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(54) METHOD FOR PROVIDING A DOUBLE SOLENOID COIL FOR AN ELECTROMAGNET AND DOUBLE SOLENOID COIL FOR AN ELECTROMAGNET

(57) A method for providing a double solenoid coil for an electromagnet (1), of the type provided with an external core (2) which is formed by a first element (2a) and by at least one second element (2b) which are mutually coupled and which defines internally a longitudinal accommodation seat (3) for two solenoids (4); the first element (2a) and the second element (2b) are provided by sintering steel powders.

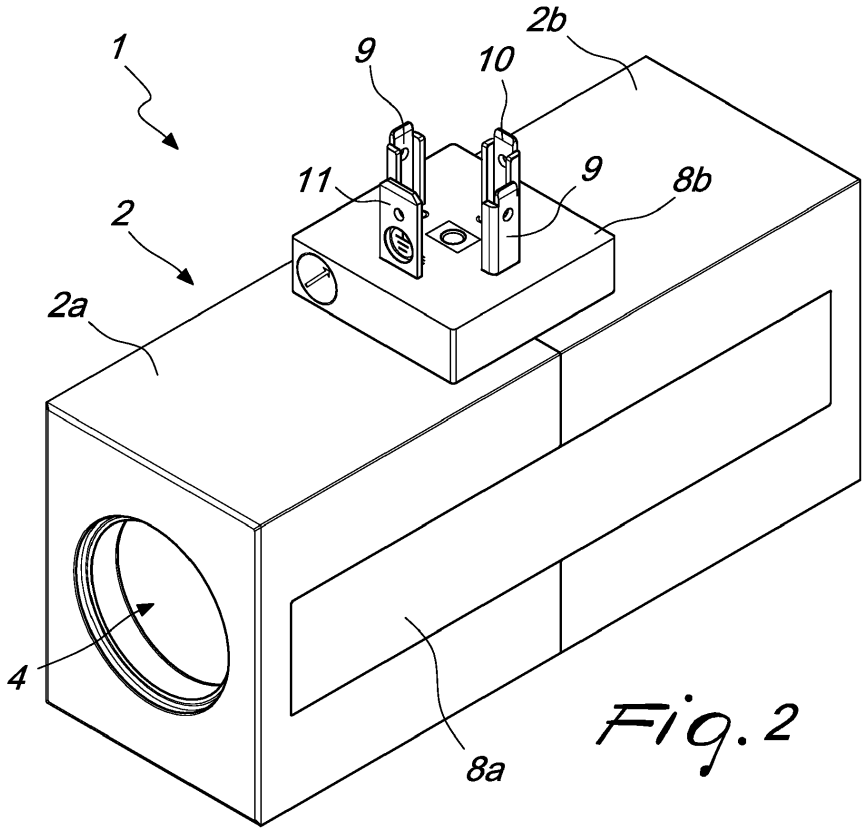

Fig. 2

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Description

[0001] The present invention relates to a method for providing a double solenoid coil for an electromagnet, and a double solenoid coil for an electromagnet.

[0002] The known art for providing some types of double solenoid coil for push-pull (double-stroke) electromagnets consists of making the external core, which is designed to accommodate the solenoids, of carbon steel. Typically the electromagnet is completed by inserting an actuator into the coil, the actuator being constituted by a sleeve (tube) containing a moveable part which determines the push or pull movement.

[0003] In particular, the external core is obtained by cutting a parallelepiped made of low-carbon steel, which subsequently is perforated longitudinally, lathed internally and along the outer edges, and milled on the outer faces.

[0004] It seems evident that such method results in a huge percentage of waste, which can be estimated at over 70%, of the starting ferrous material, since the diameter of the hole is not much smaller than the smaller side of the transverse cross-section of the parallelepiped.

[0005] Furthermore, the external core also has to be perforated transversely in order to allow the passage of the wires of the coils, in order to ensure the welding of the terminals of the solenoids to the contacts of the outer contact-supporting base (which is pre-molded) and in order to allow venting owing to the injection of the resin.

[0006] At the end of the mechanical processes the external core is subjected to an anti-corrosion surface treatment.

[0007] The two solenoids intended to be accommodated inside the external core are each wound onto a single spool made of molded plastic material, onto which is wound a copper wire with a specific design cross-section, until a number of turns is completed corresponding to the designed number of turns.

[0008] The solenoids wound onto the respective spools are inserted into the special receptacle defined in the external core (on which the threaded hole for the screw of the ground contact is first re-tapped with a drill, in order to remove the insulation afforded by the surface treatment) and are insulated from it using two rings of insulating paper so that the wire exiting from the spool cannot come directly into contact with the iron of the core.

[0009] The wires of the two coils are made to pass through special holes proximate to the contact-supporting base and are insulated with insulating sheath.

