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DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

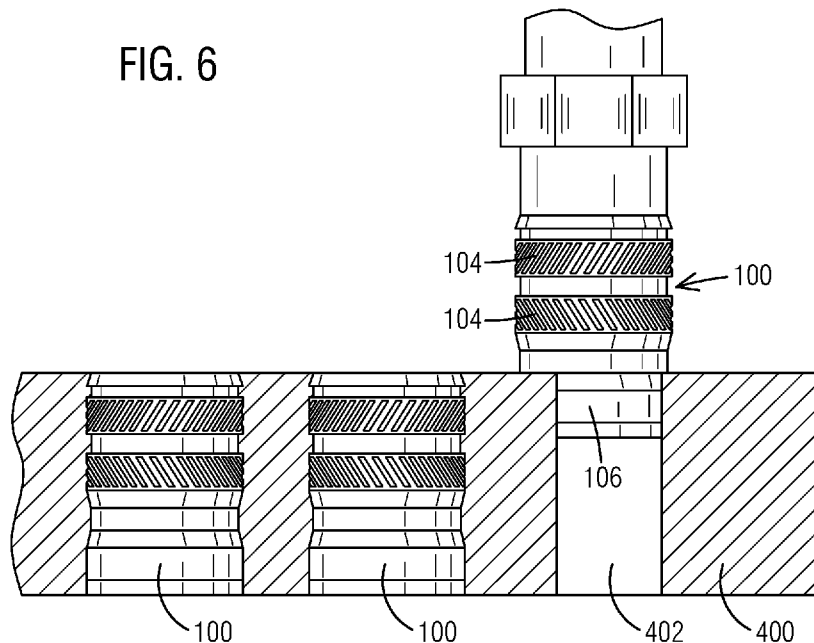
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(54) Title: INDUCTIVE HEAT SET INSERT TOOL

FIG. 6



(57) Abstract: An insertion tool for installing an insert in a base material includes an interface portion arranged to support the insert prior to insertion, a coil positioned to induce a current in the insert in response to the application of power to the coil, and a controller operable to control the application of power to the coil.



## INDUCTIVE HEAT SET INSERT TOOL

### TECHNICAL FIELD

[0001] The present disclosure is directed, in general, to a tool for inserting heat set inserts, and more specifically to a tool operable to rapidly install multiple heat set inserts.

### BACKGROUND

[0002] Additive manufacturing has grown to a point where many complicated components are now additively manufactured. While the parts made using these manufacturing techniques are high-quality, problems arise when adding drilled and threaded holes. To reduce the likelihood of damage, threaded heat set inserts are often placed in holes to provide a superior surface for the threads.

### BRIEF SUMMARY

[0003] An insertion tool for installing an insert in a base material includes an interface portion arranged to support the insert prior to insertion, a coil positioned to induce a current in the insert in response to the application of power to the coil, and a controller operable to control the application of power to the coil.

[0004] In another construction, a method of installing an insert into a base material includes forming a hole in the base material, placing the insert on an interface portion of an insertion tool, providing electrical power to a coil, inducing a current in the insert in response to electrical power passing through the coil, and pushing the insert into the hole.

[0005] The foregoing has outlined rather broadly the technical features of the present disclosure so that those skilled in the art may better understand the detailed description that follows. Additional features and advantages of the disclosure will be described hereinafter that

form the subject of the claims. Those skilled in the art will appreciate that they may readily use the conception and the specific embodiments disclosed as a basis for modifying or designing other structures for carrying out the same purposes of the present disclosure. Those skilled in the art will also realize that such equivalent constructions do not depart from the spirit and scope of the disclosure in its broadest form.

[0006] Also, before undertaking the Detailed Description below, it should be understood that various definitions for certain words and phrases are provided throughout this specification and those of ordinary skill in the art will understand that such definitions apply in many, if not most, instances prior to as well as future uses of such defined words or phrases. While some terms may include a wide variety of embodiments, the appended claims may expressly limit these terms to specific embodiments.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0007] To easily identify the discussion of any particular element or act, the most significant digit or digits in a reference number refer to the figure number in which that element is first introduced.

