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(54) **Method and device for validation of coins and counters**

(57) The present invention belongs to the class of the devices for material by mean of electrical and magnetic methods.
The method and the device proposed in the present document are aimed to validate coins and counters by means of their value determining and can be used in payphones, automatic distributors, points of payment and various vending machines.

The present document claims universal method and relative device are proposed which use measurement principles of active and reactive parts of the current (or the tension) of electromagnetic sensor contemporarily on more frequencies with relative coin image formation and its identification.

The analyzing element of the device is a sensor composed of one, two or more bobbins connected between them and enveloped the polar extremes of magnetic conductor with a pass bigger the maximal coin thickness. The mentioned polar extremes have in the section a drop form or triangular form with the base corresponding to minimal diameter of the coin and with the altitude corresponding to maximal diameter of the coins. In order to achieve maximal sensibility and to minimize the sensor exposition at electromagnetic disturbs, the magnetic conductor is realized with maximal closure of the magnetic field with calibrated gap aimed for coin passageway or with double polar extremes for compensated measurement schemes or for those of bridge type.

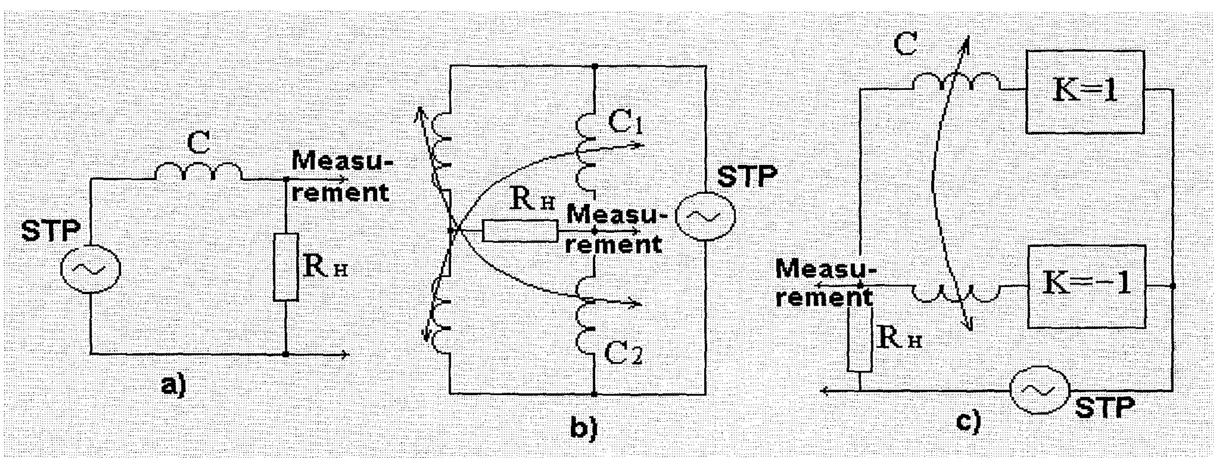

Fig. 3

EP 1 411 480 A2

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Description

[0001] The present invention belongs to the class of the devices for the analysis of materials by means of electrical and magnetic methods. The relative international classifications are the following:

G01 №	27/00 - sensors 27/04 - sensors of active resistance; 27/02 - sensors of impedance; 27/70 - measurement of current or of tension; 27/72 - measurement of magnetic parameters;
G01R	29/08, 29/14 - measurement of electromagnetic field;
G01R	17/10, 17/18 - bridges of alternate and direct current.

[0002] The method and the device proposed in the present document are aimed to validate coins and counters by means of their value determination and can be used in payphones, automatic distributors, points of payment and vending machines.

[0003] There are known devices of coin recognition based on inductive and/or capacitive sensors inserted in resonance circuits of oscillating frequencies or inserted in various measurement amplifiers.

