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(54) **Title**: SEARCH COIL FOR METAL DETECTOR

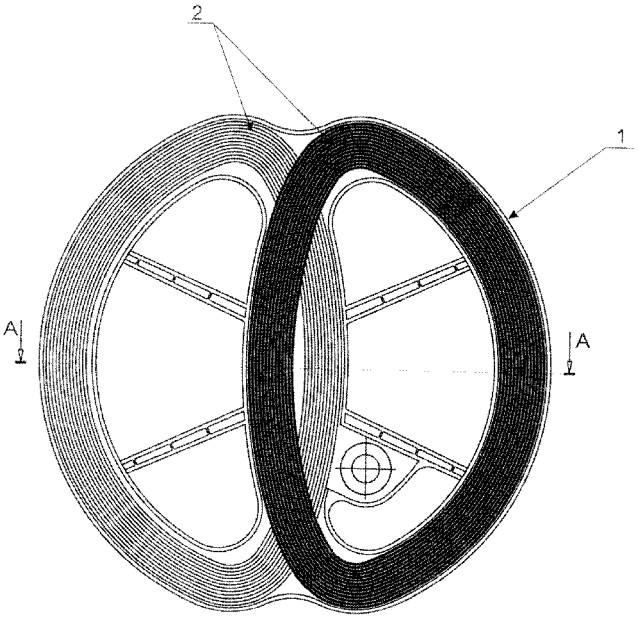

FIG. 4

(57) **Abstract**: The search coil for metal detector is applied in the archaeology, geology, construction, in the military and police practice. The search coil is distinguished with increased sensitivity, being capable of finding different sized metallic objects, buried ax significant depth. The search coil is with a simplified and technologic for production construction, with decreased expenses for materials. The search coil for metal detector consists of a housing (1), in which are placed mutually balanced transmitter (2) and receiver (3) coils. The coils 2 and 3 are wound from spirally situated in one plane windings 4, which could be close one to the other, with no interval between them, or with a distance of 0-10 mm between the windings. The coils 2 and 3 are placed ax a distance one from the other, at an angle towards the lower surface of the housing or touching each other.

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SEARCH COIL FOR METAL DETECTOR

Technical field

[0001] The metal detector search coil is applied in the archaeology, geology, construction, in the military and police practice. The search coil is appropriate for registering all kinds of metal objects, ferrous and non-ferrous metals, no matter their depth and sizes.

Background of the Invention

[0002] There are different designs of detectors for metals known, and the basic active element of these devices is the search coil of the metal detector, in the housing of which are placed transmitter and receiver coils, situated in parallel planes, touching and partially overlapping each other.

[0003] From the practice are known search coils for metal detectors, in which are used different forms of coils, made of copper conductor, with or without insulation, the coil being with round or oval form, or with form ensuring the mutual balancing of the coils.

[0004] Disadvantage of a search coil with the above mentioned coils, is that making the coils by winding the conductor on reels, is obtained a chaotic, promiscuous overlay of the electromagnetic fields, created by each of the windings, respectively of the transmitter and the receiver coils. As a result of this the efficiency of the search coil decreases with more than 15%, a circumstance, which affects additionally the relevant decrease of the sensitivity and detection depth of metallic objects of the metal detector.

[0005] Another disadvantage of the described search coil is the dependence between the size of the search coil and its sensitivity in regards to registering metallic objects of different sizes, and in regards to the different detection depth of such metallic objects. In this way, for example, search coils with diameters lower than 250 mm have good sensitivity to metallic objects with diameter lower than 20 mm, but are not so sensitive and can not reach the necessary detection depth for bigger than 20 mm sized metallic objects. At the same time search coils with larger

than 250 mm diameters have good sensitivity to metallic objects with larger than 20 mm diameters, but differ with low sensitivity to the small, less than 20 mm metallic objects.

[0006] Another disadvantage of the described search coil is connected with the technology of making the coils, as far as by winding of the transmitter and receiver coils' windings on reels is obtained big corpulence of both coils, which determines the necessity of using deeper housing. As a result the total weight of the described search coil is increased, at the same time increased is the expense of materials necessary for the make of the search coil.

[0007] It is known a patent publication – US No512340, concerning a coil used in electric apparatuses and systems, made from windings, placed in a single plane, thus forming "flat coil".

