

(19) **DANMARK**

(10) **DK/EP 3036748 T3**



(12) **Oversættelse af
europæisk patentskrift**

Patent- og
Varemærkestyrelsen

-
- (51) Int.Cl.: **H 01 F 3/08 (2006.01)** **H 01 F 17/04 (2006.01)** **H 01 F 27/02 (2006.01)**
H 01 F 27/29 (2006.01) **H 01 F 41/00 (2006.01)** **H 01 F 41/02 (2006.01)**
H 01 F 41/06 (2016.01)
- (45) Oversættelsen bekendtgjort den: **2018-01-02**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-09-13**
- (86) Europæisk ansøgning nr.: **15713459.4**
- (86) Europæisk indleveringsdag: **2015-03-27**
- (87) Den europæiske ansøgnings publiceringsdag: **2016-06-29**
- (86) International ansøgning nr.: **EP2015056758**
- (87) Internationalt publikationsnr.: **WO2015150274**
- (30) Prioritet: **2014-04-01 CN 201410129094**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **Induktor og fremgangsmåde til fremstilling heraf**
- (56) Fremdragne publikationer:
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DESCRIPTION

[0001] The present application claims priority of Chinese patent application CN 2014 1012 9094.2.

Technical Field

[0002] The invention relates to an inductor and a method of manufacturing the same, in particular to an inductor capable of improving its manufacturability and performances and a method of manufacturing the same.

Background Art

[0003] With the rapid innovation of electronic technology, demands on electronic components with high efficiency and low loss are higher increasingly. Inductors, wherein the electrodes are formed by extended portions of the coil, are known from the documents US 2010/134233 A1 as well as JP 2003168610 A. The documents US 2014/002227 A1, JP 2103916 A, US 2008/036566 A1 as well as US 2012/188040 A1 describe inductors in which the coil is connected to additional electrodes. US 2009/0278650 A1 discloses an inductor according to the preamble of present claim 1. The die-casting inductors formed integrally appearing on the present market cannot reach above-mentioned effects due to limitations in structural layout design and material combination. Therefore, there is a need for an improved induction component, as an inductor for a specific application field, which can break through above limitations and be provided with the capabilities, characteristics and functions that the current manufacturing equipment and method do not have, and a method for manufacturing the induction component.

Summary of the Invention

[0004] An object in accordance with the invention is to provide an inductor capable of improving its manufacturability and a method for manufacturing the same.

[0005] The object in accordance with the invention is achieved by the inductor according to present claim 1 and the method of manufacturing of the inductor according to present claim 7.

[0006] Preferred features are specified in the dependent claims.

[0007] The inductor has the following advantages compared with the prior art:

Through an integral moulding power casting process, the electrodes of the prefabricated mounted inner core are encased directly in the outer encasing layer, and thereby the firmness of the electrodes can be improved greatly and quality risk can be reduced; and post processing procedures for a conventional product can be derated and the manufacturing cost can be saved.

[0008] Through the combination of separated-type core shaft, the core shaft can be combined to be of different materials, thereby providing multiple electrical parameter variations for the inductors of the same specifications so as to meet demands of the client on designs of various electrical performances under the same volume.

[0009] Brief Descriptions of the Drawings

Fig. 1

is a structural perspective view illustrating an inductor in accordance with an embodiment of the present invention.

Fig. 2

is a structural perspective view illustrating a bottom of the inductor in accordance with the embodiment.

Fig. 3

is a structural perspective view illustrating an inner core of the inductor in accordance with the embodiment.

Fig. 4

is a structural perspective view illustrating a flat coil of the inductor in accordance with the embodiment.

Fig. 5

is a structural perspective view illustrating a T-shaped core shaft of the inductor in accordance with the embodiment.

Fig. 6

is a structural perspective view illustrating a sheet-shaped base of the inductor in accordance with the embodiment.

Fig. 7

is a structural perspective view illustrating a core rod of the inductor in accordance with the embodiment.

Fig. 8

is a structural perspective view illustrating an embodiment of the inductor in accordance with the invention.

Fig. 9

is a structural perspective view of a bottom of the inductor in accordance with the embodiment.

Fig. 10

is a structural perspective view illustrating an inner core of the inductor in accordance with the embodiment.

Fig. 11

is a structural perspective view illustrating a flat oval coil of the inductor in accordance with the embodiment.

