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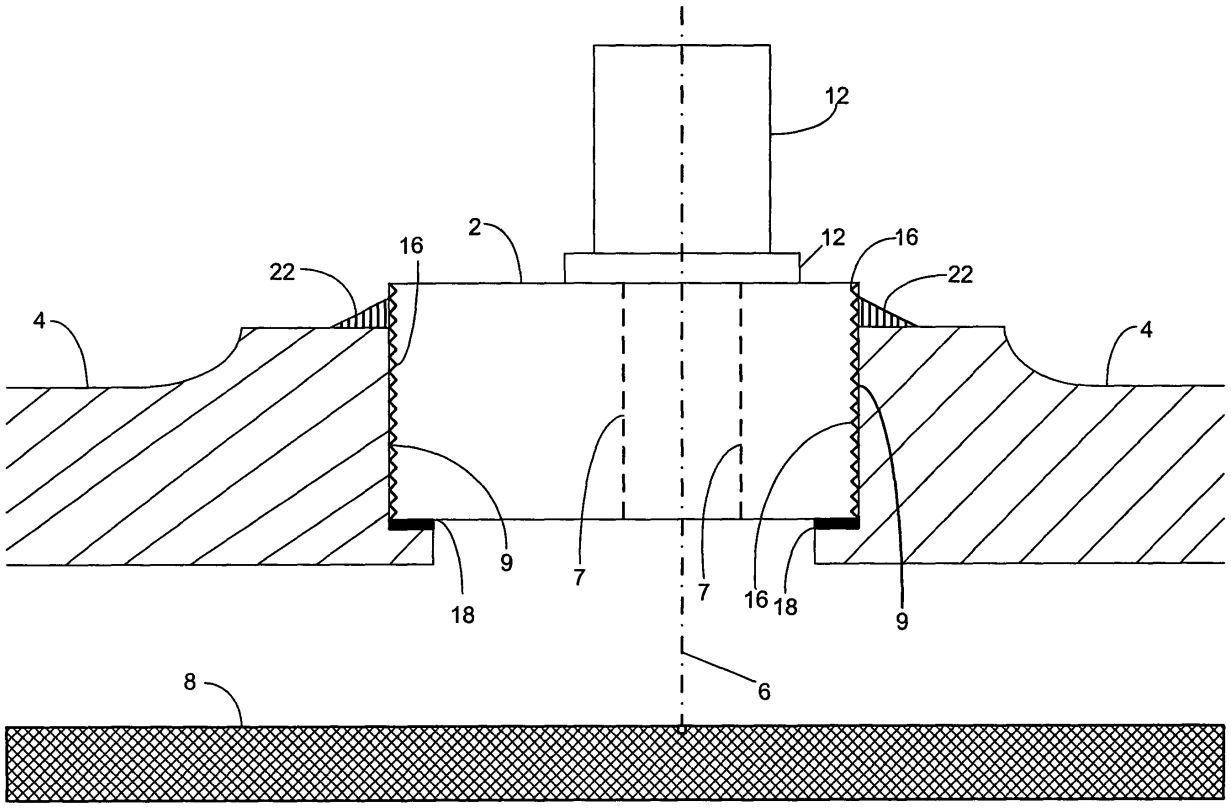
## (54) Rapper alignment plug

(57) The present invention relates generally to a rapper alignment plug (2) used in the custom alignment of one or more portions of a rapper device (2) through the walls of a vessel (4), and methods for forming and using same.

FIG. 1




EP 2 009 300 A2

## Description

**[0001]** ***Field and Background of Invention***

**[0002]** The present invention relates generally to a rapper alignment plug used in the custom alignment of actuating shafts or mechanisms through the walls of a vessel. In particular, the present invention relates to a rapper alignment plug and a process for forming such a rapper alignment plug, which is designed to permit passage therethrough and insertion into a vessel, of one or more rapper devices, which require a relatively restrictive assembly tolerance in order to function efficiently.

**[0003]** As used herein, the term rapper is used to refer to a device that aids in the cleaning and maintenance of one or more components of a heat transfer or heat exchanger unit which may be located inside a vessel.

**[0004]** The internal surfaces of certain heat exchangers often become fouled with ash encrustation during use. Such fouling adversely affects the heat transfer efficiency of the heat exchanger. Therefore, it is necessary to clean the heat exchanger on a regular basis without shutting down the entire system.