[0010] The two solenoids are closed inside the core by way of two steel rings, which are perforated with the same inside diameter as the spool, with the aid of a press; such steel rings are also subjected to an anti-corrosion surface treatment.

[0011] Once this process is finished, a gasket is inserted between the contact-supporting base and the external core, after which the terminal wires of the two spools are welded to the respective contacts that are present on the base.

[0012] Subsequently the contact-supporting base is screwed to the external core and the contacts are subjected to tests of the continuity of the solenoids.

[0013] There follows the step of inner potting and sealing of the injection hole with silicone.

[0014] The resin is allowed to dry at ambient temperature for 24 hours, and is then mechanically stabilized by post-hardening, on heating shelves at a temperature comprised between $80 \div 90°C$ for some hours.

[0015] Once hardening is complete, the hole of the coil is refaced with a reamer mounted on a column drill, in order to eliminate any resin dross that has escaped inside, in the passage hole of the sleeve.

[0016] At the end of such operations, the electromagnet is ready for the final step of testing.

[0017] Also on the market are double solenoid coils for electromagnets which are produced by overmolding, but which have a predominant part in plastic material that determines the mechanical structure, and a minor part in steel which is constituted by folded or wound sheets with the hole for the passage of the sleeve (tube) at the center.

[0018] It should be noted that such electromagnets have a low efficiency and considerable dimensions for the same performance.

[0019] This is determined, substantially, by the predominance of the plastic material over the steel and over the copper of the solenoids, which constitute the electromagnetically-active materials.

[0020] In such electromagnets, the solenoids are wound and mounted individually and, after the overmolding, machining is always necessary to reface the central hole, given the imprecision of drilling and centering of the wound or folded metallic parts that are present here, which always result in leaks.

[0021] The aim of the present invention is to provide a method for providing a double solenoid coil for an electromagnet, which is capable of improving the known art in one or more of the above mentioned aspects.

[0022] Within this aim, an object of the invention is to provide a method for providing an external core for electromagnets that makes it possible to eliminate the mechanical processing with removal of shavings and to eliminate the waste material.

[0023] Another object of the invention is to devise a method for providing an external core for electromagnets which makes it possible to eliminate the threaded hole for fixing the screw of the ground contact, which would have to be screwed manually.

[0024] Another object of the invention is to provide a construction method that makes it possible to eliminate the steps of manual insertion of the insulating rings, subsequently the manual insertion of the solenoids wound on the individual spools, and finally the closure with the steel rings by way of a manually-controlled press.

[0025] Another object of the invention is to make available a method for providing a double solenoid coil for an

electromagnet which makes it possible to eliminate the manual process of welding the contacts of the base and the manual screwing of the base onto the metallic external core.

[0026] A further object of the invention is to provide a construction method that makes it possible to eliminate the manual process of potting the coil through the injection holes, and consequently eliminate the sealing with silicone of the injection holes and eliminate the step of post-hardening.

[0027] Another object of the invention is to devise a method for providing a double solenoid coil for an electromagnet which makes it possible to eliminate the operation to ream the central hole.

[0028] Another object of the invention is to provide a method for providing a double solenoid coil for an electromagnet which is highly efficient and reliable, small in size, easy to implement and at low cost.

[0029] This aim and these and other objects which will become better apparent hereinafter are achieved by a method for providing a double solenoid coil for an electromagnet according to the independent claims, optionally provided with one or more of the characteristics of the dependent claims.

[0030] Further characteristics and advantages of the invention will become better apparent from the description of some preferred, but not exclusive, embodiments of the method for providing an electromagnet and of the electromagnet according to the invention, which are illustrated for the purposes of non-limiting example in the accompanying drawings wherein:

Figure 1 is an exploded perspective view of the electromagnet according to the invention;
Figure 2 is a perspective view of the electromagnet;
Figure 3 is a view from above of the electromagnet;
Figure 4 is a side view of the electromagnet;
Figure 5 is a front elevation view of the electromagnet;
Figure 6 is a longitudinal cross-sectional view of the electromagnet taken along the plane of arrangement identified by the line VI-VI in Figure 5.

[0031] With reference to the figures, the present invention relates to a method for providing an electromagnet, generally designated by the reference numeral 1, of the type provided with an external core 2 formed by a first element 2a and by at least one second element 2b.

[0032] The first element 2a and the second element 2b are mutually coupled.

[0033] The external core 2 defines, internally, a longitudinal accommodation seat 3 for two solenoids 4.

[0034] The method according to the invention is characterized in that the first element 2a and the second element 2b are provided by sintering steel powders.

[0035] Advantageously, the first element 2a and the second element 2b are subjected to an anti-corrosion surface treatment.

[0036] Advantageously, the first element 2a and the second element 2b are substantially identical and are adapted to define two longitudinally extended portions of the external core 2.

[0037] Conveniently, the method comprises a step of production, by sintering, of a central ring 5.