Fig. 12

is a structural perspective view illustrating a T-shaped core shaft of the inductor in accordance with the embodiment.

Fig. 13

is a structural perspective view illustrating a sheet-shaped base of the inductor in accordance with the embodiment.

Fig. 14

is a structural perspective view of an oval core rod of the inductor in accordance with the embodiment.

Fig. 15

is a structural perspective view illustrating of the inductor in accordance with an embodiment, which is not part of the present invention.

Fig. 16

is a structural perspective view illustrating the bottom 1 of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 17

is a structural perspective view illustrating the bottom 2 of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 18

is a structural perspective view illustrating the bottom 3 of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 19

is a structural perspective view illustrating the bottom 4 of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 20

is a structural perspective view illustrating the inner core of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 21

is a structural perspective view illustrating the flat circular coil of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 22

is a structural perspective view illustrating the T-shaped core rod of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 23

is a structural perspective view illustrating a sheet-shaped base of the inductor in accordance with the embodiment, which is not part of the present invention.

Fig. 24

is a structural perspective view illustrating the core rod of the inductor, which is not part of the present invention.

Fig. 25

is a structural perspective view illustrating a polygonal shape of the inductor in accordance with an embodiment.

Fig. 26

is a structural perspective view illustrating a polygonal bottom of the inductor in accordance with an embodiment.

Fig. 27

is a structural perspective view illustrating a circular shape of inductor in accordance with an embodiment.

Fig. 28

is a structural perspective view illustrating a circular bottom of the inductor in accordance with the embodiment.

DETAILED DESCRIPTION

[0010] The inductor in accordance with the present invention and the method of manufacturing the same will be described below in more detail in connection with the accompanying drawings.

[0011] As shown in Figs. 1 to 28, the present invention embodied in Fig.1-14, 25-28 and the example of Fig.15-24 not forming part of the present invention provides an inductor, comprising preparing a mounted inner core (Figs. 3, 10, 20) by using an enameled coil (4A, 4B, 4C) and a core rod (2A, 2B, 2C, 3A, 3B, 3C); putting the mounted inner core (Figs. 3, 10, 20) prepared previously into a corresponding mould so that terminals connecting the coil or portions of the coil which extend to form electrodes (5A, 5B, 6A, 6B) or which are electroplated previously to form electrodes (5C, 5D, 5E, 5F, 6C, 6D, 6E, 6F) are suitable for being exposed out; forming an outer encasing layer (1A, 1B, 1C) through die-casting metal powder by a mechanical or hydraulic powder metallurgy moulding press, wherein the mounted inner core (Figs. 3, 10, 20) and the electrodes (5A, 5B, 5C, 5D, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F) are buried into the centre of the outer encasing layer, and the electrodes (5A, 5B, 5C, 5D, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F) can be formed by extending and bending the enameled coil or be formed by connecting the enameled coil to the corresponding end faces through the processing such as spot welding, soldering, film plating with silver paste, electroplating and the like, thereby the inductor is manufactured.

[0012] The mounted inner core (Figs. 3, 10, 20) comprises the enameled coil (4A, 4B,4C) and the core shaft (2A, 2B, 2C, 3A, 3B, 3C) disposed in the inner diameter of the enameled coil; the mounted inner core (Figs. 3, 10, 20) may be in the shape of a square (Figs. 1, 8, 15), a circle (Fig. 27) or a polygon (Fig. 25); the electrodes of the mounted inner core (Figs. 3, 10, 20) may be formed by extended portions of the coil or be formed by previously electroplating or film plating with the silver paste on both ends and the bottom of the mounted inner core; and the mounted inner core (Figs. 3, 10, 20) is buried into the centre of the outer encasing layer so

that the both ends of the exposed electrodes are encased by a small part of the outer encasing layer.

[0013] The enameled coil (4A, 4B, 4C) may be in the shape of a circle or an oval; the enameled coil may comprise a round enameled wire or a flat enameled wire according to wire shape; leading-outs of the enameled coil may be formed, by winding the wire, to be in the same direction or opposite directions, respectively; the leading-outs of the enameled coil may be on the bottom or sides of the inductor; the enameled coil may be formed by winding the wire in a clockwise or counterclockwise direction; the enameled coil may comprise a single layer or multiple layers; and the enameled coil may be formed through winding and stacking the wire by wide faces or narrow faces thereof.

