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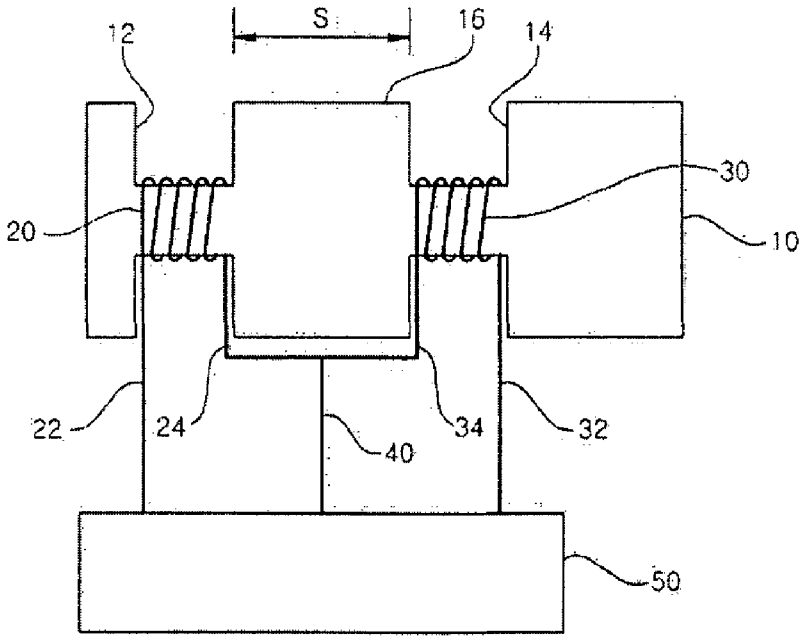
(54) **Title**: INDUCTIVE PROXIMITY SENSOR



(57) **Abstract**: An inductive proximity sensor includes a bobbin configured to have a first winding unit formed on the side to which an object to be detected approaches and a second winding unit formed with a blocking plate for blocking a magnetic field interposed between the first winding unit and the second winding unit; a pair of first and second sensor coils wound on the first and the second winding units of the bobbin, respectively, and configured to have respective one ends grounded together; and a signal processor coupled with the other ends of the first and the second sensor coils and a line connected to a ground portion where the one ends are grounded together and configured to analyze a change of a received first signal based on a received second signal by processing a change of received signals to determine whether the object to be detected approaches or not based on a result of the determination.

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Description

Title of Invention: INDUCTIVE PROXIMITY SENSOR

Technical Field

[1] The present invention relates to an inductive proximity sensor and, more particularly, to an inductive proximity sensor capable of precisely detecting whether a metal object approaches or not irrespective of temperature or surrounding environments.

Background Art

[2] In general, a proximity sensor is used to detect whether an object to be detected approaches or not within a detection range. In particular, a proximity sensor is used in the automation of manufacturing equipment in order to detect whether a metal object approaches or not.

[3] For example, the switch of a brake light for a vehicle is installed in such a way as to operate in conjunction with a brake pedal and is also used when whether or not a driver has pressed the brake pedal with his or her foot is detected using a proximity sensor in a non-contactless way.

[4] Korean Patent Registration No. 10-0689196 discloses a technique related to a switch for a vehicle using the principle of a proximity sensor.

[5] In the proximity sensor of the patent, whether an object to be detected (e.g., a brake pedal) has approached or not within a detection range is performed by measuring an inductance value of a coil. Here, more precise measurement is made possible when the influence of surrounding environments on the inductance value of the coil is a minimum.

[6] In general, a coil has an inductance value varying according to a change of temperature, etc. Accordingly, whether an object to be detected approaches or not can be detected more precisely by compensating for the varying inductance value.

Disclosure of Invention

Technical Problem

[7] The present invention has been made in view of the above problems, and it is an object of the present invention to provide an inductive proximity sensor capable of detecting whether an object to be detected approaches or not always precisely because a change of an external environment, such as temperature, is autonomously compensated for.

Solution to Problem

[8] An inductive proximity sensor in accordance with an embodiment of the present invention includes a bobbin configured to have a first winding unit formed on the side to which an object to be detected approaches and a second winding unit formed with a

blocking plate for blocking a magnetic field interposed between the first winding unit and the second winding unit; a pair of first and second sensor coils wound on the first and the second winding units of the bobbin, respectively, and configured to have respective one ends grounded together; and a signal processor coupled with the other ends of the first and the second sensor coils and a line connected to a ground portion where the one ends are grounded together and configured to analyze a change of a received first signal based on a received second signal by processing a change of received signals to determine whether the object to be detected approaches or not based on a result of the determination.

[9] The thickness of the blocking plate preferably is 3 mm or more in order to minimize a change of a magnetic field occurring when the object to be detected approaches.

