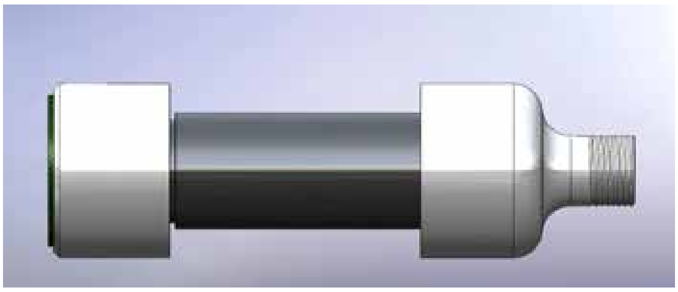
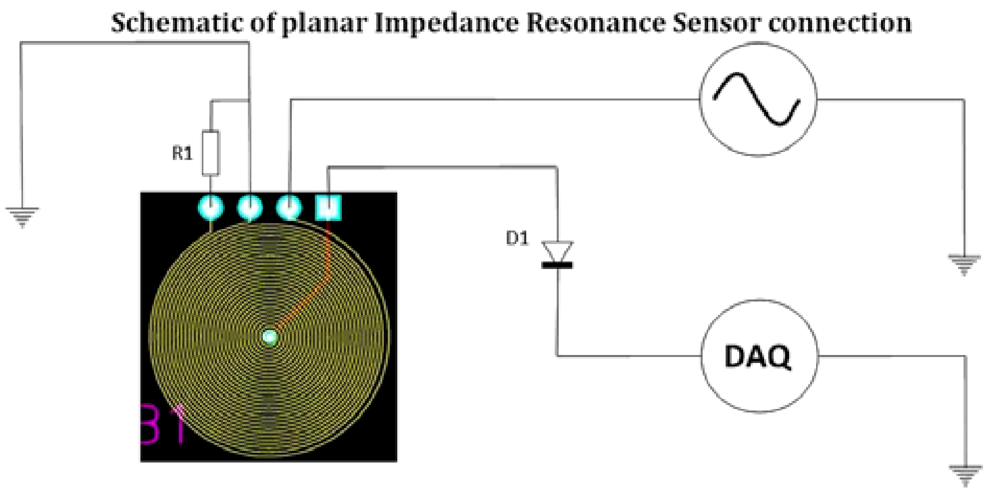


Figure 7.



The system shown in the diagram, employing a planar coil as the sensor, provides significant operational advantages and can also be used as a scanning measuring device.

This design is ideally suited for mass production, and its applications include use as a personal device, as an instrument for a physician's office, and as a laboratory testing and measurement system.

Figure 8.

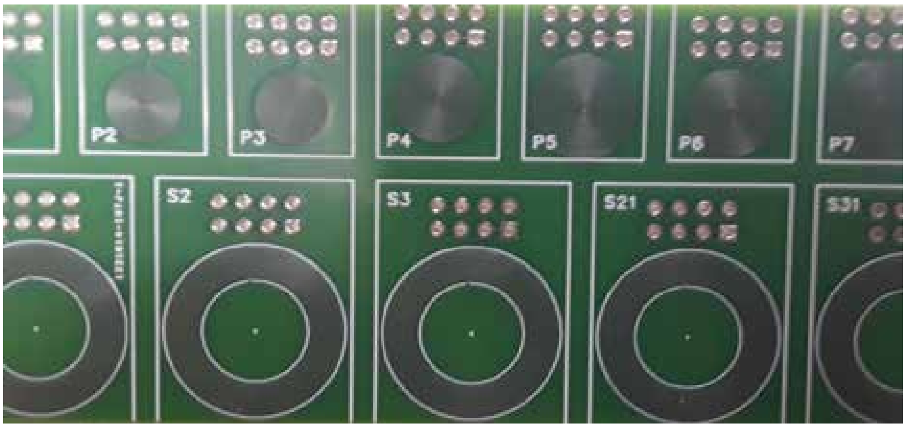


Figure 9.