[0004] For example, in the European patent № 304535B1 three independent inductive sensors are claimed, aimed to point out the diameter, the thickness and the alloy of the coin. There are a series of patents of Great Britain №№ 1397083, 1483192, 1272560, 2094008, 1255492 based on inductive sensors inserted in resonance circuits of oscillating frequencies. As supplementary sensors, the optical or contact ones can be used. A device claimed in Russian patent RU 02155381 C2 has two inductive sensors and the authors insure a high stability of measurement for jumping up and for percussion of the coins moving in the pass channel. It is also known a series of patents like Germany № 3007484, USA № 3378469 and Russia RU 2088970 C1 and others dedicated to the improvement of coin pass channel or of measurement sensors. In the devices claimed in the patents EP 0708420 A2 and PCT/GB 96/01109 the algorithms of processing parameters and of recognizing process are proposed. Nevertheless, because of the low selectivity of coin parameters, even the use of rather complex algorithms does not permits to distinguish a large family of coins.

[0005] The common disadvantage of the known devices is their low sensibility to the coin's material and geometry which implies excessive reject of the coins and consequently, a low rate of their validation. This fact .. implies a large specialization of the devices able to recognize a limited number of coins. A prototype device of reference respectively to the solution claimed in the present document is Great Britain patent № 1.483.182. The relative device claimed in this patent is rather complex and uses three electromagnetic sensors connected to three generators of frequencies; but the device recognizes only six coins.

[0006] In order to cancel the mentioned above and other disadvantages, a universal method and relative device are proposed which use measurement principles of active and reactive parts of the current (or the tension) of electromagnetic sensor contemporarily on more frequencies with relative coin image formation and its identification.

[0007] In Fig.1 the functional scheme is reported for the device realizing the above mentioned method.

[0008] The device contains :

- start module - MA;
- sensor - S;
- polyharmonic tension synthesizer for the sensor power supply - STP;
- measurement module - MM;
- executive module- ME;
- numeric data processing module - EN;
- data exchange rail - BUS

[0009] Moreover, the BUS, using a filter F, can be used also for the device power supply through power supply module AL, having on its terminals some power supply stabilized tensions and permitting contemporarily to realize data exchanging between various modules of the device.

[0010] The analyzing element of the device is a sensor composed of one, two or more bobbins connected between them and enveloping the polar extremes of magnetic conductor with a pass bigger than the maximal coin thickness. Moreover, the mentioned polar extremes have in the section a drop form or triangular form with the base corresponding to the minimal diameter of the coin and with the altitude corresponding to the maximal diameter of the coins. The magnetic conductor of the sensor enveloping the bobbins can also be designed in a form III (fig. 2a) or in a form C (fig. 2b). In order to achieve maximal sensibility and to minimize the sensor exposition at electromagnetic disturbs, the magnetic conductor is realized with maximal closure of the magnetic field with calibrated gap aimed for coin passageway (fig. 2c) or with double polar extremes for compensated schemes or for those of bridge type (fig. 2d).

[0011] The present document claims the following types of circuits used for sensor managing: singular inductor (fig. 3a) or double one realized in a compensation bridge scheme or in differential scheme (fig. 3b, 3c). The above mentioned schemes with double sensors have higher sensibility and are auto-compensated for temperature variation and for power supply tension instability.

[0012] The power supply of the sensors is realized using a polyharmonic tension synthesizer of frequencies $f_1 < f_2 <...< f_{k-1} < f_k$, in sonar or ultrasonar band. The requisites of the frequency composition are the following:

1. The set of frequencies $f_1, \ldots f_k$ is chosen by means of division of the base frequency $f_{max} \geq f_k$ by integer numbers with the following selection criteria: the ratio of neighbouring frequencies f_2 / f_1, f_3 / f_2, ..., f_k / f_{k-1} must be semi-integer numbers (2m + 1) / 2, or even ones 2m, where m is any integer number and the minimal frequency is constrained by the condition $f_1 \geq 1 / T$, where T is the period of measurement cycle.