[10] The length of the winding of the first sensor coil is the same as the length of the winding of the second sensor coil.

Advantageous Effects of Invention

[11] In accordance with the inductive proximity sensor according to an embodiment of the present invention, a signal value of the first sensor coil having a varying magnetic field is analyzed based on whether an object to be detected approaches or not on the basis of a signal value of the second sensor coil having a fixed magnetic field although the object to be detected approaches, and whether the object to be detected approaches or not is detected based on a result of the analysis. Accordingly, an influence due to surrounding environments, such as temperature, can be minimized, and detection can be performed always precisely.

[12] For example, a change in the signal values of the first sensor coil and the second sensor coil attributable to surrounding environments, such as temperature, is the same in the first sensor coil and the second sensor coil. If a signal value of the first sensor coil is analyzed based on a signal value of the second sensor coil that is not influenced by whether the object to be detected approaches or not, whether the object to be detected approaches or not can be detected always precisely.

Brief Description of Drawings

[13] FIG. 1 is a side view showing an inductive proximity sensor in accordance with an embodiment of the present invention;

[14] FIG. 2 is a graph showing a change in the inductance values measured when an object to be detected approaches in the inductive proximity sensor in which a blocking plate has a thickness of 3 mm or more in accordance with an embodiment of the present invention; and

[15] FIG. 3 is a graph showing a change in the inductance values measured when an object to be detected approaches in the inductive proximity sensor in which a blocking

plate has a thickness of less than 3 mm in accordance with an embodiment of the present invention.

Mode for the Invention

[16] An exemplary embodiment of the present invention is described in detail below with reference to the accompanying drawings so that those skilled in the art can easily practice the present invention. In the exemplary embodiment of the present invention, specific technical terms are used for the clarity of the contents. It is however to be noted that the present invention is not limited to the specific terms and each specific terminology includes all technical synonyms operating in a similar way in order to accomplish similar objects.

[17] An inductive proximity sensor in accordance with an exemplary embodiment of the present invention is described in detail below with reference to the accompanying drawings.

[18] The present invention can be implemented in various forms and is not limited to the following embodiment.

[19] Hereinafter, in order to clarify a description of the present invention, a detailed description of parts not closely related to the present invention is omitted. In the entire specification, the same or similar reference numbers are used to refer to the same or similar elements, and a redundant description of the parts is omitted.

[20] First, the inductive proximity sensor in accordance with an embodiment of the present invention includes a bobbin 10, a pair of a first sensor coil 20 and a second sensor coil 30, and a signal processor 50, as shown in FIG. 1.

[21] A first winding unit 12 on which the first sensor coil 20 is wound and a second winding unit 14 on which the second sensor coil 30 is wound are formed in the bobbin 10.

[22] For example, the first winding unit 12 can be formed on the side to which an object to be detected approaches, and a blocking plate 16 for blocking a magnetic field is formed between the first winding unit 12 and the second winding unit 14.

[23] The bobbin 10 is made of synthetic resin.

[24] The first sensor coil 20 is wound on the first winding unit 12 of the bobbin 10, and the second sensor coil 30 is wound on the second winding unit 14 of the bobbin 10.

[25] The length of the winding of the first sensor coil 20 is the same as the length of the winding of the second sensor coil 30.

[26] The blocking plate 16 formed between the first winding unit 12 and the second winding unit 14 maintains a thickness S of 3 mm or more.

[27] If the thickness S of the blocking plate 16 is less than 3 mm, an inductance value of the second sensor coil 30 is changed when an object to be detected, for example, a

metal material approaches the first winding unit 12.

[28] As the thickness S of the blocking plate 16 is increased, a change in the magnetic field of the second sensor coil 30 due to an object to be detected can be minimized, but the thickness S of the blocking plate 16 preferably is determined by taking the total size and weight of the bobbin 10 and a reduction raw material costs into consideration.

[29] A first ground terminal 24, that is, one end of the first sensor coil 20, and a second ground terminal 34, that is, one end of the second sensor coil 30, are grounded together.

[30] A ground signal line 40 is drawn from a ground portion where the first ground terminal 24 of the first sensor coil 20 and the second ground terminal 34 of the second sensor coil 30 are grounded together.

[31] A first sensor signal line 22 is drawn from the other end of the first sensor coil 20, and a second sensor signal line 32 is drawn from the other end of the second sensor coil 30.

[32] The ground signal line 40, the first sensor signal line 22, and the second sensor signal line 32 are coupled with the signal processor 50.

[33] The signal processor 50 compares a signal value (i.e., inductance value) received through the first sensor signal line 22 and the ground signal line 40 with a signal value (i.e., inductance value) received through the second sensor signal line 32 and the ground signal line 40 and determines whether an object to be detected approaches or not based on a result of the comparison.