[0014] The core shaft (2A, 2B, 2C, 3A, 3B, 3C) may be of a 'T' shape or a 'rod' shape; the core shaft in 'T' shape may be formed integrally, of the same material, into the 'T' shape, or may be formed into the 'T' shape by combining a rod with a sheet-shaped base which each other are made of different materials and are separated; and the core shaft is made of a material such as manganese zinc, nickel zinc, iron powder core or alloy powder, or is made of a combination of various materials such as manganese zinc, nickel zinc, iron powder core and alloy powder.

[0015] The outer encasing layer (1A, 1B, 1C) is formed of metal powder particles through die-casting process; the metal powder particles are formed by selecting, according to requirements for properties, corresponding alloy powder, reduced iron powder, carbonyl iron powder or ferrite material and corresponding adhesive resin containing a curing agent to be stirred fully and mixed; or the metal powder particles are formed by selecting, according to requirements for properties, a combination of various metal powders such as alloy powder, reduced iron powder, carbonyl iron powder or ferrite material and corresponding adhesive resin containing a curing agent to be stirred fully and mixed; and the adhesive resin comprises epoxy resin, phenolic resin, phenolic epoxy resin, o-cresol formaldehyde epoxy resin or a mixture of multiple resins and corresponding curing agent as well as other organic solvents.

[0016] One way for forming the electrodes (5A, 5B, 5C, 5D, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F) is that the electrodes may be formed by terminals of the enameled coil connected thereto or may be formed directly by extending and bending the enameled coil, or be formed by flattening or thinning the enameled coil, then performing soldering or electroplating based on the flattening or thinning of the enameled coil and directly extending the enameled coil; or be formed by connecting the enameled coil to corresponding end faces through a process such as spot welding, soldering, film plating with silver paste and electroplating.

[0017] Both ends of the electrodes (5A, 5B, 5C, 5D, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F) are buried in the outer encasing layer deeply, and exposed middle sections of the electrodes are cleaned to become smooth end faces by grinding with a grinding wheel or stripping paint with laser and are soldered or electroplated to form final electrodes of the inductor.

[0018] Another way for forming the electrodes (5A, 5B, 5C, 5D, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F) is to form the electrodes previously by performing electroplating or film plating with silver paste on both ends and the bottom of the mounted inner core; and the electrodes are connected electrically to the internal coil through soldering and spot welding.

[0019] The electrodes (5A, 5B, 5C, 5D, 5E, 5F, 6A, 6B, 6C, 6D, 6E, 6F) have bottoms which can be made into various shapes, depending on requirements, such as symmetrical or asymmetrical strips, squares, and trapezoids.

[0020] The inductor can have an appearance of a square, a circle or a polygon; the inductor can be spray-painted or be not spray-painted; and the height of the inductor can be adjusted correspondingly according to the design requirements and the performance parameters.

[0021] A method for manufacturing an inductor, characterized in that the method comprises the steps of:

1. (1) Selecting a type of enameled wire and winding the enameled wire in a clockwise or counterclockwise direction into a single-layer or multiple-layer-stacked coil upon design requirements, wherein the coil has leading-outs preferably in the same direction;
2. (2) Putting a 'rod-shaped'/'T-shaped' core shaft into inner diameter of the coil so that a bottom of a sheet-type core shaft is inserted, with two sides of the bottom, into the two leading-outs of the coil to form a prefabricated mounted inner core; or selecting an enameled coil to be put to the bottom of an electroplated sheet-type core shaft and connecting, respectively, leading-outs of the coil to the corresponding end faces by spot welding or soldering to form a prefabricated mounted inner core; or selecting a 'rod-shaped' or 'T-shaped' core shaft and winding directly the wire around the core shaft so that the core shaft is enwrapped by the coil to form a prefabricated mounted inner core; or winding directly the wire around a 'T-shaped' core shaft so that the core shaft is enwrapped by the coil, wherein electrodes are formed by mosaicing terminals or electroplated coatings on both ends of the 'T-shaped' core shaft, and a prefabricated mounted inner core is formed by connecting both ends of the coil to the electrodes through directly spot welding process;
3. (3) Putting the prefabricated mounted inner core into a corresponding mould so that the coil connecting the terminals or portions of the coil which extend to form the electrodes or which are electroplated previously to form the electrodes are suitable for being exposed out of an encasing layer;
4. (4) Filling the mould with mixed metal powder particles and forming the outer encasing layer of the inductor through die-casting with cold pressing or a combination of cold pressing and hot pressing by a mechanical or hydraulic powder metallurgy moulding press;
5. (5) Both ends of the electrodes formed by the terminals connecting the coil or the extended portions of the coil are buried in the outer encasing layer deeply, and exposed middle sections of the electrodes are cleaned to become smooth end faces by grinding with a grinding wheel or stripping paint with laser, and are soldered or electroplated to

form final electrodes of the inductor; and the inductor is formed.