[0008] The windings of the flat coil are wound in a spiral, in one plane, thus ensuring greater difference of potential between its adjacent turns or convolutions, and since the energy is stored in the coil, considering the latter as a condenser, is proportional to the square of the potential difference between two adjacent windings. Due to the described positioning of the windings are created conditions for increasing and correct distribution of the potential between two adjacent windings, as the increase of the capacity of the flat coil is due to the increased potential difference between the spirally wound in one plane windings.

[0009] It is appropriate to note, that for the specialists in the field is well known the correlation between capacity, self-induction, as well as the frequency and the potential difference of the current. With the described positioning of the windings, in each winding there is a certain relation between self-induction and capacity, which allows a flow of a certain frequency and potential to pass through it with no other opposition than that of the normal osmic resistance, or, with other words, as if the winding does not possess self-induction. This is due to the mutual relations existing between the special character of the current and the self-induction and capacity of the coil, the latter quantity is capable of neutralizing the self-induction for that frequency.

[0010] It is well known, that the higher the frequency or the potential difference of the current the smaller the capacity required for counteract the self-induction. Therefore even the small value capacity in each winding could be enough for the purposes stated if the proper conditions in other aspects be secured.

[0011] In the ordinary coils the difference of potential between the adjacent windings is very small, so that, in some sense, the windings have the role of condensers, but they have too small capacity and the relations between the two quantities – self-induction and capacity are not such as under any ordinary conditions, because the capacity relatively to the self-induction is very small.

Summary of the Invention

[0012] Having in mind the described prior state of the technology in the field discussed, the aim of the invention is to offer a search coil for metal detector, showing up increased sensitivity to registering metal objects of different sizes and increased depth of detection of the metallic objects.

[0013] Another task of the useful model is the coils in the metal detector's search coil to be formed and positioned in a way, determining technological and economical manufacturing by decreasing the number of technological operations and the expenses, to be distinguished with easy maintenance and decreased total weight of the search coil.

[0014] The task of the useful model is solved with a search coil for metal detector, consisting of housing, and attached to its lower surface two coils, respectively transmitter and receiver coils, which partially overlap one another.

[0015] According to the useful model the windings of the coils are made as flat coils, with windings, positioned in spiral, in one plane, and the two coils are situated in two parallel planes at 0 to 30mm distance between them.

[0016] In accordance with one variant of performing the useful model the windings of the coils are situated in different planes.

[0017] In accordance with one variant of making the search coil the coils are positioned at an angle of 1 – 10 Degrees towards the horizontal plane.

[0018] It is appropriate the windings of the coils to be at 1 to 10 mm distance one from another.

[0019] It is preferable if the coils are made from a conductor with 0.02 to 5.00 mm thickness.

[0020] In accordance with one variant of making the coils the latter are made from a multicore conductor with 0.02 to 5.00 mm thickness.

[0021] According to one variant of implementation of metal detector's searchcoil, the coils consist of a basis, representing a layer of insulation material, and covered with a layer of electro-conductive material with outlined on it windings in spiral form.

[0022] The coils of the search coil are made in a D form.

[0023] The coils of the search coil are made with oval form.

[0024] In dependence with tangible implementation of the metal detector the search coil could be made in a way, that the form of the housing is the same as the form of the coils.

[0025] In accordance with one variant of the search coil's make-up the form of the housing is different from the form of the coils.

[0026] The advantages of the search coil for metal detector according to the useful model are that it is distinguished with increased sensitivity regarding metallic objects with different sizes, and their search is effective at greater depths in comparison with analogical constructions of search coils with two coils. The increased sensitivity is due to the flat coils used, with windings wound in spiral in one plane, and with that practically antennae is obtained, formed by numerous, decreasing by size antennas, which makes the search coil equally sensitive to the small, and to bigger sized metallic objects too. The sensitivity is improved additionally by positioning the flat coils at a distance one from the other, including at an angle one towards the other, which ensures correct distribution of the electromagnetic fields of each winding of the transmitter and receiver coils, and also improved is their mutual balancing and the efficiency coefficient of the search coil.

[0027] Another advantage of the utility model, is that the described way of positioning the windings – in spiral, in one plane – allows the realization of coils with a thickness equal to that of the section of the conductor they are made from.

[0028] This circumstance allows the positioning of the transmitter and receiver coils in much shallower housing, resulting in search coil with much lower weight.