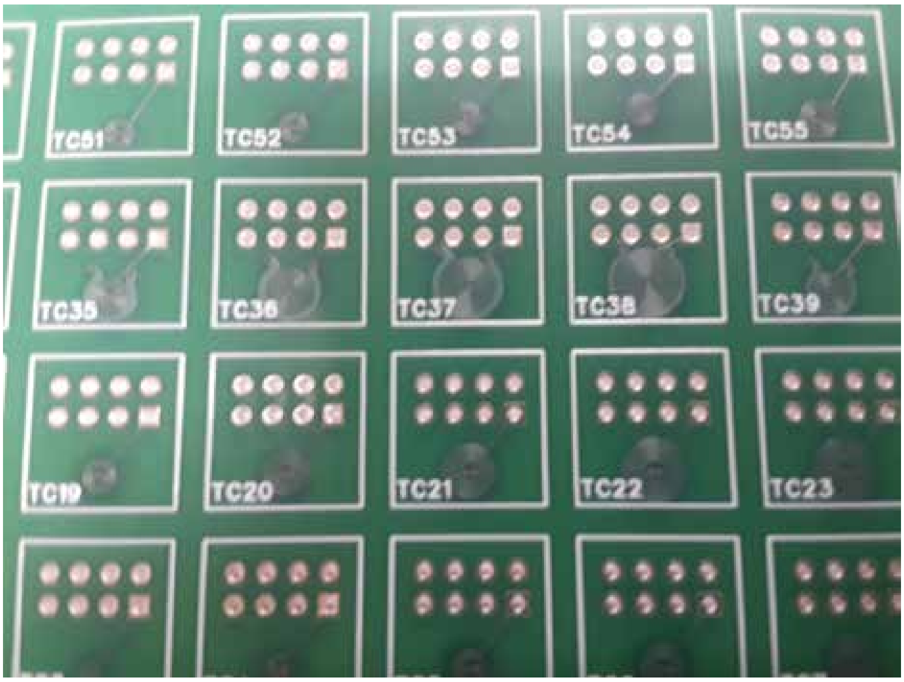


Figure 10.

Appendix 1.

Potential applications of electromagnetic spectroscopy in multifunctional Sensor Technology in medicine and biology.

I. Measurement of the concentration and composition of components in liquids.

These include mixtures of both solutions and dispersed systems: emulsions, suspensions, and biological fluids (blood, milk, lymph, urine, etc.). Due to the high sensitivity of the proposed design options for sensors, the proposed technology can be widely used:

1. In the pharmaceutical industry in technological processes for the production of medicines;

2. For laboratory and off-laboratory analyzes of biological fluids: blood, milk, urine, etc .;

3. In medical, technical and food microbiology for monitoring the concentration of microorganisms and the presence of viruses, including the corona viruses.

II. Measurement of the electromagnetic impedance of biological tissues of the body.

Currently, the measurement of the impedance of biological tissues at different frequencies of alternating current is widely used in diagnostics, as well as in biological and medical research.

For example, a significant increase in tissue impedance at low frequencies can detect inflammation in the early stages. Some thyroid diseases are diagnosed by a change in the phase angle between current and voltage.

Electro – impedance mammography is an effective method for early diagnosis of breast cancer.

Measuring the impedance of the skin helps to diagnose skin diseases, for example, to detect unpainted malignant melanoma and also to identify foci of contamination of the surface of the skin of the corona viruses.

To identify the pathology of the internal organs, an endoscopic impedance measurement can be used. This also includes a non-invasive blood test, for example, for the presence of high sugar levels, and an analysis of the state of lymphatic fluid.

In all the fields of application of impedance measurements listed above, the technology of electromagnetic spectroscopy can contribute, significantly increasing the sensitivity of such measurements.

In addition, the use of these sensors can detect the presence of a corona of viruses in the throat of a person in the initial stages of infection.