[0008] FIG. 1 illustrates a perspective view of a prior art heat set insert including internal threads.

[0009] FIG. 2 is a perspective view of a prior art heat set insert tool.

[0010] FIG. 3 is a schematic illustration of a heat set insert installation tool embodying the invention.

[0011] FIG. 4 is a perspective view of a component ready to receive the heat set inserts of FIG. 1.

[0012] FIG. 5 is a perspective view of the component of FIG. 4 with a heat set insert installed.

[0013] FIG. 6 is a section view illustrating the insertion of the heat set inserts.

[0014] FIG. 7 illustrates a system 700 in accordance with one embodiment.

#### DETAILED DESCRIPTION

[0015] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

[0016] Various technologies that pertain to systems and methods will now be described with reference to the drawings, where like reference numerals represent like elements throughout. The drawings discussed below, and the various embodiments used to describe the principles of the present disclosure in this patent document are by way of illustration only and should not be construed in any way to limit the scope of the disclosure. Those skilled in the art will understand that the principles of the present disclosure may be implemented in any suitably arranged apparatus. It is to be understood that functionality that is described as being carried out by certain system elements may be performed by multiple elements. Similarly, for instance, an element may be configured to perform functionality that is described as being carried out by multiple elements. The numerous innovative teachings of the present application will be described with reference to exemplary non-limiting embodiments.

[0017] Also, it should be understood that the words or phrases used herein should be construed broadly, unless expressly limited in some examples. For example, the terms “including,” “having,” and “comprising,” as well as derivatives thereof, mean inclusion without limitation. The singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless

the context clearly indicates otherwise. Further, the term “an/or” as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. The term ‘or’ is inclusive, meaning and/or, unless the context clearly indicates otherwise. The phrases “associated with” and “associated therewith,” as well as derivatives thereof, may mean to include, be included within, interconnect with, contain, be contained within, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, or the like.

**[0018]** Also, although the terms “first”, “second”, “third” and so forth may be used herein to refer to various elements, information, function, or acts, these elements, information, functions, or acts should not be limited by these terms. Rather these numeral adjectives are used to distinguish different elements, information, functions or acts from each other. For example, a first element, information, functions, or acts could be termed a second element, information, function, or act could be termed a first element, information, function, or act, without departing from the scope of the present disclosure.

**[0019]** In addition, the term “adjacent to” may mean: that an element is relatively near to but not in contact with a further element; or that the element is in contact with the further portion, unless the context clearly indicates otherwise. Further, the phrase “based on” is intended to mean “based, at least in part, on” unless explicitly stated otherwise. Terms “about” or “substantially” or like terms are intended to cover variations in a value that are within normal industry manufacturing tolerances for that dimension. If no industry standard is available a variation of 20 percent would fall within the meaning of these terms unless otherwise stated.

**[0020]** Most additive manufacturing techniques involve the layer-by-layer addition of materials that eventually form a completed part or component. Many different materials can be used including plastics, fibers, carbon fibers, wood, paper, and metals. While additively

manufactured components are generally high-quality parts that operate well in its intended functions, the parts can experience premature damage or failure in drilled and threaded holes. The orientation of the holes and threads with respect to the various layers can lead to threaded holes that are not as durable as the rest of the component. To address this problem, holes can be formed in the additively manufactured part without forming threads. A heat set insert 100, such as the one illustrated in FIG. 1, includes preformed internal threads 102 of the desired size and pitch and can be placed in the pre-drilled hole.

[0021] Typically, a tool 200 such as a soldering iron or soldering gun, illustrated in FIG. 2 includes an insert end 202 that receives the heat set insert 100 and heats the heat set insert 100 during the installation process. However, as additive manufacturing has become more prevalent, the installation of heat set inserts 100 using a soldering iron 200 has been shown to be slow and problematic.