2. In order to increase the working speed of the system, the above mentioned ratio of the frequencies is chosen with $f_{max} = f_k$ with the ratio of neighbouring frequencies f_i / f_{i-1} , $2 \leq i \leq k$ equal to an even number and the signal proportional to the sensor's current is integrated on every quarter of the highest frequency f_k during all the period of the lowest frequency f_1 and then the combinatorial sum of elementary integrals on the above mentioned periods is calculated.

3. The amplitude of the sensor power supply, for every frequency f, must be chosen proportionally to the value f^{β}, where β depends of the sensor typology.

[0013] The determination of active and reactive parts of the current (or conductivity) of the sensor for every frequency with the following image elaboration of the coin is executed in the module of numerical processing (EN) according to the method described above.

[0014] The coin validation device can work in idle regime or in the regime of continuous measurement.

I. In the continuous measurement regime ..... the device works in the following mode:

[0015] By the power supplying of the device, all the modules go to working regime. For the measurement circuit ignition, the coin passage detection is realized by an optical coupling or other sensor registering the coin entering. ..... At the distance $L = V \cdot t_3$ (where V is the coin speed, t_3 - expected time of arrival) the sensor of coin analysis is installed. In such a mode, the coin firstly induces the ignition impulse at an instant $t_0 \leq t_3$ necessary for initialization procedures of the device preparation for the coin measurement.

[0016] The coin, passing through the sensor, alters its electrical parameters implying the current variation on the sensor. The measurement unit transforms the sensor current into the proportional tension and integrates this tension on the intervals determined in the above mentioned method. Whereupon, contemporarily and independently, the integrals of the mentioned signals are summed with initial phase zero and with initial phase 90 electrical degrees determining in such a mode the active and reactive parts of the sensor current for every k of N frequencies. In such a mode, the numerical processing module calculates and records the active and reactive parts of the current for every frequency.

[0017] Such a working regime of the validator is useful for statistical data collection of the coins measurement and for the coin's image processing.

II. The expectation regime is characterized by the fact that in the initial state all the modules are working in economic mode (that is by lower tension of power supply) or are switched-off.

[0018] The coin introduction generates the start impulse as described above. Such an impulse, in the time interval t_3, puts into working regime the numerical processing module ME, the synthesizer of polyharmonic tension STP for the sensor S power supply and the measurement module MM. From this instant, the functionality of the device is identical to those of continuous measurement. In the instant of coin pass, the measurement unit analyses the active and reactive parts of the current for every of N predetermined frequencies. The acquired results are to be compared with 2N parameters of the coin's reference image and the numerical processing module releases the decision to the executive module on acceptance of a good coin or reject of a false one.

[0019] At this point the working process of the proposed device stops and the device returns to the expectation regime.

Claims

1. The method of metallic coins recognition by means of a device which contains coin channel with inductive sensor, generator of the sensor electrical supply and module of numerical processing of the sensor signals where the above mentioned power supply tension of the sensor is a multi-harmonic signal is synthesized as a sum of k tensions of the frequencies $f_1 < f_2 < \ldots < f_{k-1} < f_k$ in sound and ultrasound band. The above mentioned numerical processing module finds contemporarily the active and reactive parts for every frequency and makes the comparative analysis with coin model sample values stored in the device's memory.

2. The method of metallic coins recognition as claimed in p.1 above in which the amplitude of the tension of the sensor power supply, for any frequency $\boldsymbol{f}$, is chosen to be proportional to the value $\boldsymbol{f}^{\beta}$, where β is a parameter which depends on the sensor's design.

3. The method of metallic coin recognition as claimed in pp. 1, 2 above in which the set of frequencies

f_1, ... f_k is chosen by dividing the base frequency $f_{max} \geq f_k$ by integer number with the following selection criteria: the ratio of neighbouring frequencies f_2 / f_1, f_3 / f_2 , ..., f_k / f_{k-1} must be semi-integer numbers (2m + 1) / 2, or even ones 2m, where m is any integer number and the minimal frequency is constrained by the condition $f_1 \geq 1 / T$, where T in the period of measurement cycle.