6. (6) Another way for forming the electrodes is to form the electrodes previously by performing electroplating or film plating with silver paste on both ends and the bottom of the mounted inner core, wherein the electrodes are connected electrically to the internal coil through soldering and spot welding; and the inductor is formed.

[0022] The enameled coil in the step (1) is in the shape of a circle or an oval; the enameled coil can comprise a round enameled wire or a flat enameled wire according to wire shape; leading-outs of the enameled coil are formed, by winding the wire, to be in the same direction or opposite directions, respectively; the leading-outs of the enameled coil are on the bottom or sides of the inductor; the enameled coil is formed by winding the wire in a clockwise or counterclockwise direction; the enameled coil comprises a single layer or multiple layers; and the enameled coil is formed through winding and stacking the wire by wide or narrow faces thereof.

[0023] The mounted inner core in the step (2) comprises the enameled coil and the core shaft disposed in the inner diameter of the enameled coil; the mounted inner core may be in the shape of a square, a circle or a polygon; the electrodes of the mounted inner core may be formed by extended portions of the coil or are formed by previously electroplating or film plating with the silver paste on both ends and the bottom of the mounted inner core; the mounted inner core is buried into the centre of the outer encasing layer so that both ends of the exposed electrodes are encased by a small part of the outer encasing layer.

[0024] The core shaft in the step (2) is of a 'T' shape or a 'rod' shape; the core shaft in 'T' shape is formed integrally, of the same material, into the 'T' shape, or is formed the 'T' shape by combining a 'rod' with a sheet-shaped base which each other are made of different materials and are separated; and the core shaft is made of a material of manganese zinc, nickel zinc, iron powder core or alloy powder, or is made of a combination of various materials such as manganese zinc, nickel zinc, iron powder core and alloy powder.

[0025] The outer encasing layer in the step (4) is formed of metal powder particles through die-casting process; the metal powder particles are formed by selecting, according to requirements for properties, corresponding alloy powder, reduced iron powder, carbonyl iron powder or ferrite material and corresponding adhesive resin containing a curing agent to be stirred fully and mixed; or the metal power particles are formed by selecting, according to requirements for properties, a combination of various metal powders such as alloy powder, reduced iron powder, carbonyl iron powder, or ferrite material and corresponding adhesive resin containing a curing agent to be stirred fully and mixed; and the adhesive resin comprises epoxy resin, phenolic resin, phenolic epoxy resin, o-cresol formaldehyde epoxy resin or a mixture of multiple resins and corresponding curing agent as well as other organic solvents.

[0026] The one way for forming the electrodes in the step (5) is that the electrodes are formed

by terminals of the enameled coil connected to the coil or are formed by directly extending and bending the enameled coil, or are formed by flattening or thinning the enameled coil, then performing soldering or electroplating based on the flattening or thinning of the enameled coil and directly extending the enameled coil; or are formed by connecting the enameled coil to corresponding end faces through a process such as spot welding, soldering, film plating with silver paste and electroplating.

[0027] The both ends of the electrodes in the step (5) are buried in the outer encasing layer deeply, and the exposed middle sections of the electrodes are cleaned to become smooth end faces by grinding with a grinding wheel or stripping paint with laser and are soldered or electroplated to form final electrodes of the inductor.

[0028] The another way for forming the electrodes in step (6) is to form the electrodes previously by performing electroplating or film plating with silver paste on both ends and the bottom of the mounted inner core; the electrodes are connected electrically to the internal coil through soldering and spot welding; and the inductor is formed.

[0029] The electrodes in the step (6) have bottom which can be made into various shapes such as symmetrical or asymmetrical strips, squares, trapezoids depending on requirements.