[0022] FIG. 3 schematically illustrates an induction insertion tool 300 that is operable to insert heat set inserts 100 such as the one illustrated in FIG. 1 at better controlled temperatures, at a faster rate, and with greater heat application accuracy than can be achieved using the tool 200 of FIG. 2. The induction insertion tool 300 of FIG. 3 includes an end portion 302 arranged to receive the heat set insert 100 and one or more coils 304. Each of the coils 304 is electrically connected to a controller 306 that will be described in greater detail below.

[0023] The end portion 302 defines an interior space 308 to receive the coil 304 and an interface portion 310 arranged to engage the heat set insert 100. The end portion 302 can be formed from a number of different materials including ceramics, metals, composites, and the like. It is important to note that during the installation process, the heat set insert 100 will reach a high temperature. As such, the material used for the end portion 302 should be selected to assure that the high temperature does not cause any damage. In addition, it is desirable to select

a material that is non-conductive or is less susceptible to induction heating. For example, ceramics and composites generally do not conduct electrical current well and are not generally susceptible to induction heating making them good material for the end portion 302. In some constructions, the end portion 302 is formed from a first material and an insulating material such as a ceramic or a composite is used to form the interface portion 310 which is then attached to the remainder of the end portion 302.

**[0024]** The coil 304 is an electromagnetic induction heating coil formed and positioned within the end portion 302 in a manner that efficiently induces an electrical current in the heat set insert 100 when it is positioned on the interface portion 310 of the end portion 302. The induced electrical current in the heat set insert 100 rapidly heats the heat set insert 100 without heating any of the adjacent components. In some constructions, multiple coils 304 having different turns per length, different diameters, lengths, etc., are provided to accommodate differently shaped heat set inserts 100 or a different quantity of heat set inserts 100. For example, one coil 304 may be well-suited to longer skinnier inserts, while a second coil 304 is suited to flatter and shorter heat set inserts 100. In still other constructions, the coil 304 is positioned outside of the end portion 302 and may be operable to heat multiple heat set inserts 100 simultaneously.

**[0025]** The controller 306 includes an inverter 312 or other device that receives electrical power, typically AC power 314 at a line frequency (typically 60 Hz or 50 Hz) and converts that power to a desired frequency (typically between 100 Hz and 10 MHz). In addition, a voltage controller 316 and a current controller 318 may be provided to provide total control of the power delivered to the coil 304. The controller 306 can include multiple switches and gauges but in its simplest form may include a simple on/off switch 320 and no other controls. In the simple case, the frequency, voltage and current levels of the power delivered to the coil 304 is

fixed or restrained between desired limits and not adjustable by the user. However, preferred systems include a frequency control 322 that allows the user to vary the frequency of the power delivered to the coil 304 to better optimize the operation. Other constructions may include the voltage controller 316 for adjusting the voltage and the separate current controller 318 for adjusting the current delivered to the coil 304. Thus, one induction insertion tool 300 can be adjusted or optimized for the installation of different size heat set inserts 100.

**[0026]** FIGs. 4-6 illustrate the installation of several heat set inserts 100 as illustrated in FIG. 1. With reference to FIG. 4, a component 400 that is preferably manufactured using additive manufacturing techniques is provided. The component 400 may be made from a plastic material, with other components formed from fibers, carbon fibers, wood, paper, or other non-conducting or low conducting materials. Several holes 402 are drilled in desired locations and are sized to each receive one of the heat set inserts 100. In the construction of FIG. 4, all the holes 402 are the same and are sized to receive the same heat set insert 100. However, different sized holes 402 could be formed with the induction insertion tool 300 of FIG. 3 being well-suited to handling the different sized heat set inserts 100.