4. The method of metallic coin recognition as claimed in pp. 1, 2, 3 above in which, in order to discriminate the active and reactive part of the current for every frequency, the signal proportional to the sensor's tension is integrated on time intervals multiple to a quarter of the period of every frequency and then the obtained signals are summed according to certain rules. In particular, the integrals of the mentioned signals are summed with initial phase zero and with initial phase 90 electrical degrees giving in such a mode the active and reactive parts of the sensor current for every k of N frequencies.

5. The method of metallic coin recognition as claimed in pp. 1, 2, 3 and 4 above in which, in order to increase the functional speed of the system, the above mentioned ratio of the frequencies is chosen with $f_{max} = f_k$ with the ratio of neighbouring frequencies f_i / f_{i-1} , $2 \leq i \leq k$ equal to an even number and the signal proportional to the sensor's current is integrated on every quarter of the highest frequency f_k during all the period of the lowest frequency f_1 and then the combinatorial sum of elementary integrals on the above mentioned periods is calculated.

6. The method of metallic coin recognition as claimed in pp. 1, 2, 3, 4 and 5 above containing ignition module, generator of polyharmonic oscillations, the sensors perceptible to variations of the above mentioned oscillations in function of the material and the geometry of tested coins, measurement modules for revelation of the sensor electrical parameter variation, numerical processing module of the measurement results, executive module of the decision "acceptance - reject" of the coin, whose originality is **characterized by** the fact that in the device, in the place of the above mentioned generators of frequencies, a generator of polyharmonic oscillations with the parameters as claimed in pp. 2, 3 and 5 is utilized. The above mentioned generator of polyharmonic oscillations is connected, through the sensor, to the measurement module consisting of two converters, connected in series, of instant value of the sensor's current into the tension proportional to the current connected with integrator of the mentioned tensions as claimed in pp. 4 and 5. The module of numerical processing contains a sub module for active and reactive parts determination of the sensor current as claimed in pp. 1, 4 and 5, an algebraic summation sub module, a memory sub module with predetermined results of the sampled coins, a comparison sub module, of the current measurement with the predetermined data. All the mentioned modules are interconnected by a communication channel.

7. The device of metallic coin recognition as claimed in p. 6 above where, in order to achieve maximal sensibility for geometry and alloy of the coin, the above mentioned sensor is composed of one, two or more bobbins connected between them and enveloping the polar extremes of magnetic conductor with a pass bigger than the maximal coin thickness. Moreover, the mentioned polar extremes have in the section a drop form or triangular form with the base corresponding to the minimal diameter of the coin and with the altitude corresponding to the maximal diameter of the coins.

8. The device of metallic coin recognition as claimed in pp. 1, 2, 3, 4 and 5 above where, in order to achieve maximal sensibility and to minimize the sensor exposition at electromagnetic disturbs, the magnetic conductor is realized with maximal closure of the magnetic field with calibrated gap aimed for coin passageway or with double polar extremes for compensated schemes or for those of bridge type.

9. The device of metallic coin recognition as claimed in pp. 6 and 7 above where, in order to achieve maximal stability for temperature variation, the magnetic conductor is realized with the form in section III with two conical extremes and unique magnetic core.

10. The device of metallic coin recognition as claimed in pp. 6 and 7 above where, in order to achieve maximal sensibility for coin measurement and to reduce the sensor sensibility for temperature variation, and for electronic components growing old, one can use a second sensor or its electromagnetic equivalent connected with the main sensor of revelation by bridge of balancing scheme.