[0030] Additionally, from technological point of view, the production of the search coil is significantly simplified, as far as the technological expenses for materials are decreased, dropping off the fulfillment of some technological operations like fixing and balancing the coils.

Brief Description of the Drawings

[0031] Further in the description the search coil for metal detector according to the useful model is presented by examples of fulfillments with the help of the accompanying the description drawings, where:

Fig.1 – general, axonometric view of housing of search coil of the prior state of the technology.

Fig. 2 – view from below of the housing from Fig.1 with transmitter and receiver coils put in it

Fig.3 – cross-section of the housing from Fig.2, with D-formed transmitter and receiver coils with square section of the windings put in it.

Fig.4 – view of a search coil for metal detector with two flat, D-shaped coils, with windings positioned in spiral in one plane.

Fig.5 – cross-section of a search coil from Fig.4 with two flat coils, positioned at a distance one from the other.

Fig.6 – cross-section of a search coil from Fig. 4, with two flat coils, touching each other.

Fig. 7 – cross-section of a search coil from Fig.4, with two flat coils, positioned at an angle one from the other.

Fig.8 – cross-section of a search coil, with coils, made from bilaterally conductive layer, with outlined windings, wound in spiral.

Details description of the Invention

[0032] Exemplary implementations of search coil for metal detector in accordance with the useful model are shown with more details in description and referring to the accompanying the description drawings. Although, the specialists in the field would easily accept, and assess, that the exemplary descriptions, with some figures, are for explanation purposes, as the range of protection of the useful model spreads out of these exemplary implementations, without putting any limits to them, and allows the specialists in the field find out numerous alternative and appropriate constructive fulfillments of the searchcoil, preferred in dependence with the needs of the concrete application of the metal detector, with precise carrying out of the presented herewith detailed exemplary implementation. That means, that the substantial signs allow the realization of numerous modifications and variations of the useful model, which are included in the range of protection of the useful model. Also, where appropriate the used words in plural should be understood also in single, and vice versa, as the alternative variants does not presuppose by all means, that both are mutually incompatible.

[0033] One preferred exemplary implementation of the search coil in accordance with the useful model is shown on fig.4 – it consists of housing 1, on the lower surface of which are put flat transmitter 2 and receiver 3 coils. The flat coils are made of spirally positioned windings 4, oriented in one plane, where the transmitter 2 and the receiver 3 coils are situated at a distance one from the other.

[0034] The described basic construction of search coil with two flat coils allows the realization of different constructive decisions, part of which are described in exemplary implementations.

Example 1.

[0035] One preferred exemplary implementation of the search coil in accordance with the useful model is shown on fig. 4, which consists of housing 1, in which are put flat transmitter 2 and receiver 3 coils. The housing is with a circle form, and is made of polymer. Each of the coils 2 and 3 is made in D form, with spirally positioned windings 4. The windings 4 of the flat coils are made of insulated,

multi-core conductor, with 0.5mm diameter, as all the windings 4 of the coils 2 and 3 are wound closely, with no interval between them, and lie in one plane. The transmitter 2 and the receiver 3 coils lie in parallel planes, which are at 10 mm distance one from the other.

Example 2.

[0036] The search coil consists of housing 1, in which are placed transmitter 2 and receiver 3 coils (Fig.6). The housing 1 is made of polymer with a circle form. Each of the coils 2 and 3 is made with an oval form, for example ellipse, with spirally positioned windings 4. The windings 4 are made of single-core conductor, with 1.2 mm diameter, and all the windings 4 of the flat coils 2 and 3 lie on one plane. The transmitter 2 and the receiver 3 coils lie in parallel planes, with no interval between them, the coils are touching one another, fixed in inductive balance, i.e. mutually balanced.

Example 3.

[0037] As shown on Fig 7, the search coil consists of housing 1, in which are placed transmitter 2 and receiver 3 coils. The housing is oval, made of polymer. Each of coils 2 and 3 is made in a circle form, with spirally positioned windings 4. The windings 4 are made of single-core conductor, with 1.5 mm diameter, and all windings 4 of coils 2 and 3 lie in one plane. The flat transmitter 2 and receiver 3 coils are oriented at 5° angle towards the lower surface of the housing 1.

Example 4.