[34] For example, the signal processor 50 can determine a change of a signal value (i.e., inductance value), received through the first sensor signal line 22 and the ground signal line 40, on the basis of a signal value (i.e., inductance value) received through the second sensor signal line 32 and the ground signal line 40 and detects whether an object to be detected approaches or not based on a result of the determination.

[35] FIG. 2 is a graph showing a change in the inductance values measured when an object to be detected approaches in the inductive proximity sensor in which the blocking plate 16 has a thickness of 3 mm or more in accordance with an embodiment of the present invention, and FIG. 3 is a graph showing a change in the inductance values measured when an object to be detected approaches in the inductive proximity sensor in which the blocking plate 16 has a thickness of less than 3 mm in accordance with an embodiment of the present invention.

[36] From FIG. 2, it can be seen that a signal of a reference coil (i.e., a blue line in FIG. 2), that is, a signal value (i.e., inductance value) received through the second sensor signal line 32 and the ground signal line 40, has a constant value when the blocking plate 16 has a thickness of 3.5 mm.

[37] From FIG. 3, it can be seen that a signal of a reference coil (i.e., a blue line in FIG.

3), that is, a signal value (i.e., inductance value) received through the second sensor signal line 32 and the ground signal line 40, has a partially varying value when the blocking plate 16 has a thickness of 2 mm.

[38] Accordingly, it can be seen that when the blocking plate 16 has a thin thickness, a magnetic field of the second sensor coil 30 is changed when an object to be detected approaches.

[39] In accordance with the present invention, experiments performed by changing the thickness of the blocking plate 16 variably revealed that there is no change in the magnetic field (i.e., a change in the inductance value) of the second sensor coil 30 when the blocking plate 16 has a thickness of 3 mm or more.

[40] While an exemplary embodiment of the inductive proximity sensor according to the present invention has been described, the present invention is not limited to the disclosed embodiment, but the present invention can be changed in various ways within the spirit and scope of the appended claims, the specification, and the accompanying drawings. The modifications also fall within the scope of the present invention.

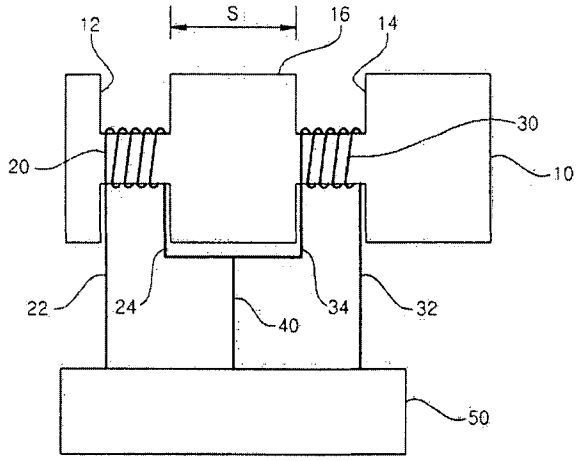
Claims

[Claim 1] An inductive proximity sensor, comprising:
a bobbin configured to have a first winding unit formed on a side to which an object to be detected approaches and a second winding unit formed with a blocking plate for blocking a magnetic field interposed between the first winding unit and the second winding unit;
a pair of a first sensor coil and a second sensor coil wound on the first winding unit and the second winding unit of the bobbin, respectively, and configured to have respective first ends grounded together; and
a signal processor coupled with second ends of the first sensor coil and the second sensor coil and a line connected to a ground portion where the first ends are grounded together and configured to analyze a change of a received first signal based on a received second signal by processing a change of received signals to determine whether the object to be detected approaches or not based on a result of the determination.

[Claim 2] The inductive proximity sensor of claim 1, wherein a thickness of the blocking plate is 3 mm or more.

[Claim 3] The inductive proximity sensor of claim 1 or 2, wherein a length of the winding of the first sensor coil is identical with a length of the winding of the second sensor coil.