[0038] Conveniently, the central ring 5 is inserted into a double spool for supporting the solenoids 4 and the quick connectors 9.

[0039] Such step of production of the central ring 5 also entails the sintering of steel powders.

[0040] Conveniently, the method entails that the solenoids 4 are provided by winding turns of enameled copper wire onto a single spool, advantageously molded, 6, which, preferably, is provided with two receptacles: 6a and 6b.

[0041] The two solenoids 4, advantageously, are wound consecutively, without interruption of the wire when it is connected and welded to the common contact 9.

[0042] The spool 6 with receptacles 6a, 6b is made of insulating material, preferably thermoplastic.

[0043] Conveniently, the method entails a step of stable coupling between the central ring 5 and the spool 6 with the first and the second accommodation 6a, 6b onto which the respective solenoids 4 have been wound.

[0044] Subsequently, the method comprises a step of inserting the central ring 5 into the special receptacle at the center of the double spool 6, and inserting the two solenoids 4 into the elements 2a and 2b that constitute the external core and, subsequently, a step of mutual locking between the first element 2a, the second element 2b and the central ring 5.

[0045] The method then entails a step of inserting the external core 2, which accommodates the spool 6 for supporting the coils 4 and the central ring 5, into a filling mold and a step of filling the mold with thermoplastic material in order to provide at least one insulating sealing surface 8 between the outer surface of the solenoids 4 and the external core 2.

[0046] During the step of filling, the coupling base from which the contacts 9, 10 and 11 protrude is also provided.

[0047] The present invention further relates to a double solenoid coil for an electromagnet, generally designated by the reference numeral 1, which comprises a external core 2 which forms internally a longitudinal accommodation seat 3 for two solenoids 4.

[0048] According to the present invention, the external core 2 comprises at least one first element 2a and at least one second element 2b which are provided by sintering steel powders.

[0049] Conveniently, the first element 2a and the second element 2b are substantially identical and are adapted to define two longitudinally extended portions of the external core 2.

[0050] Conveniently, the double solenoid coil for an electromagnet 1 comprises a central ring 5 which is provided by sintering steel powders, which is inserted into

a spool, conveniently a double spool, for supporting the two solenoids 4 and the quick connectors 9, 10, 11.

[0051] The solenoids 4 are wound onto the receptacles 6a and 6b of the spool 6 for a double solenoid, which is made of insulating material.

[0052] Preferably, the double solenoid coil for an electromagnet 1 comprises a single supporting spool 6, by way of the two receptacles 6a and 6b, for the two solenoids 4 which advantageously are wound consecutively, without interruption of the wire when it is connected and welded to the common contact 10.

[0053] Preferably, the double solenoid coil for an electromagnet 1 comprises a single spool 6 for supporting the sintered central ring 5 and the quick contacts 9, 10 and 11.

[0054] Preferably, the double solenoid coil for an electromagnet 1 comprises an insulating sealing surface 8a which lies between the outer surface of the coils 4 and the external core 2 and is provided by overmolding.

[0055] Preferably, the double solenoid coil for an electromagnet 1 comprises a contact-supporting base 8b which is provided by overmolding, which seals the contacts 9, 10, 11 insulating them from each other and from the external core 2 and locking them mechanically. Typically the contact-supporting base 8b is connected to a commercial DIN connector with complementary quick contacts that bring the power supply voltage to the solenoids 4. The envelopment mold is adapted to be capable of varying the type of electrical connector and therefore the shape of the contact-supporting base as well.

[0056] In practice it has been found that the invention fully achieves the intended aim and objects, by making available a method that does not generate waste material, which would be generated by using traditional methods that involve machining with the removal of shavings.

[0057] The method according to the invention further leads to the elimination, with respect to the traditional methods, of the process of welding the contacts of the base and of manual screwing of the base onto the metallic core, and therefore the elimination of any human error.

[0058] This determines an improvement in safety at work for operators, who no longer need to manually weld the contacts and therefore will no longer be subject to the risk of breathing the fumes of weld metal, even though previously they always worked with the aid of a fume extractor.

[0059] There is furthermore an additional improvement in safety at work for operators, who no longer have to perform the manual potting of the coils, exposing themselves to the vapors emanated by the resin when it is injected at a higher temperature than ambient temperature, even though previously they always worked with the aid of respiratory protection masks.

[0060] The method according to the invention further leads to the elimination of the operation to ream the central hole, after the automated molding using a central pivot which prevents leaks of material inside the hole.

[0061] The method further makes it possible to obtain an electromagnet that is extremely compact and efficient, with a low cost of production by virtue of the industrialization of the processes and the use of sinterized materials that are molded with optimized shapes with no machining material discarded.

[0062] The invention, thus conceived, is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims. Moreover, all the details may be substituted by other, technically equivalent elements.

[0063] In practice the materials employed, provided they are compatible with the specific use, and the contingent dimensions and shapes, may be any according to requirements and to the state of the art.