The use of methods and technologies of electromagnetic spectroscopy in integrated biosensors.

The term "biosensor" is usually understood as a device in which biological material: (enzymes, tissues, bacteria, yeast, antigens / antibodies, liposomes, organelles, receptors, DNA, viruses, including corona viruses), directly respond to the presence of a signal from of the proposed sensor and generates a resonant signal functionally associated with the presence and concentration of this component.

In this case, using the proposed device implements a fundamentally new way of obtaining information about the chemical composition of the solution.

The presence of a biomaterial with unique properties in the solution allows high selectivity to determine the desired compounds in a complex mixture, without resorting to any additional operations associated with the use of other reagents, concentration, etc. (hence the name – analysis methods without chemical and biological reagents).

Appendix 2.

Brief explanatory description of the sensor module with a single sensor designed as a conventional coil (solenoid).

All structural components of the sensor module are made of irradiated polyethylene or a plastic with similar properties.

In general, the channel through which the measured liquid flows is designed as a communicating vessel with a V-shaped configuration, in which the measured liquid is located in the lower branch of the system.

The description is presented in four figures.

Figure 11.1.

The figure shows, by means of arrows, the flow path of the measured liquid through the combined channel – a communicating vessel in which the sensor is installed on the lower channel with maximum filling of the internal volume at the sensor location.

This arrangement prevents air from entering the measurement zone.

Figure 11.1.

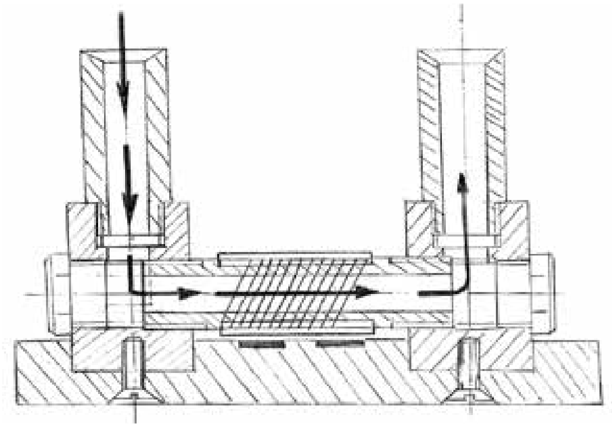


Figure 11.2

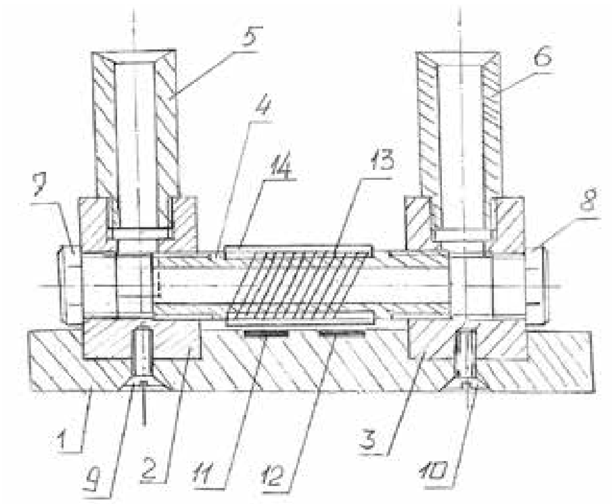


Figure 11.3.