[0038] The search coil consists of housing 1, in which are placed transmitter 2 and receiver 3 coils. The housing 1 is made of polymer, with oval form, for example ellipse. Each of the coils 2 and 3 is made in oval form, with spirally positioned windings 4. The windings 4 are made of multi-core insulated conductor, with 1.8 mm diameter, and all windings 4 of coils 2 and 3 lie in one plane. The transmitter 2 and the receiver 3 coils lie in parallel planes, positioned at 28 mm distance one from the other, fixed in inductive balance, i.e. mutually balanced.

Example 5.

[0039] The search coil's made in accordance with the constructive decision in Example 1. The difference is that the windings 4 of the coils, not shown on the figures, are situated in different planes, thus forming a coil with conical form.

Example 6.

[0040] The search coil consists of housing 1, in which are placed transmitter 2 and receiver 3 coils. The housing 1 is made from polymer in circular form. Each of the coils 2 and 3 is made in D shape, with a base of insulation material, covered with a layer of electro-conductive material, in a spiral form, all windings 4 of the coils 2 and 3 are formed closely, without interval between them, and lie in one plane. The transmitter 2 and receiver 3 lie in parallel planes, at a distance of 20 mm one from the other.

[0041] In accordance with one variant of implementation of the search coil for metal detector the flat coils 2 and 3 are made in the following way – on a bilaterally foiled conductive material, for example textolit, by printing are made spirally wound transmitter 2 and receiver 3 coils (Fig. 8), respectively on the one side of the textolit is made the transmitter 2 coil, and on the other side of the textolit is made the receiver coil 3.

CLAIMS

1. Search coil for metal detector, consisting of housing and two coils placed in it, respectively receiver and transmitter coils, which partially overlap, distinguished with the implementation of the two coil (2,3), which are made of windings (4), positioned spirally, in one plane, where the flat coils (2,3) are placed in two parallel planes and are at 0 to 30 mm one from the other.

2. Search coil for metal detector in accordance with claim 1, characterized with the positioning of the windings (4) of the two coils (2,3) in different planes.

3. Search coil for metal detector in accordance with claim 1, characterized with that the flat coils (2,3) are positioned at an angle of m1 to 10 degrees towards the lower horizontal plane of the housing (1).

4. Search coil for metal detector in accordance with claim 1, where the windings (4) of the flat coils (2,3) are positioned at 0-10 mm distance one from the other.

5. Search coil for metal detector in accordance with claim 1, where the flat coils (2,3) are made of a single-core or multi-core conductor with thickness of 0.02 to 5.00 mm.

6. Search coil for metal detector in accordance with claim 1, where the flat coils (2,3) consist of a base of insulation material, covered with a layer of electro-conductive material, in the form of spiral.

7. Search coil for metal detector in accordance with claim 1, where the coils 2 and 3 are made on a bilaterally foiled sheet with conductive material- on the one side of the conductive material is made the transmitter (2), and on the other side of the sheet is made the receiver (3) coil.

8. Search coil for metal detector in accordance with claim 1, where the flat coils are made with oval form.

9. Search coil for metal detector in accordance with claim 1, where one of the coils (2,3) is made in oval form, and the other oil – with a circular form.

10. Search coil for metal detector in accordance with claim 1, where the shape of the housing (1) is the same as the form of the coils (2,3).

11. Search coil for metal detector in accordance with claim 1, where the form of the housing (1) is different from the form of the coils (2,3).