**[0005]** One method/system for removing ash deposits from heat exchanger surfaces is through the use of mechanical rappers. Such rappers typically include an impacter which through a mechanical linkage strikes a surface within the heat exchanger to produce a mechanical vibration causing ash deposits to dislodge from the heat exchanger surface. One advantage of mechanical rappers is that such devices do not remove the protective oxide layer on the surface of the tubes, thereby enabling the oxide layer to continue protecting the surfaces of the tubes from corrosive environments. Mechanical rappers can be manually, pneumatically or electrically actuated. Mechanical rappers may be designed in such a way so as to pass through an opening in the vessel wall in such a manner that permits the actuator portion of the rapper device to remain outside the vessel wall. The interior portion of the rapper device contains at least one impact portion that is designed to strike one or more surfaces of the heat exchanger located within the vessel.

**[0006]** An important consideration in the design of a rapper is to provide proper contact between the impact portion of the rapper and the one or more surfaces to be cleaned. The alignment of the impact portion of a rapper device with a heat exchanger surface is important for effective use of such a rapper device.

**[0007]** United States Patent No. 5,079,459 discloses an electromagnetic hammer rapper having forward and retract coils for controllably causing a centrally disposed armature to activate an impact transfer pin causing the transfer pin to knock-off slag and other encrustations from heat transfer tubes or walls of heat exchanger components, and for causing the armature to recoil to a retracted position.

**[0008]** Given the above, a need exists for a device and method that permits increased control of the machining and/or construction of a rapper alignment passage, as well as one that permits various components of the rapper device to be machined in separate locations, thus reducing construction time and the costs associated therewith.

**[0009]** ***Summary of invention***

**[0010]** The present invention relates generally to a rapper alignment plug used in the custom alignment of actuating shafts or mechanisms through the walls of a vessel. In particular, the present invention relates to a rapper alignment plug and a process for forming such a rapper alignment plug, which is designed to permit passage therethrough and insertion into a vessel, of one or more rapper devices which require a relatively restrictive assembly tolerance in order to function efficiently.

**[0011]** In accordance with the present invention it is possible to achieve, among other things, a process that permits for the simultaneous machining of various vessel components. The present invention also includes a method for permitting and/or facilitating the custom alignment and manufacture of components in parallel.

**[0012]** Accordingly, one aspect of the present invention is drawn to an alignment plug comprising: a body element; at least one thread element formed on at least one surface of the body element; and at least one passage located within the body element, wherein the at least one passage permits the insertion of at least one object through the body element of the alignment plug, wherein the alignment plug is capable of being inserted into at least one threaded opening in a vessel wall, and the alignment plug acts to align the at least one object that is capable of being inserted therethrough.

**[0013]** Another aspect of the present invention is drawn to a process for forming an alignment plug comprising the steps of: (a) providing an alignment plug comprising a body element capable of being inserted into at least one threaded opening in a vessel wall, wherein the body element contains thereon at least one thread element formed on at least one surface thereof; (b) inserting the alignment plug into the at least one threaded opening in a vessel wall to a predetermined depth; (c) removing the alignment plug a predetermined amount from the at least one threaded opening in the vessel wall, wherein the amount the alignment plug is removed is less than the insertion amount; (d) marking the alignment plug so as to create an alignment mark; and (e) forming at least one passage in the body element of the alignment plug, wherein the at least one passage permits the insertion of at least one object through the body element of the alignment plug.

**[0014]** Yet another aspect of the present invention is drawn to a process for forming an alignment plate and/or cover comprising the steps of: (i) providing an alignment plate and/or cover comprising a body element capable of covering at least one opening in a vessel wall, wherein the body element contains thereon at least one attachment means for attaching the body element to the vessel wall; (ii) temporarily attaching the alignment plate and/or cover to the vessel wall; (iii) marking the alignment plate and/or cover so as to create a alignment mark; and (iv)

forming at least one passage in the body element of the alignment plate and/or cover, wherein the at least one passage permits the insertion of at least one object through the body element of the alignment plate and/or cover.