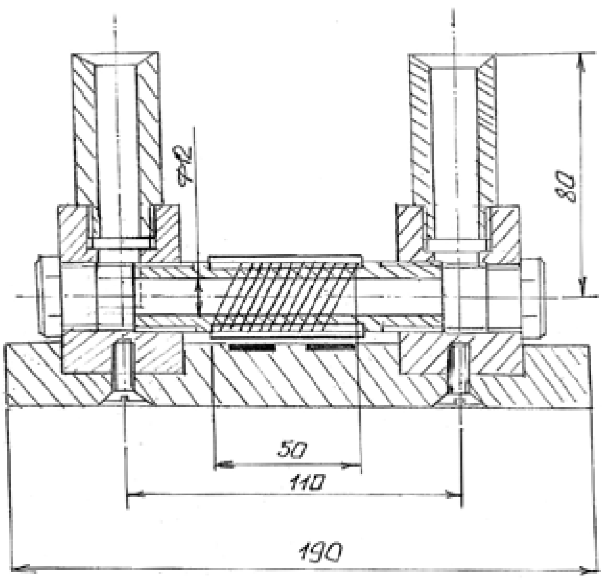


Figure 11.4.

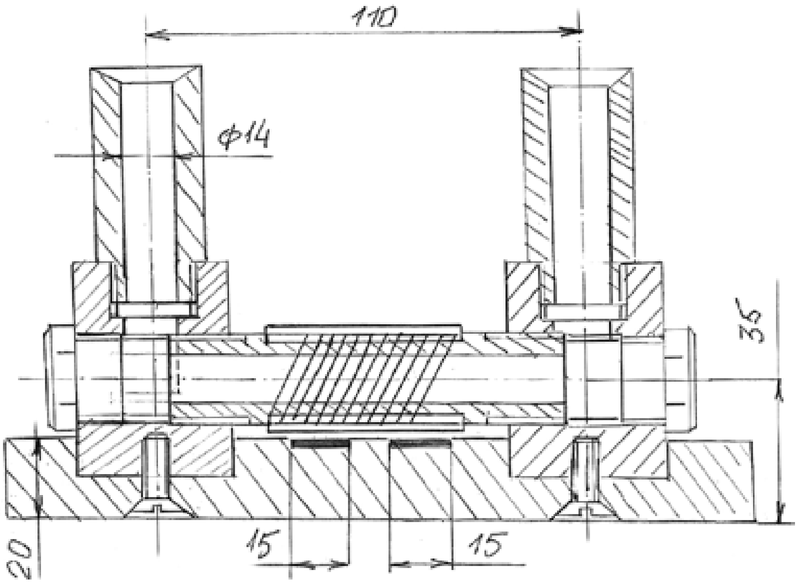


Figure 11.2.

The figure identifies all the components of the sensor module.

The numbered components are as follows:

1 – Base support plate.

The plate is made of plastic and includes two slots for installing and securing the support posts, items 2 and 3, which are fastened to the base support plate using M6 screws, indicated in the figure as items 9 and 10.

Before installing support posts 2 and 3 into the base support plate 1, the sensor working tube, indicated as item 4 in the figure, is screwed into the support posts.

Before assembling the working tube of the sensor (4) with support posts 2 and 3, sensor 13 together with protective shield 14 is mounted onto the working tube.

After that, plugs 7 and 8 and inlet tubes 5 and 6 are screwed into the support posts.

The output from the pulse generator and the input to the monitoring and analytical instrument – the processor (not shown in Figure 11.2.) – are then connected to printed circuit boards 11 and 12.

As a result of the assembly procedure described above, a communicating vessel structure is formed, and after verifying the tightness of all connections, the sensor module can be incorporated into the test unit.

Figure 11.3.

Figure 3 shows the principal overall dimensions of the sensor module with a single sensor.

The length of the solenoid coil is 50 mm.

The distance between the centers of the support posts is 110 mm.

The length of the base of the sensor module with a single sensor solenoid is 190 mm.

The diameter of the measurement channel is 12 mm.

The height of inlet tubes 5 and 6 above the measurement channel with a diameter of 12 mm is 80 mm.

If necessary, this height can be increased.

Figure 11.4.

Figure 11.4. shows the internal diameters of inlet tubes 5 and 6–14 mm.

The height of the center of the measurement channel above the base support plate is 35 mm.

The distance between the axes of inlet tubes 5 and 6 is 110 mm.

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