[0064] The disclosures in Italian Patent Application No. 102018000004063 from which this application claims priority are incorporated herein by reference.

[0065] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A method for providing a double solenoid coil for an electromagnet (1), of the type provided with an external core (2) which is formed by a first element (2a) and by at least one second element (2b) which are mutually coupled and which defines internally a longitudinal accommodation seat (3) for two solenoids (4), said method being **characterized in that** said first element (2a) and said second element (2b) are provided by sintering steel powders.

2. The method according to claim 1, **characterized in that** said first element (2a) and said second element (2b) are substantially identical and are adapted to define two longitudinally extended portions of said external core (2).

3. The method according to one or more of the preceding claims, **characterized in that** it comprises a step of production, by sintering steel powders, of a central ring (5) which is inserted into the adapted receptacle for the spool (6) that supports said solenoids (4) and which supports quick connectors (9, 10, 11).

4. The method according to one or more of the preceding claims, **characterized in that** said solenoids (4) are provided by way of a step of winding onto a respective receptacle (6a, 6b) of said spool (6) in a consecutive manner, without interruptions of the enameled copper wire which remains continuous after electrical connection by being welded onto the

quick contact (10).

5. The method according to one or more of the preceding claims, **characterized in that** it comprises a step of stable coupling between said central ring (5) and said supporting spool (6) which defines said receptacles (6a, 6b) for the two solenoids (4).

6. The method according to one or more of the preceding claims, **characterized in that** it comprises a step of insertion of said supporting spool (6) for said two solenoids (4), which is coupled stably to said central ring (5), into said longitudinal accommodation seat (3), and a locking step between said first element (2a) and said second element (2b) with the central ring (5).

7. The method according to one or more of the preceding claims, **characterized in that** it comprises a step of insertion of said external core (2) which accommodates said supporting spool (6) with said two solenoids (4), the central ring (5) and the quick contacts (9, 10, 11) into a filling mold and a step of filling said mold with thermoplastic material so as to provide at least one insulating sealing surface (8a) between the outer surface of said coils (4) and said external core (2), and to provide a base for the support and insulation of the electrical contacts (8b).

8. A double solenoid coil for an electromagnet (1), which comprises an external core (2) which defines internally a longitudinal accommodation seat (3) for two solenoids (4), **characterized in that** said external core (2) comprises at least one first element (2a) and at least one second element (2b) which are made of sintered steel powders.

9. A double solenoid coil for an electromagnet (1) according to claim 8, **characterized in that** said first element (2a) and said second element (2b) are substantially identical and are adapted to define two longitudinally extended portions of said external core (2).

10. A double solenoid coil for an electromagnet (1) according to one or more of claims 8 to 9, **characterized in that** it comprises a central ring (5) which can be associated with a supporting spool (6) which defines two receptacles (6a, 6b) for the two solenoids (4) and receptacles for the quick contacts (9, 10, 11).

11. The double solenoid coil for an electromagnet (1), according to one or more of claims 8 to 10, **characterized in that** said solenoids (4) are wound onto a single spool (6) which is made of insulating material and which is provided with two receptacles (6a, 6b) for said solenoids (4).

12. The double solenoid coil for an electromagnet (1) according to one or more of claims 8 to 11, **characterized in that** it comprises an insulating sealing surface (8a) between the external surface of said solenoids (4) and said external core (2).

13. The double solenoid coil for an electromagnet (1) according to one or more of claims 8 to 12, **characterized in that** it comprises a contact-supporting base (8b) made of insulating overmolding material, which is designed to insulate and mechanically support said quick contacts (9, 10, 11).