[0030] The inductor has the following advantages compared with the prior art:

Through an integral moulding power casting process, the electrodes of the prefabricated mounted inner core are encased directly in the outer encasing layer, and thereby the firmness of the electrodes can be improved greatly and quality risk can be reduced; and post processing procedures for a conventional product can be derated and the manufacturing cost can be saved.

[0031] Through the combination of separated-type core shaft, the core shaft can be combined to be of different materials, thereby providing multiple electrical parameter variations for the inductors of the same specifications so as to meet demands of the client on designs of various electrical performances under the same volume.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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Patentkrav

1. Induktor, som omfatter:
- 5 - en monteret indre kerne,
- hvor den monterede indre kerne omfatter en spole (4A) og en T-
 formet kernestav (2A, 3A),
- hvor den T-formede kernestav (2A, 3A) er anbragt på en indre
10 diameter af spolen (4A),
- elektroder (5A, 6A),
- hvor elektroderne (5A, 6A) er tildannet direkte ved, at man har
15 forlænget og bukket spolen (4A), så at der herved er dannet en
 forlænget spoledel (4A),
- og hvor hver elektrode (5A, 6A) omfatter en ende, og
- et ydre omsluttende lag (1A), hvor den monterede indre kerne og
20 elektroderne (5A, 6A) er indlejret i centrum af dette ydre omsluttende lag
 (1A), og hvor
- en arkformet basisdel (3A) og den T-formede kernestav (2A, 3A) er
 indskudt med to sider af basisdelen (3A) i to tilslutninger til spolen (4A), så
 at der tilvejebringes en monteret indre kerne, hvor de to tilslutninger er
25 dannet ved hjælp af elektroderne,

kendetegnet ved,

- at spolen (4A) er lakeret, og
- 30 - at begge ender af elektroderne (5A, 6A) er indstøbt i det ydre
 omsluttende lag (1A).

2. Induktor ifølge krav 1, **kendetegnet ved, at** den monterede indre kerne har form som et kvadrat, en cirkel eller en polygon.
3. Induktor ifølge krav 1 eller 2, **kendetegnet ved, at** den lakerede spole (4A) har form som en cirkel eller oval; at den lakerede spole (4A) hvad angår trådformen omfatter en flad lakeret tråd, tilslutningerne til den lakerede spole (4A) er dannet ved at vikle tråden; at den lakerede spole (4A) omfatter et enkelt lag eller flere lag; og at den lakerede spole (4A) er tildannet ved vikling og stabling af tråden ved dennes bredder.
- 10
4. Induktor ifølge mindst et af kravene 1 til 3, **kendetegnet ved, at** den T-formede kernestav (2A, 3A) er udformet som en del af samme materiale og med T-form, eller er udformet med T-form ved at kombinere en stav (2A) med en arkformet basisdel (3A), der hver for sig er fremstillet af forskelligt materiale og adskilt; og hvor den T-formede kernestav (2A, 3A) er fremstillet af et materiale valgt blandt manganzink, nikkelzink, jernpulver-kerne eller legeringspulver.
- 15
5. Induktor ifølge mindst et af kravene 1 til 4, **kendetegnet ved, at** det ydre omsluttende lag (1A) er fremstillet af metalpulverpartikler ved en formstøbningsprocedure, hvilke metalpulverpartikler er formet ved, at man, i overensstemmelse med de krav, der stilles, har valgt fuldt ud at omrøre og blande tilsvarende legeringspulver, reduceret jernpulver, carbonyl-jernpulver eller ferritmateriale og tilsvarende klæbende harpiks, som indeholder en hærdekomponent, eller at man – i overensstemmelse med de krav til egenskaber, der stilles – har valgt at forme ved at omrøre fuldt ud og blande en kombination af multiple metalpulvere af legeringspulver, reduceret jernpulver, carbonyl-jernpulver eller ferritmaterialer og tilsvarende klæbende harpiks, som indeholder et hærdemiddel, hvor den klæbende harpiks omfatter et epoxy-harpiks, phenol-harpiks, phenol-epoxyharpiks, o-cresol-formaldehyd-epoxy-harpiks eller en blanding af multiple harpikser og et tilsvarende hærdemiddel samt andre organiske opløsningsmidler.
- 20
- 25
- 30

6. Induktor ifølge mindst et af kravene 1 til 5, **kendetegnet ved, at** nogle midtersektioner af elektroderne (5A, 6A) er rensed for at tilvejebringe jævne endeflader ved slibning med en slibeskive og er loddet eller elektroplatteret for at tilvejebringe de endelige elektroder på induktoren.