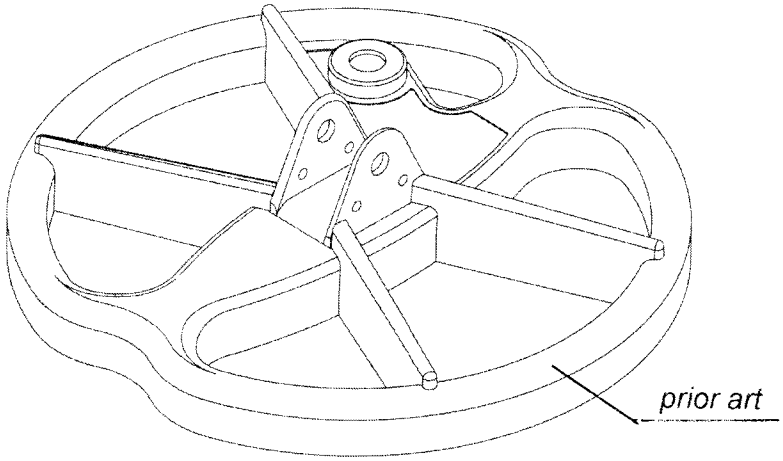

FIG. 1

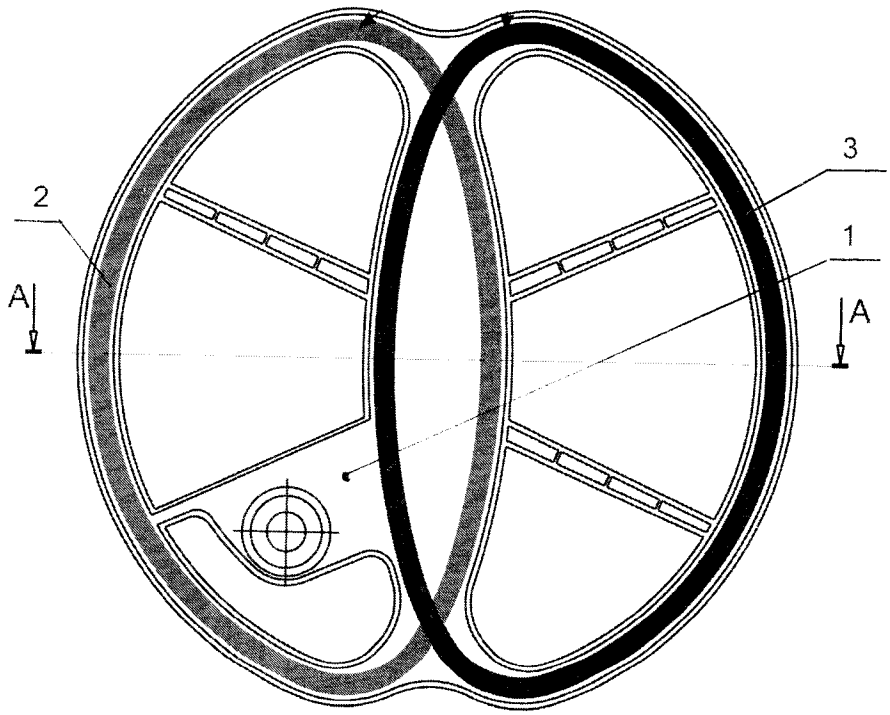

FIG. 2

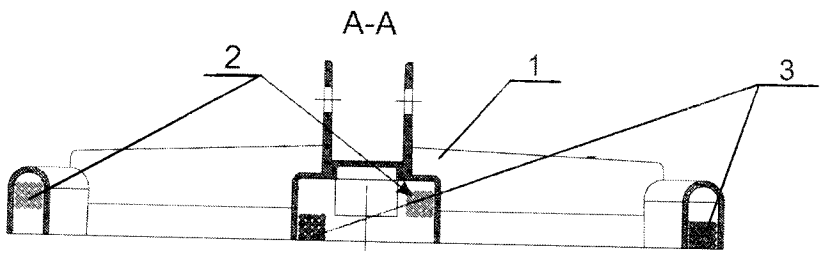

FIG. 3

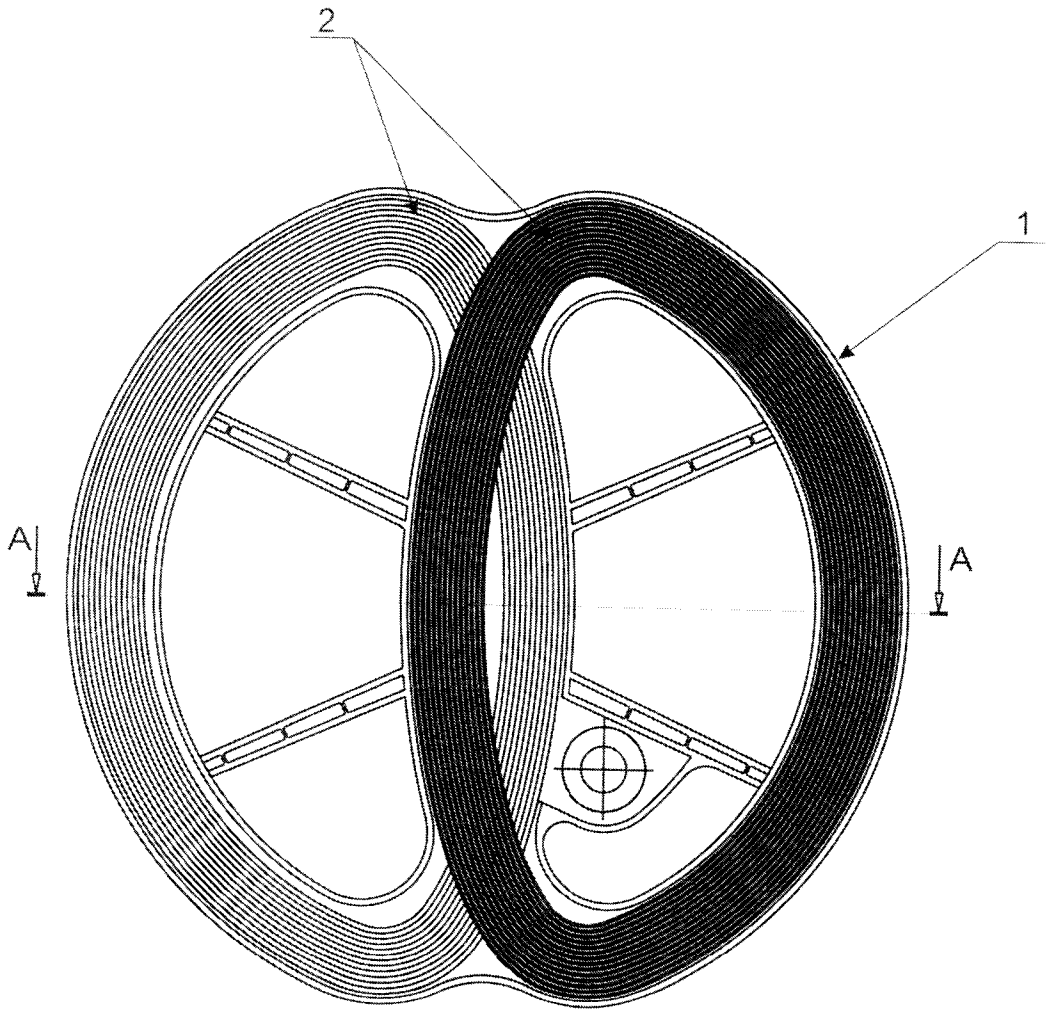

FIG. 4

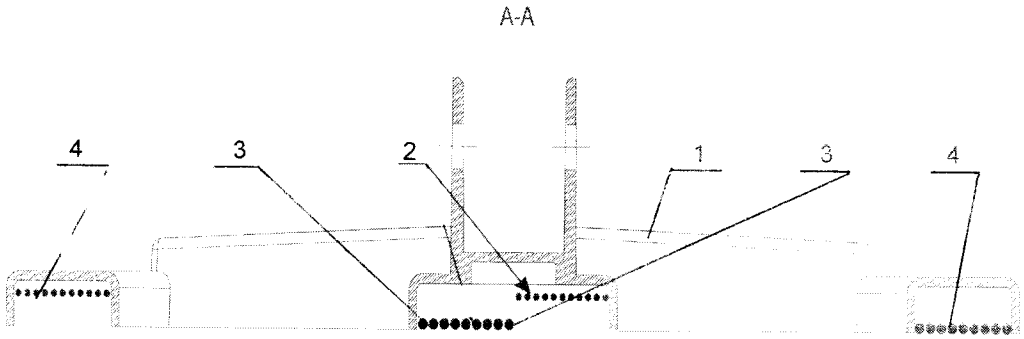

FIG. 5

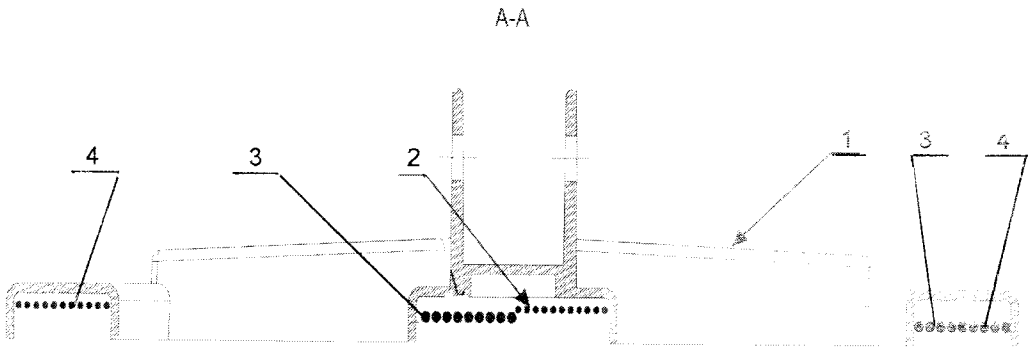

FIG. 6

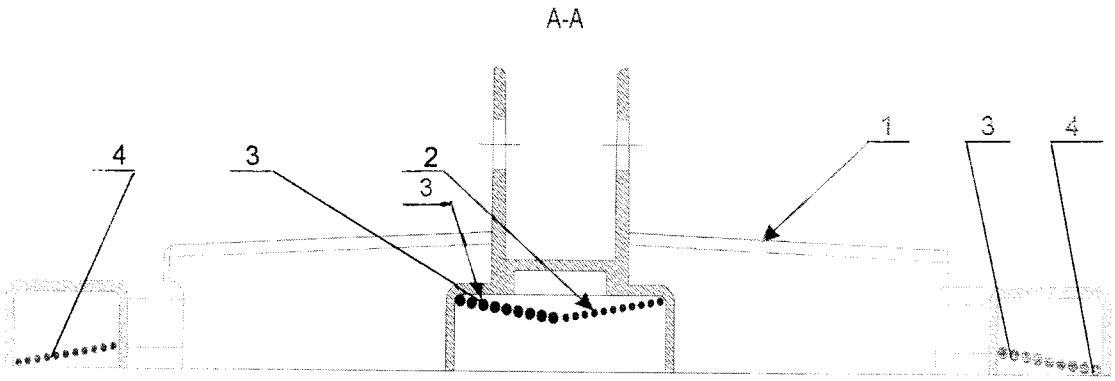

FIG. 7

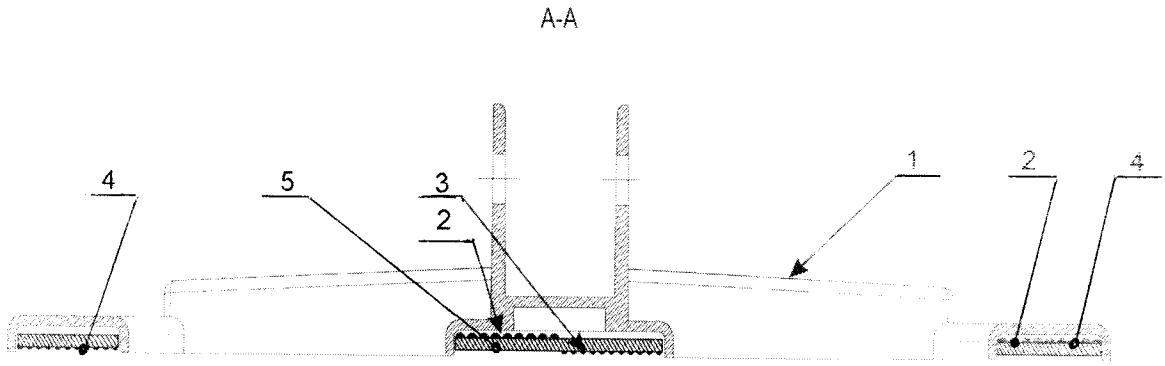

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/BG 2015/000035

A. CLASSIFICATION OF SUBJECT MATTER

G01V 3/11 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01V 3/10, 3/11

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10318350 B3 (WERNER TURCK GMBH & CO. KG) 09.12.2004, par. [0025], [0026], fig. 1-4	1, 4, 6-7
Y		2, 5, 8-11
A		3
X	US 2012/0049850 A1 (GERD REIME) 01.03.2012, par. [0032], [0013], fig. 1, 8, 10	1
Y	US 5729143 A (ZIRCON CORPORATION) 17.03.1998, fig. 1B, col. 3, lines 51-57	2
Y	EP 0654685 A2 (VALLON GMBH) 24.05.1995, p. 4, col. 5, lines 11-12, 47-48, fig. 1, 2b	8-10
Y	US 4423377 A (GARRETT ELECTRONICS) 27.12.1983, col. 3, lines 54-57, col. 2, lines 19-28, fig. 1, 2	5, 11

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 February 2016 (29.02.2016)	17 March 2016 (17.03.2016)

Name and mailing address of the ISA/RU:	Authorized officer
Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	T. Schukina Telephone No. 499-240-25-91