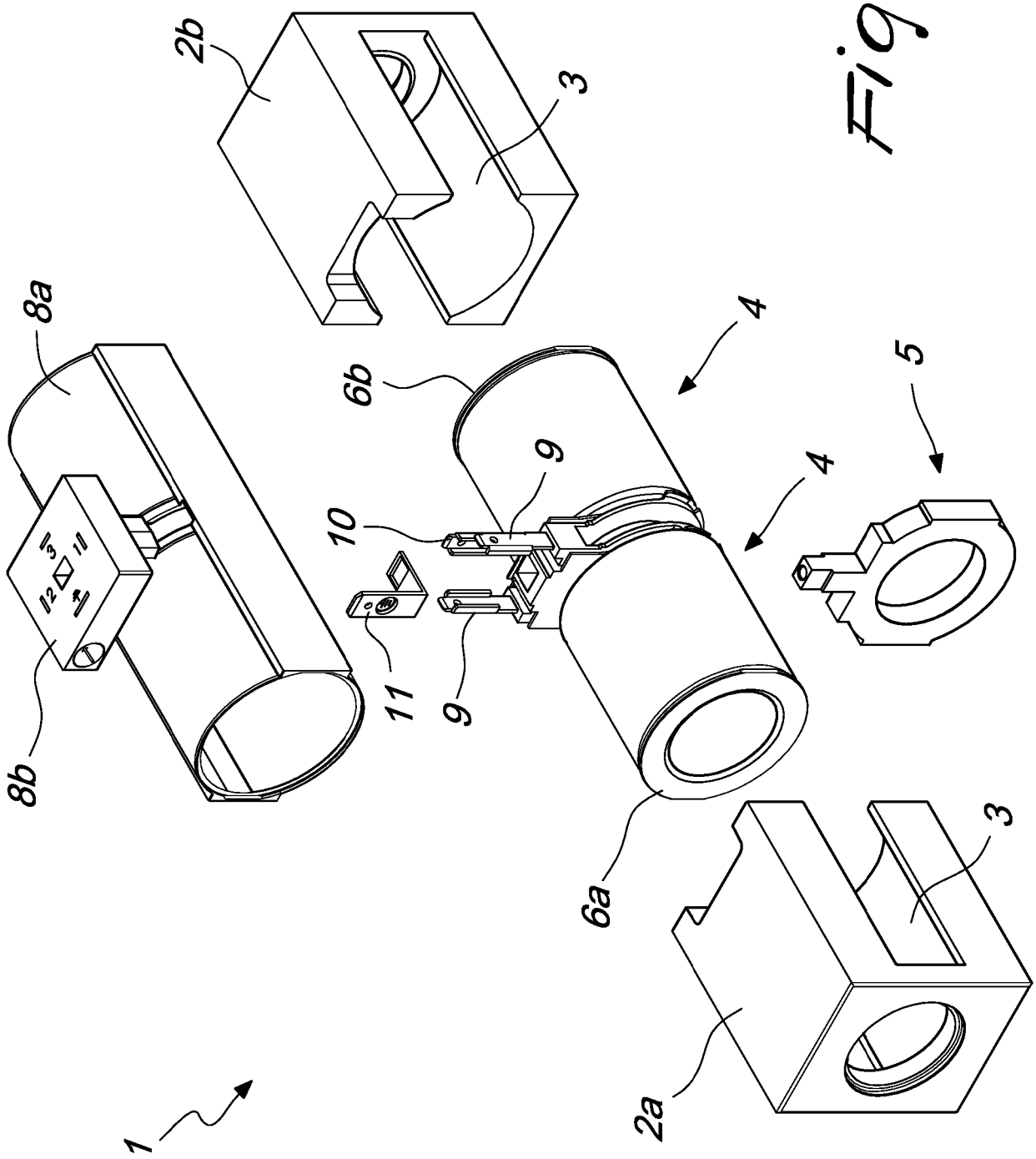

Fig. 1

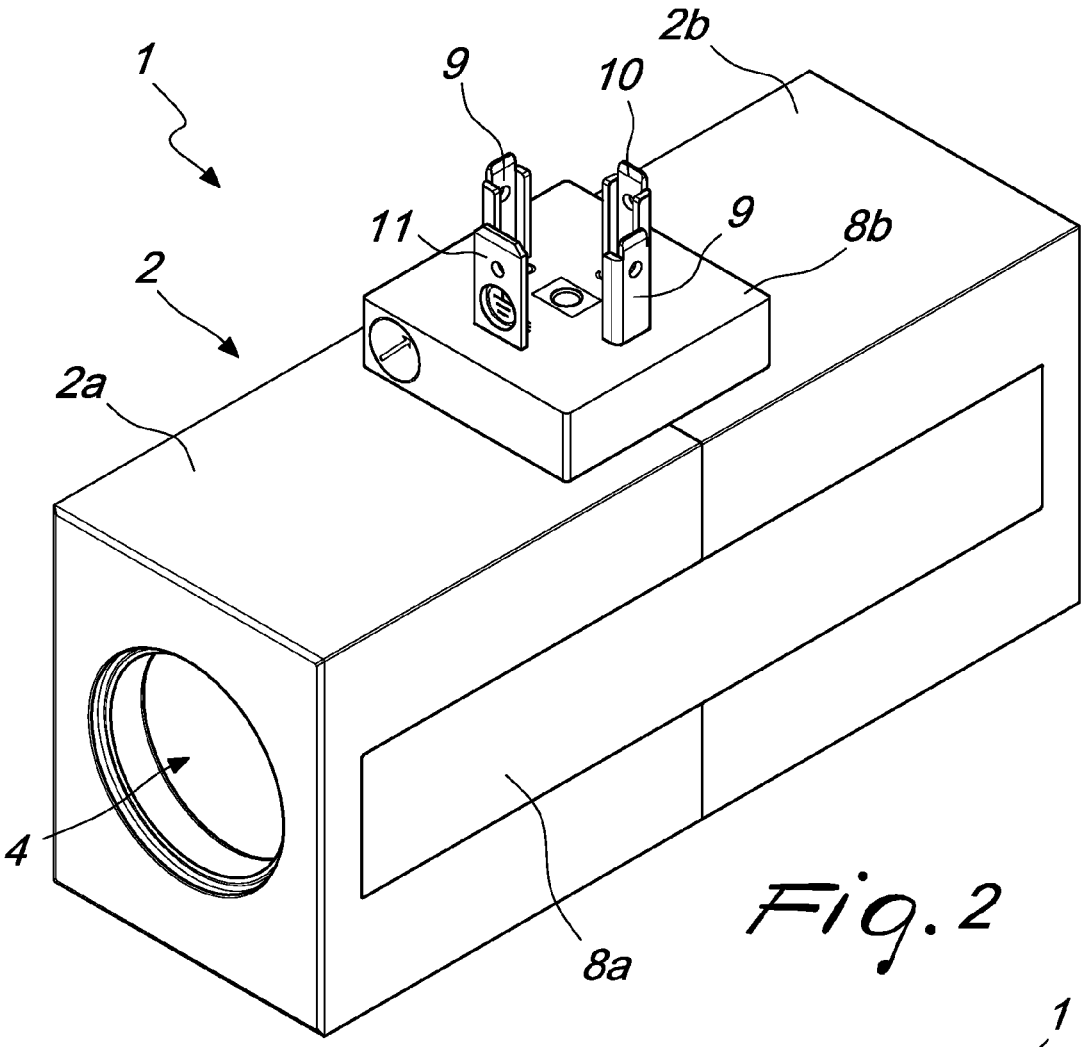

Fig. 2

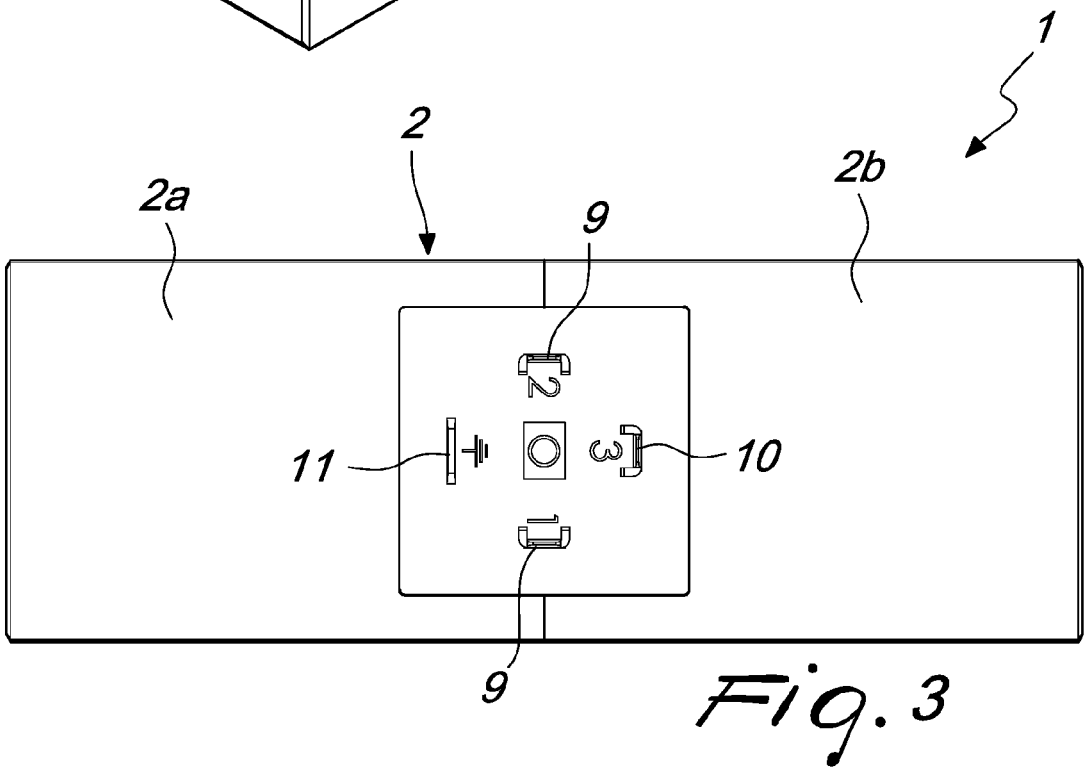

Fig. 3

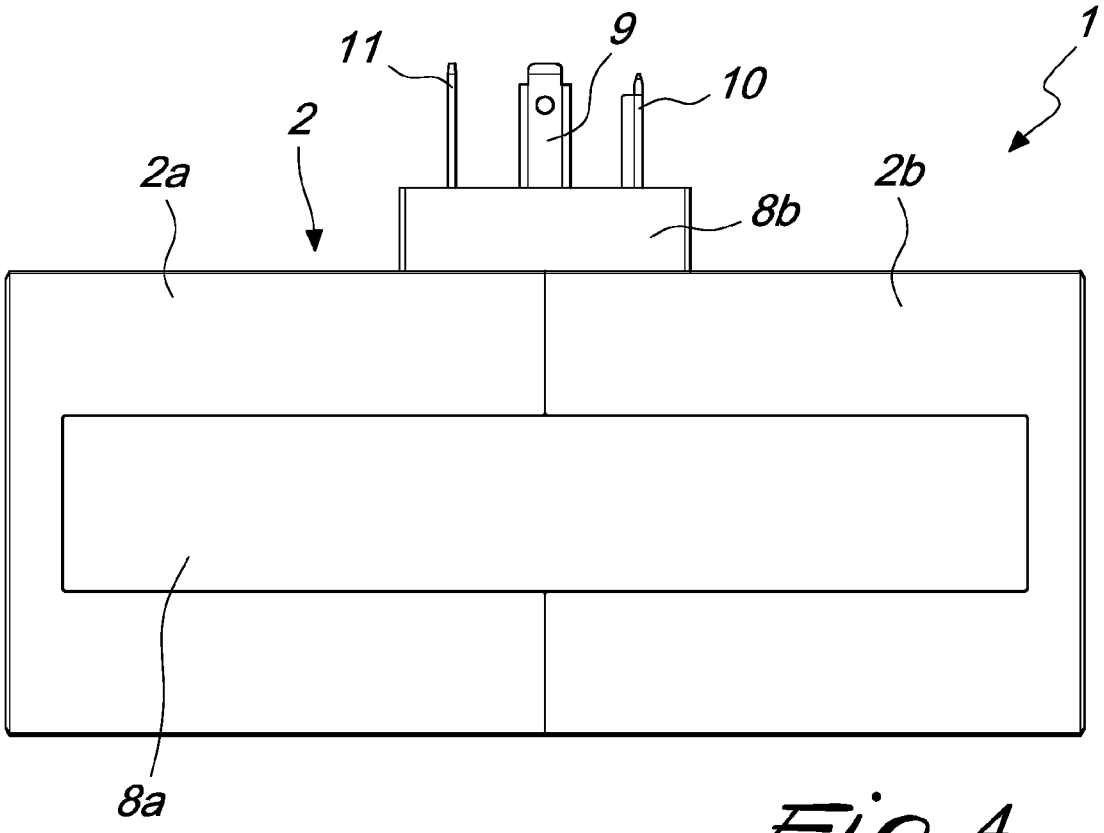

Fig. 4

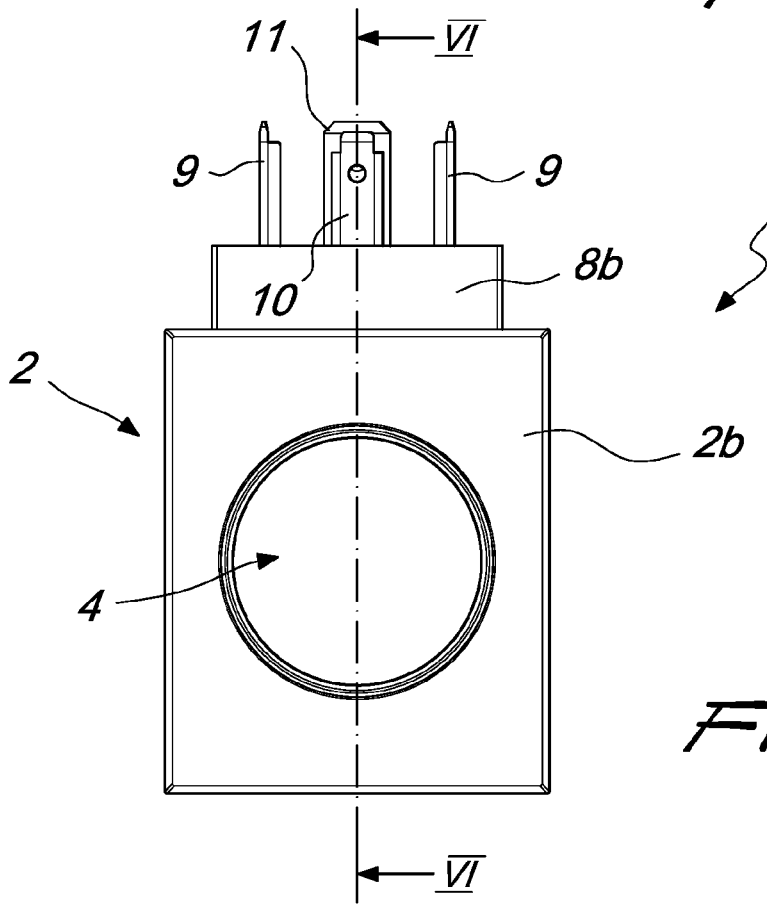

Fig. 5

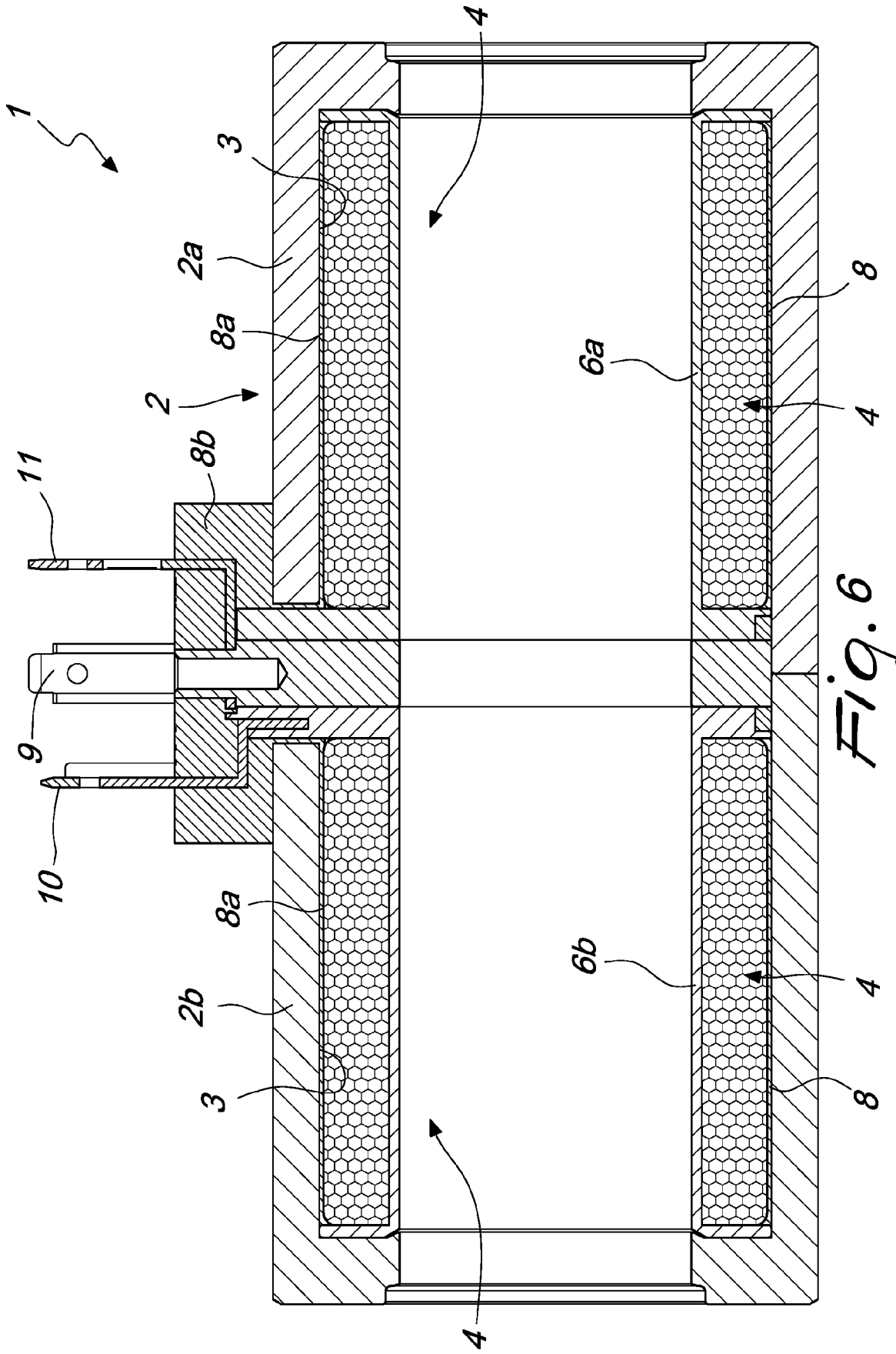

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 19 16 4989

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 171 371 A1 (HAMILTON SUNDSTRAND CORP [US]) 24 May 2017 (2017-05-24) * abstract; figures 3,5 * * paragraph [0015] - paragraph [0017] *	1,2,8,9, 12	INV. H01F3/08 H01F7/08
A	DE 20 2008 008650 U1 (BOSCH GMBH ROBERT [DE]) 12 November 2009 (2009-11-12) * abstract; figure 1 * * paragraph [0003] *	1-13	
A	DE 10 2008 061949 A1 (SCHAEFFLER KG [DE]) 17 June 2010 (2010-06-17) * figure 2 * * paragraph [0013] - paragraph [0014] * * paragraphs [0031], [0034] *	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

H01F
H02K
H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 July 2019	Tano, Valeria

CATEGORY OF CITED DOCUMENTS

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