5

7. Fremgangsmåde til fremstilling af en induktor, hvilken fremgangsmåde omfatter følgende trin:

10 (1) at man vikler en lakeret tråd, så at der dannes en enkeltlaget eller flerlaget stablet spole (4A), hvortil spolen (4A) har tilledninger;

(2) at man anbringer en T-formet kernestav (2A, 3A) inde på den indre diameter af spolen (4A), idet man indfører en arkformet basisdel (3A) på den T-formede kernestav (2A, 3A) med to sider af basisdelen (3A) anbragt i to tilslutninger på spolen (4A), så at der dannes en præfabrikeret monteret indre kerne;

15 (3) at man anbringer den præfabrikerede indre kerne i en tilsvarende støbeform, så at dele af spolen (4A), som strækker sig, så at de danner tilledningselektroder (5A, 6A), er egnet til at kunne blive udsat for et omsluttende lag (1A);

20 (4) at man fylder støbeformen med blandede metalpulverpartikler og anbringer et ydre omsluttende lag (1A) på induktoren ved hjælp af formstøbning med koldpresning eller en kombination af koldpresning og varmpresning ved hjælp af en mekanisk eller hydraulisk pulver metallurgisk formpresse;

25 (5) at man – idet begge ender af elektroderne (5A, 6A) formes ved, at man strækker og bøjer spolen (4A), så at de forlængede dele af spolen (4A) formes – indlejrer disse dele i det ydre omsluttende lag (1A), og dette dybt, så at begge ender af elektroderne (5A, 6A) omsluttet af det ydre omsluttende lag (1A), og at fritliggende midtersektioner af elektroderne (5A, 6A) renses, så at de danner jævne endeflader, når de
30 slibes med en slibeskive og loddes eller elektroplatteres, så at der frembringes nogle færdige elektroder til induktoren, og induktoren frembringes.