[Fig. 1]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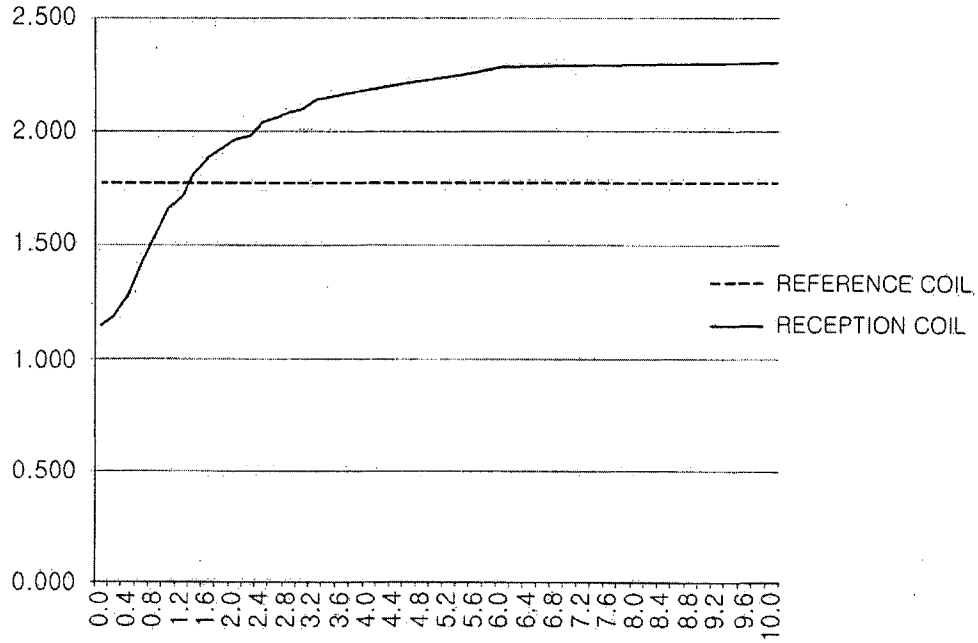
[Fig. 2]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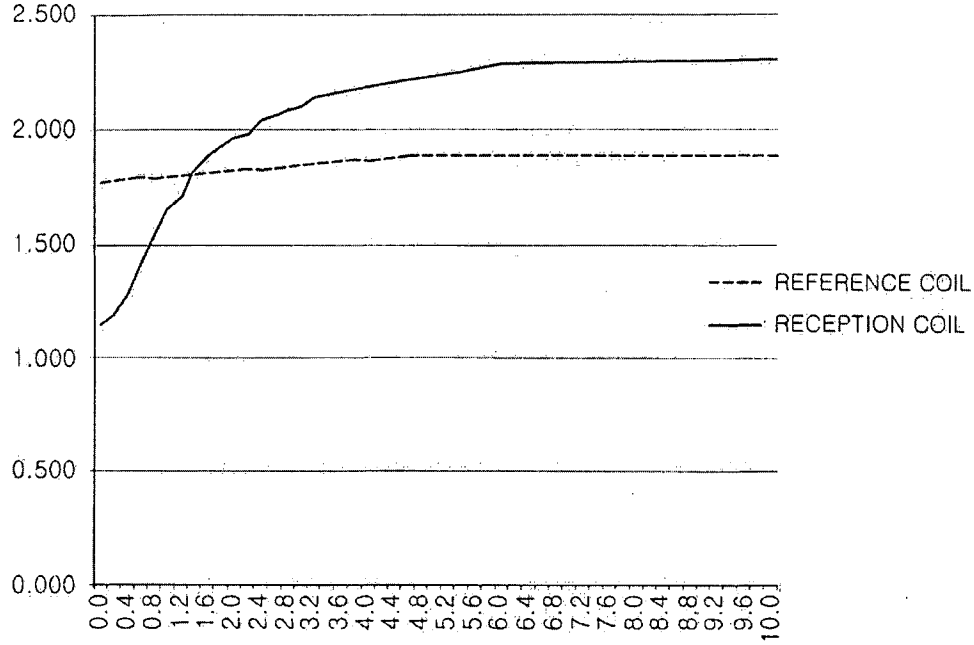
REFERENCE COIL
RECEPTION COIL

[Fig. 3]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REFERENCE COIL
RECEPTION COIL

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2013/004705

A. CLASSIFICATION OF SUBJECT MATTER

G01B 7/14(2006.01)i, G01D 5/20(2006.01)i

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)
G01B 7/14; G01B 7/00; G01D 5/12; G01V 3/10; G01D 5/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: inductive proximity sensor, bobbin, coil, block, barrier, shield

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7129701 B2 (LACLAIR, ROBERT D.) 31 October 2006 See column 3 lines 7-19, column 5 lines 24-30, and figure 1.	1-3
A	US 2012-0081106 A1 (GRINBERG et al.) 05 April 2012 See paragraphs [0023], [0031], [0044], and figures 1,5.	1-3
A	US 5065093 A (NAUTA et al.) 12 November 1991 See column 4 lines 54-62, claim 1, and figure 1.	1-3
A	JP 05-113302 A (DREONE ALEXANDRO) 07 May 1993 See paragraphs [0008], [0009], [0014], [0015], claim 1, and figure 2.	1-3
A	JP 2009-264992 A (SHINSHU UNIVERSITY et al.) 12 November 2009 See paragraphs [0003], [0018], [0019], and figure 1.	1-3

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

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 October 2013 (30.10.2013)	**01 November 2013 (01.11.2013)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2013/004705

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