**[0027]** A first heat set insert 100 to be installed is placed on the interface portion 310 of the end portion 302 and then positioned adjacent the hole 402 into which it will be installed. The controller 306 is activated by activating the on/off switch 320, which in preferred constructions is built into the portion of the induction insertion tool 300 held by the user (e.g., a trigger on a gun-type tool). Upon activation, power in the form of high-frequency electricity flows through the coil 304. The user can adjust the voltage, the current, and/or the frequency to optimize the operation of the induction insertion tool 300. As current flows through the coil 304, the coil 304 generates a magnetic field that induces a current in the heat set insert 100 (typically a brass or an iron insert). The resistance of the heat set insert 100 to the current flow results in significant



and rapid heating of the heat set insert 100. While portions of the magnetic field produced by the coil 304 may interact with the interface portion 310, if the interface portion 310 is made from a non-conducting material little to no unwanted heating of the interface portion 310 will occur.

**[0028]** As discussed previously, the coil 304 is preferably shaped and positioned to focus the induced magnetic field on the heat set insert 100 supported on the interface portion 310 to assure an efficient energy transfer. In addition, the end portion 302 including the interface portion 310 are preferably formed from non-conductive materials to reduce any heating that might be caused by induced currents therein.

**[0029]** As the heat set insert 100 heats, it will reach an optimal temperature where some localized softening (plastic transition temperature) of the component 400 occurs. At this point, the heat set insert 100 can be pushed into the hole 402. Once pushed into the hole 402, as shown in FIG. 5, the component 400 material around the heat set insert 100 moves back toward its undeformed position and engages the heat set insert 100 such that the heat set insert 100 and the component 400 are essentially bonded to one another to provide a substantially permanent connection. As described, the component 400 experiences some localized plastic deformation but there is no melting of the component 400. As the heat set insert 100 cools, the ability of the material to plastically deform ends and the insertion is complete.

**[0030]** As illustrated in FIG. 6, a starting portion 106 of the heat set insert 100 is sized to closely match the size of the hole 402 such that the heat set insert 100 can be partially inserted. The heat set insert 100 includes a number of textured bosses 104 that serve to enhance the connection between the heat set insert 100 and the component 400. The heating of the heat set insert 100 locally heats the component 400 past its plastic transition temperature which softens

the component 400 and allows for the heat set insert 100 to be pushed into the holes 402 with the component 400 plastically deforming to engage the bosses 104.

**[0031]** FIGs. 1-6 illustrate a system that operates to install one heat set insert 100 at a time. However, the present induction insertion tool 300 is easily adapted to robotic or automated systems that may simultaneously install two or more heat set inserts 100. For example, FIG. 7 schematically illustrates a system 700 that simultaneously installs four different heat set inserts 100. Each of the induction insertion tools 300 could be individually adjusted for the particular heat set insert 100 being installed, thereby optimizing the installation process. In an alternate embodiment, the surface area of the coil 304 may be configured to allow a user to heat multiple heat set inserts 100 at once with a single induction insertion tool 300.

**[0032]** By using induction heating and insulated or non-conducting materials to support the heat set insert 100 prior to installation, a much more energy efficient transfer process is possible without unwanted heating of the induction insertion tool 300 or the material into which the heat set insert 100 is being installed.

**[0033]** Although an exemplary embodiment of the present disclosure has been described in detail, those skilled in the art will understand that various changes, substitutions, variations, and improvements disclosed herein may be made without departing from the spirit and scope of the disclosure in its broadest form.

**[0034]** None of the description in the present application should be read as implying that any particular element, step, act, or function is an essential element, which must be included in the claim scope: the scope of patented subject matter is defined only by the allowed claims. Moreover, none of these claims are intended to invoke a means plus function claim construction unless the exact words “means for

## CLAIMS

What is claimed is:

1. A method of installing an insert (100) into a base material (400), the method comprising:
  - forming a hole (402) in the base material (400);
  - placing the insert (100) on an interface portion (310) of an insertion tool (300);
  - providing electrical power to a coil (304);
  - inducing a current in the insert (100) in response to electrical power passing through the coil (304); and
  - pushing the insert (100) into the hole (402).
2. The method of claim 1, wherein the base material (400) is manufactured by an additive manufacturing technique.
3. The method of claim 1, wherein the base material (400) comprises a material selected from the group consisting of a plastic material, a fiber material, a carbon fiber material, wood, paper, a non-conducting material, a low conducting material, and combinations thereof.
4. The method of claim 1, wherein the surface area of the coil (304) is sufficient to induce a current in each of a plurality of inserts (100) in order to push the plurality of inserts (100) into corresponding holes at the same time.
5. The method of claim 1, wherein the insert (100) comprises brass.
6. The method of claim 1, wherein the insert (100) comprises iron.