Tav. I

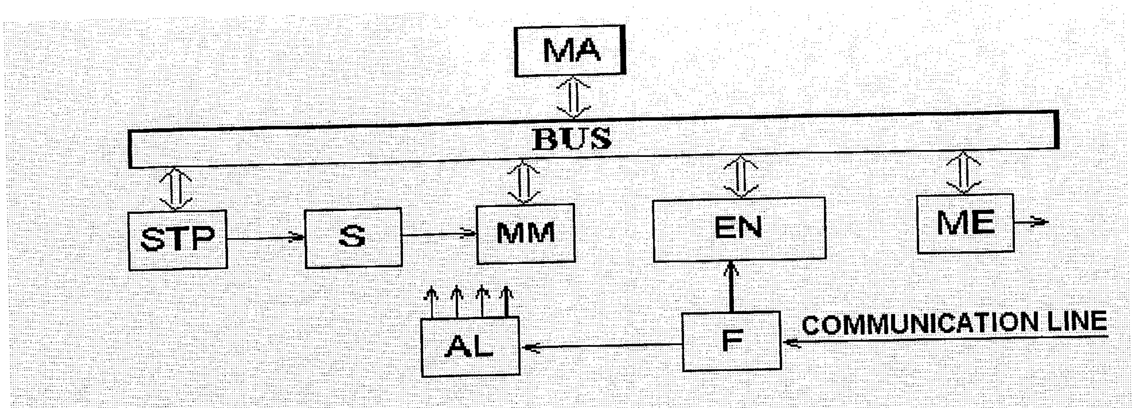

Fig.1

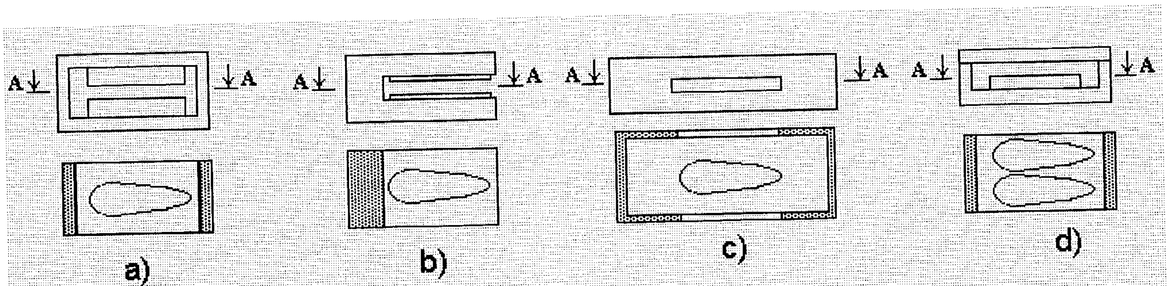

Fig. 2

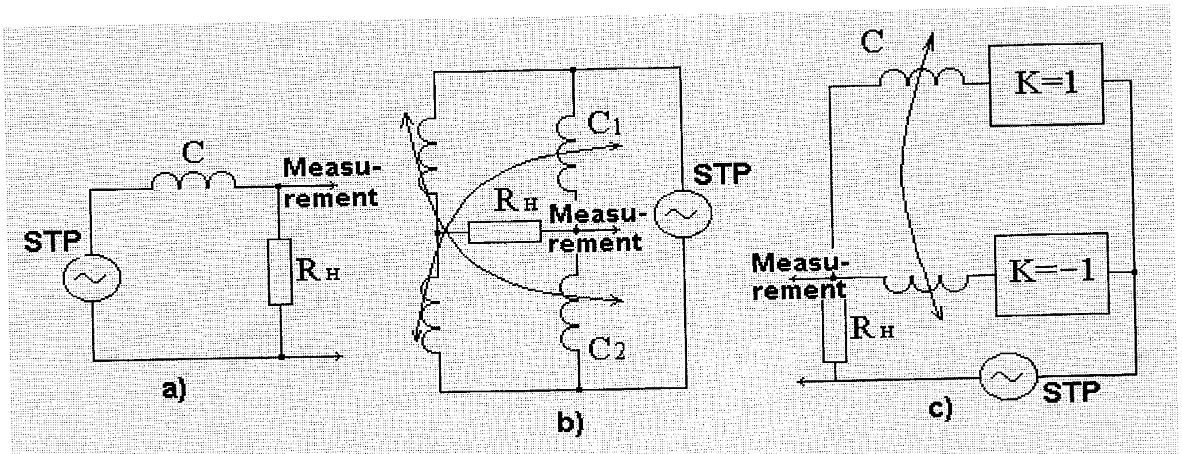

Fig. 3