**[0015]** ***Brief Description of the Drawings***

**[0016]** Fig. 1 is a cross-sectional illustration of a rapper alignment plug according to one embodiment of the present invention, where the rapper alignment plug is inserted into a vessel wall;

**[0017]** Fig. 2 is a cross-sectional illustration of a rapper device as the rapper device passes through a rapper alignment plug, the rapper alignment plug being formed in accordance with one embodiment of the present invention; and

**[0018]** Fig. 3 is an illustration of the outer surface of a vessel wall having a rapper alignment plug according to one embodiment of the present invention is inserted therein; and

**[0019]** Fig. 4 is a cross-sectional illustration of a rapper alignment plug according to another embodiment of the present invention, where the rapper alignment plug is inserted into a vessel wall.

**[0020]** ***Description***

**[0021]** A brief discussion of some background information and definitions relating to the present invention will be presented before commencing the detailed description.

**[0022]** The term rapper is used to refer to a device that aids in the cleaning and/or maintenance of one or more heat transfer and/or heat exchange units by striking at least one surface of such units. Such striking prevents slag and other deposits from accumulating on the units. Various embodiments of a rapper are possible; such embodiments include rappers where a portion of the rapper is designed to pass through the outer walls of a vessel in order to contact the one or more heat transfer and/or heat exchange units located inside. The interior portion of such a rapper includes, as is discussed above, at least one impact portion designed to strike one or more surfaces located in the interior of the vessel. A second or different portion of such a rapper (*e.g.*, a control or actuator portion) is designed to remain outside the vessel and permit and/or facilitate control of the rapper.

**[0023]** In one instance, to permit and/or facilitate the passage of one or more rappers through a vessel wall, as well as to provide for proper alignment between the at least one impact portion of the rapper and any surface to be impacted, a rapper alignment plug is utilized. Such a rapper alignment plug is designed to fit, either temporarily or permanently, into an opening in the wall of the vessel. The rapper alignment plug comprises at least one passage formed through the rapper alignment plug where the one or more passages are designed to permit the insertion therethrough of at least one rapper. As would be apparent to those of skill in the art, depending upon a number of design factors, one or more rapper alignment plug openings, and associated rapper alignment plugs, could be provided for any given vessel.

**[0024]** The rapper alignment plug according to the present invention can be used in the custom alignment of one or more portions of a rapper, where such rapper is designed to pass through one or more openings located in the rapper alignment plug and come into contact with at least one surface located within a vessel. The present invention also relates to a process for forming such a rapper alignment plug, where the plug is designed to permit passage therethrough and insertion into a vessel, of one or more rapper devices.

**[0025]** The rapper alignment plug may be formed from any suitable material that can withstand the temperatures and/or environments associated with both the near external environment surrounding a vessel, as well as the interior environment of such a vessel. Such materials can include, but are not limited to, metal, plastic, ceramics, or any combination of two or more thereof. Suitable metals include, but are not limited to, steel, stainless steel, titanium, iron, nickel, zinc, or any metallic alloy containing, at a minimum, two or more metals or metallic elements or compounds (*e.g.*, Inconel® alloys). Suitable ceramics include, but are not limited to, ceramics designed to withstand a temperature of at least about 200°C, or at least about 250 °C.

**[0026]** Since rapper alignment plugs are typically utilized in conjunction with vessels that are large in size, one or more rapper alignment plugs may be needed to permit the adequate maintenance of such a vessel by one or more rappers. Accordingly, when manufacturing vessels of this magnitude/size, the ability to manufacture, for example, a large number of identical, or substantially identical, components in parallel is beneficial from both a cost and time standpoint. As an example, the ability to manufacture multiple rapper alignment plugs having identical, or nearly identical, design and tolerance criteria is desired. This ability can then translate into rapper alignment plugs that are interchangeable between the one or more openings in a vessel.

**[0027]** The moving components of a rapper (*e.g.*, the actuating shaft, actuating mechanisms, and/or impact transfer devices) require tight, relatively restrictive assembly tolerances in order to permit and/or facilitate proper alignment of the rapper with the surface to be struck. In addition, the actuating mechanisms require proper alignment with the vessel wall. The ability to manufacture these devices to the tolerances required, while remaining separate from the entire unit, allows more precise manufacturing and decreases production time/turnaround.

**[0028]** Additionally, the vessel walls may typically involve a rounded internal or external surface. Such surfaces create a challenge for adhering and/or inserting a rapper device through such a surface. Accordingly, a rapper alignment plug that can be inserted and/or located within a wall of the vessel can provide a flat work and/or attachment surface for the rapper device.