DRAWINGS

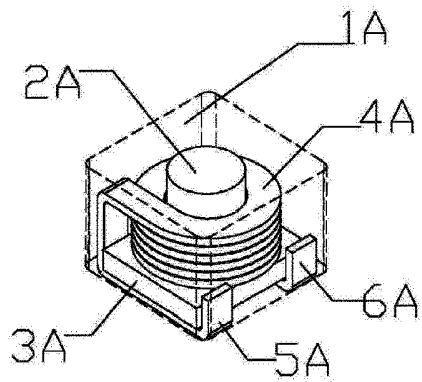


Fig. 1

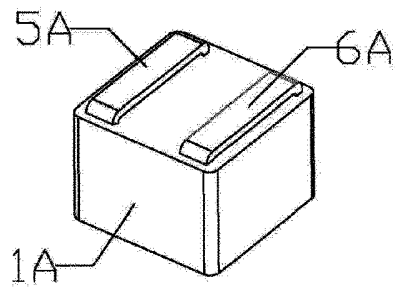


Fig. 2

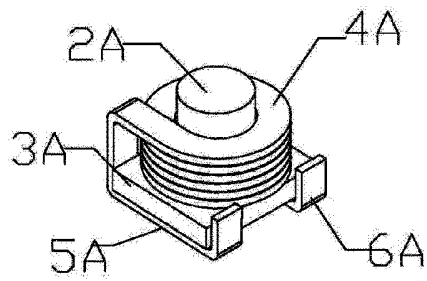


Fig. 3

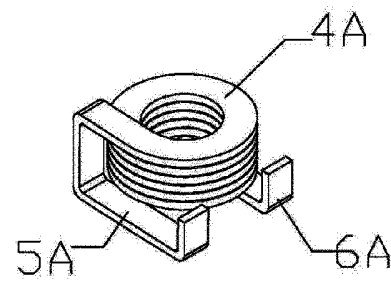


Fig. 4

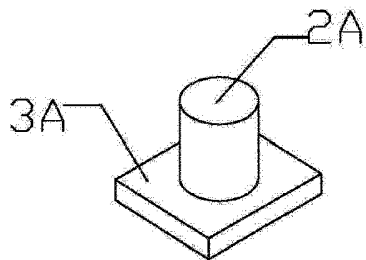


Fig. 5

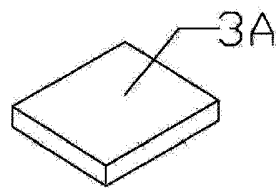


Fig. 6

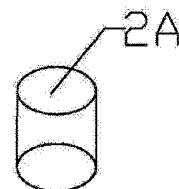


Fig. 7

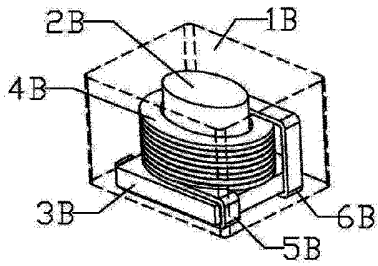


Fig. 8

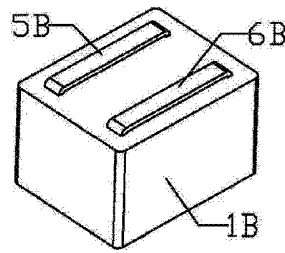


Fig. 9

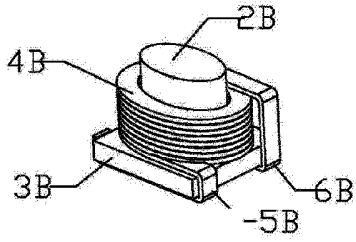


Fig. 10

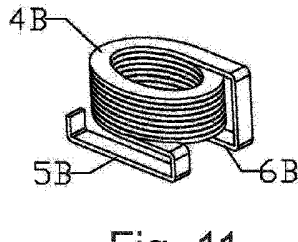


Fig. 11

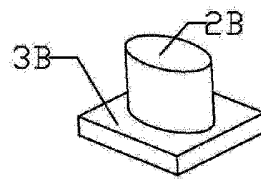


Fig. 12

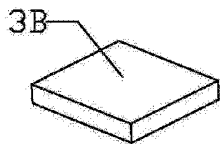


Fig. 13

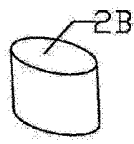


Fig. 14

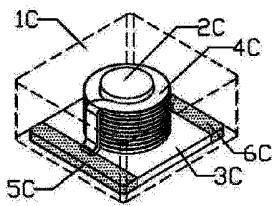


Fig. 15

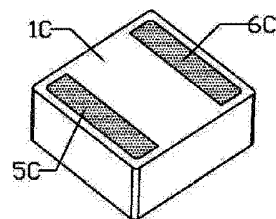


Fig. 16

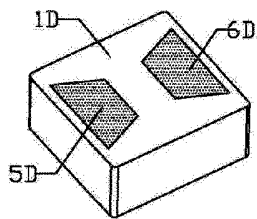


Fig. 17

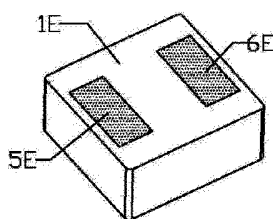


Fig. 18

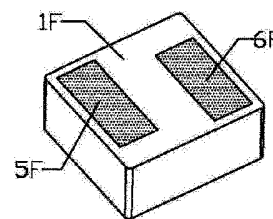


Fig. 19

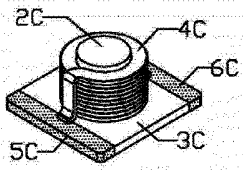


Fig. 20

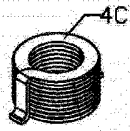


Fig. 21

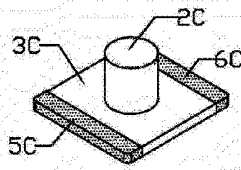


Fig. 22

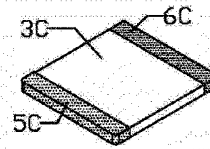


Fig. 23

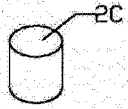


Fig. 24

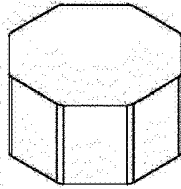


Fig. 25

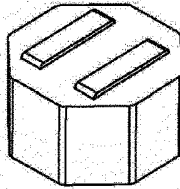


Fig. 26

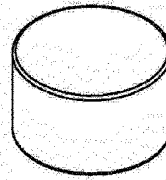


Fig. 27

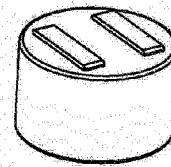


Fig. 28