7. An insertion tool (300) for installing an insert (100) in a base material (400), the insertion tool (400), comprising:
  - an interface portion (310) arranged to support the insert (100) prior to insertion;
  - a coil (304) positioned to induce a current in the insert (100) in response to the application of power to the coil (304); and
  - a controller (306) operable to control the application of power to the coil (304).
8. The insertion tool (300) of claim 7, wherein the base material (400) is manufactured by an additive manufacturing technique.
9. The insertion tool (300) of claim 7, wherein the insert (100) comprises brass.
10. The insertion tool (300) of claim 7, wherein the insert (100) comprises iron.
11. The insertion tool (300) of claim 7, wherein the coil (304) is positioned 3 inches or less from the surface of the base material (400).
12. The insertion tool (300) of claim 7, wherein the interface portion (310) includes an insulating material.

13. A system (700) for installing a plurality of inserts (100) in a base material (400) simultaneously, the system (700) comprising:

a base material (400) including a plurality of holes (402); and

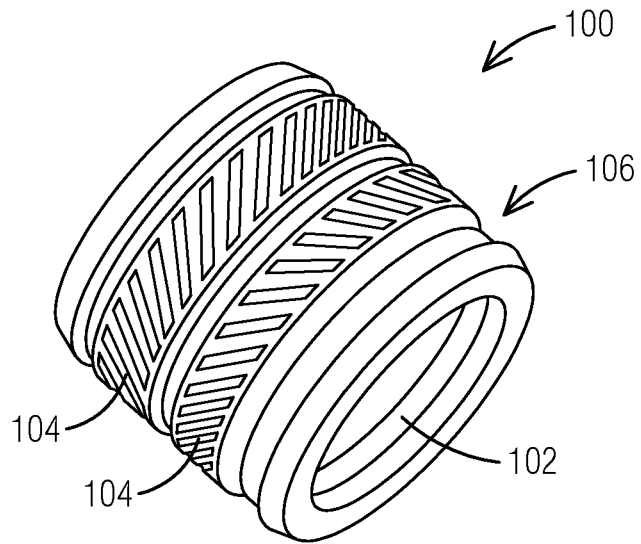
a plurality of insertion tools (300), each insertion tool (300) corresponding to hole (402) in the base material (400), each insertion tool (300) comprising:

an interface portion (310) arranged to support the insert (100) prior to insertion;

a coil (304) positioned to induce a current in the insert (100) in response to the application of power to the coil (304);

wherein a controller (306) is operable to control application of power to the plurality of coils (304) so that the plurality of inserts (100) are installed in the base material (400) simultaneously.

**FIG. 1**  
PRIOR ART



**FIG. 2**  
PRIOR ART

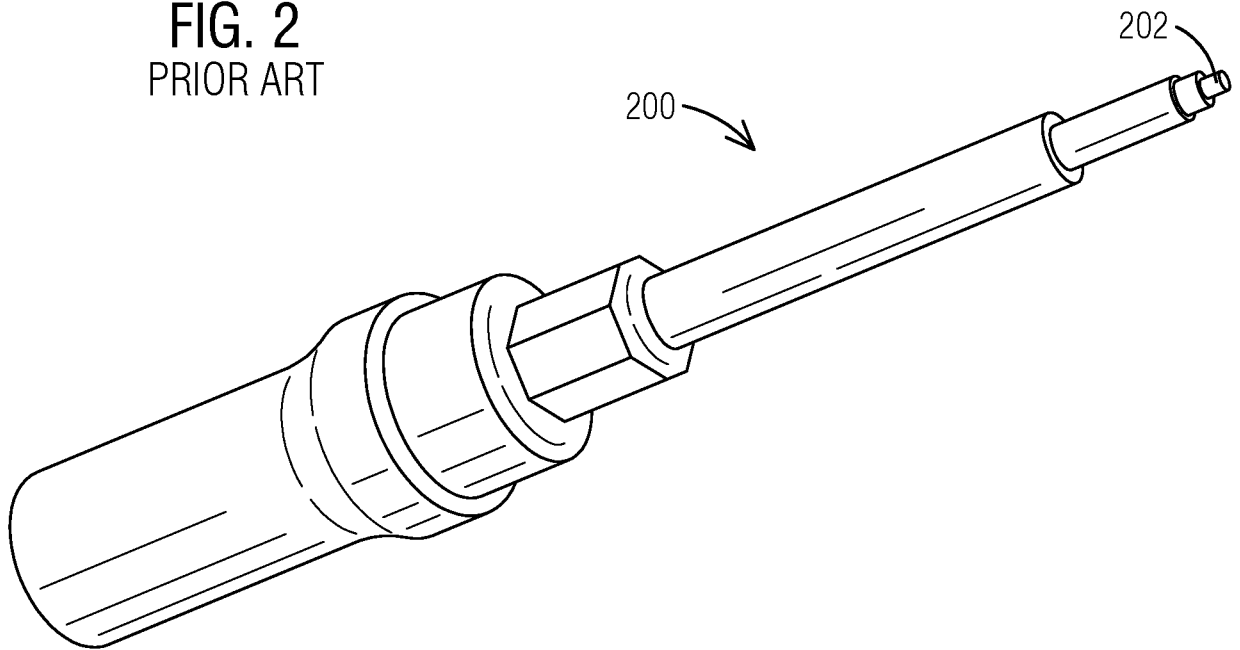


FIG. 3

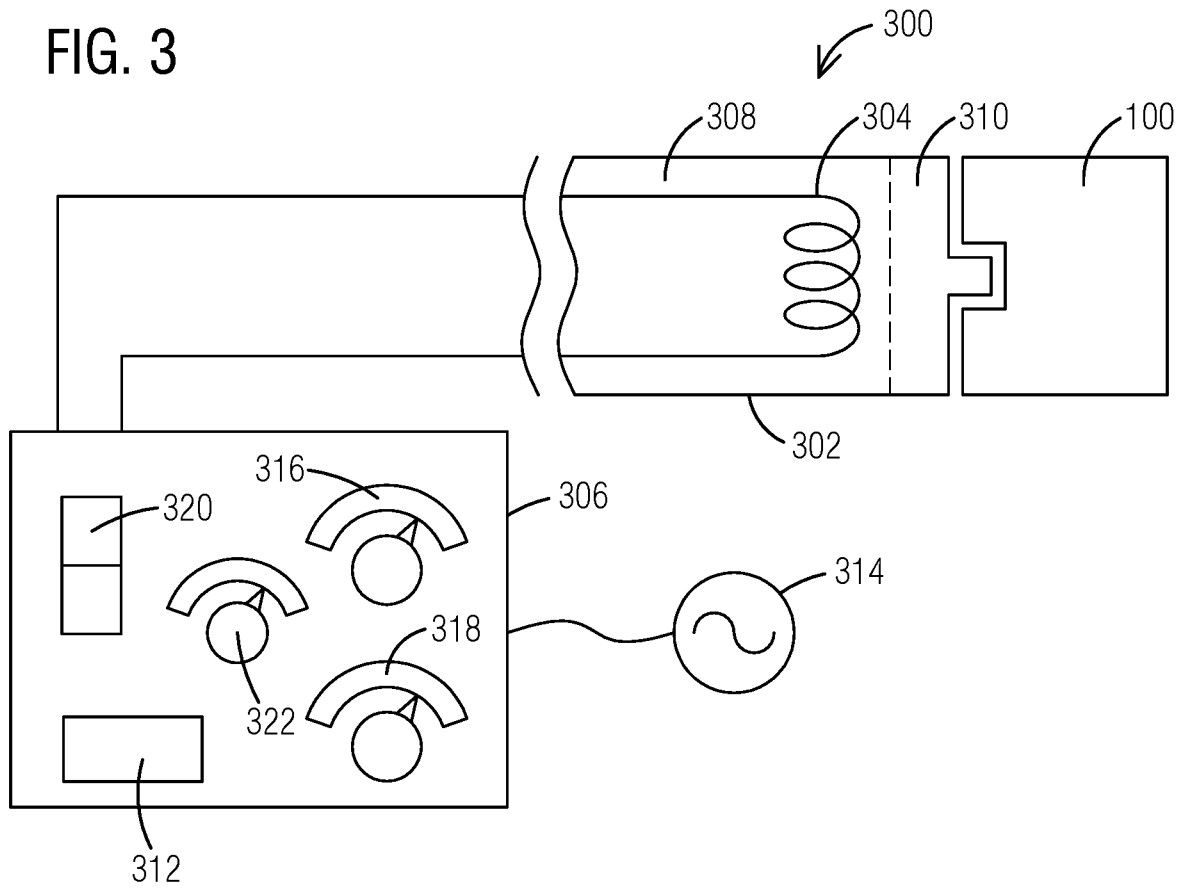


FIG. 4

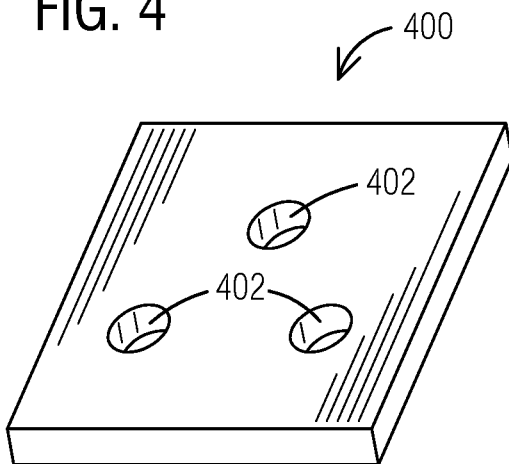


FIG. 5

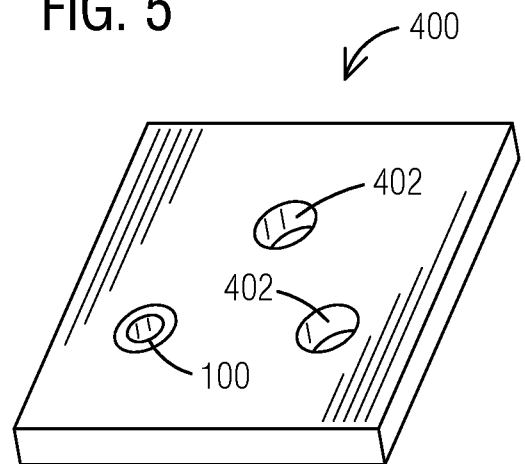


FIG. 6

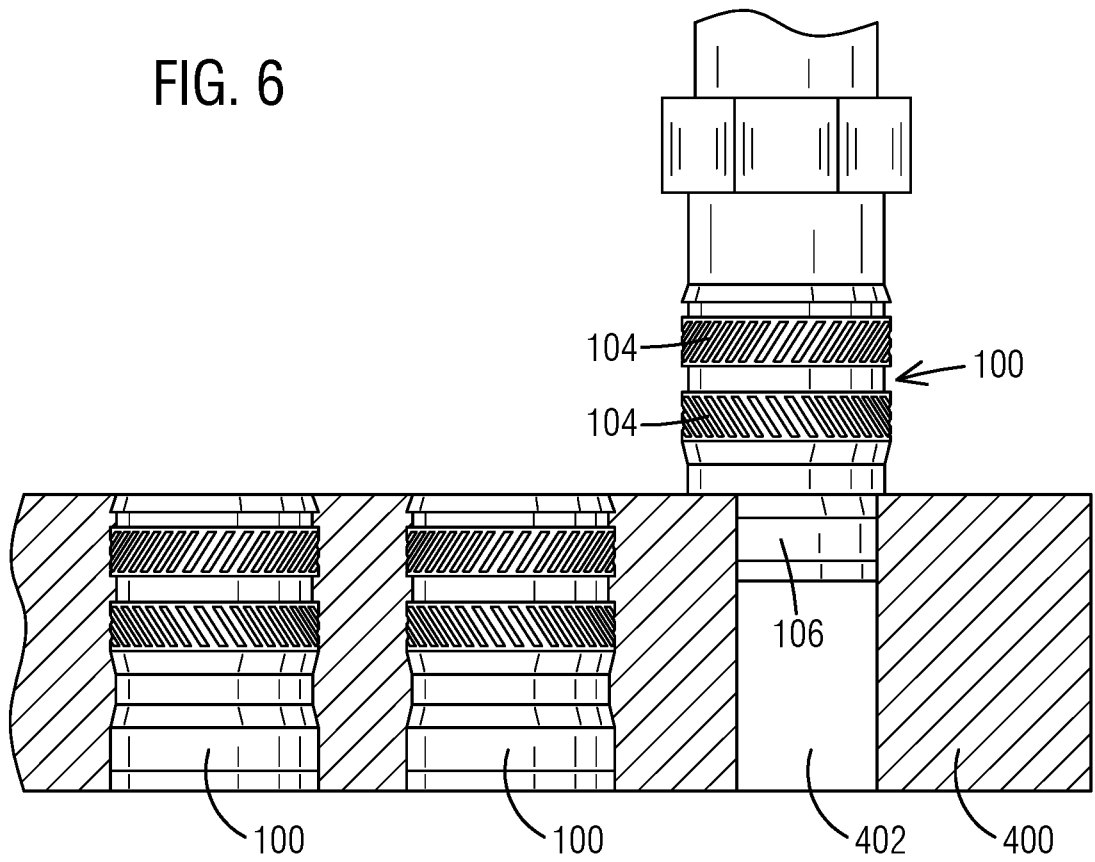
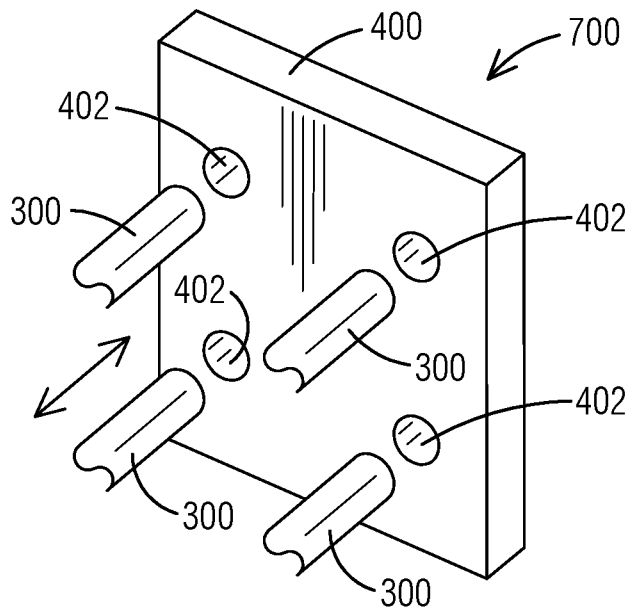


FIG. 7





INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2020/016472

A. CLASSIFICATION OF SUBJECT MATTER  
 INV. F16B33/00 F16B37/04  
 ADD. B29C65/46 B29C65/00

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)  
 B29C

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)  
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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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
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- "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 <b>27 April 2020</b>	Date of mailing of the international search report <b>07/05/2020</b>
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer <b>Härtig, Thomas</b>
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2020/016472

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Y	EP 3 072 626 A1 (NEWFREY LLC [US]) 28 September 2016 (2016-09-28) Para. [0051, 0060] -----	6,10
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Information on patent family members

International application No PCT/US2020/016472
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