**[0029]** Referring to the figures generally, wherein like

numerals designate the same or functionally similar elements throughout the several drawings, and to Figs. 1 and 2 in particular, Fig. 1 is a cross-sectional illustration of a rapper alignment plug 2 according to one embodiment of the present invention, where the rapper alignment plug 2 is inserted into a vessel wall 4. Also shown are alignment markings 6 used to create a rapper passage 7 and which are used to designate the subsequent machining required. Alignment marking 6 maybe created utilizing the as built features of the vessel internals which in turn reduces the potentially accumulative manufacturing tolerances that may cause misalignment of the actuating shafts.

**[0030]** Vessel wall 4 is, for example, the outside surface of a cylindrical vessel that contains at least one heat transfer unit 8. Such vessels are typically made from metal, but can be made from any suitable material that is able to withstand the temperature, pressure and other environmental factors associated with the operation of such a vessel.

**[0031]** In one embodiment, such vessels are designed so as to withstand a wide range of pressures and temperatures, including high pressures and temperatures. By high pressures, it is meant that such vessels can withstand pressures of at least about 2 atmospheres, at least about 3 atmospheres, at least about 5 atmospheres, or even at least about 10 atmospheres. By high temperatures, it is meant that such vessels can withstand temperatures of at least about 200°C, or at least about 300°C, or at least about 400°C, or at least about 500°C, or at least 600°C, or even at least about 750°C. Here, as well as elsewhere in the specification and claims, individual number limits can be combined to form number ranges. Due to the heavy duty nature of vessel wall 4, a suitable vessel passage 9 and rapper passage 7 must be manufactured which resists breakage, corrosion and maintains integrity under a wide range of pressures and temperatures, including high pressures and temperatures. In one embodiment, rapper alignment plug 2 accomplishes such a goal by occupying vessel passage 9 and by providing a suitable opening for rapper passage 7 that is designed to withstand the temperatures and pressures associated with the functioning of a vessel. The rapper passage can be located at any point within the plug 2, not just at the center.

**[0032]** Heat transfer unit 8 is used to transport a fluid used as a means of delivering or distributing heat to a separate unit and/or area. In one embodiment, heat transfer unit 8 may comprise a series of tubes that contains, transports and/or delivers a water or water/steam mixture. As discussed above, over a given amount of time, the outside surfaces of the tubes of heat transfer unit 8 become covered with ash deposits.

**[0033]** Turning to Fig. 2, there is a illustrated a cross-sectional view of impact transfer pin 10 passing through rapper alignment plug 2 at rapper passage 7. In the embodiment of Fig. 2, impact transfer pin 10 passes through vessel wall 4 at vessel passage 9, and rapper alignment plug 2 at rapper passage 7 is positioned to effectively strike or make intermittent contact with heat transfer unit 8. Outside the vessel, impact transfer pin 10 is enclosed in rapper housing 12, with rapper housing 12 encasing the mechanical portions of the rapper unit and permitting/allowing impact transfer pin 10 to move. Inside rapper housing 12 and immediately adjacent to impact transfer pin 10 is rapper actuating mechanism 14. The rapper actuating mechanism 14 is moved by electrical, mechanical, pneumatic or hydraulic means causing impact transfer pin 10 to strike heat transfer unit 8.

**[0034]** The rapper alignment plug 2 typically begins as a solid piece, or slug, of metal that is machined and/or forged into a desired shape via any appropriate number of steps. Once the piece, or slug, of metal has been processed into the desired shape for rapper alignment plug 2, one or more processing steps (*e.g.*, machining steps) are utilized to finalize the overall design of rapper alignment plug 2. For example, rapper alignment plug 2 undergoes machining to create some form of attachment or insertion means therein/thereon so that rapper alignment plug 2 can be attached to, or inserted in, an appropriate point such as vessel passage 9, of vessel wall 4. In one embodiment, the rapper alignment plug 2 according to the present invention is cylindrical in shape and contains at least one thread 16 along the outer surface of the circular portion of the cylindrical rapper alignment plug 2. Thread 16 is designed allow rapper alignment plug 2 to be screwed into a suitably designed opening such as vessel pass through 9 in vessel wall 4. In another embodiment, rapper alignment plug 2 could be cast or molded into a desired shape, and then subjected to further processing to yield a completed rapper alignment plug. Alternatively, in one casting or molding embodiment, rapper alignment plug 2 could be completely formed in one step and no further processing/machining thereof is necessary.

**[0035]** In one embodiment, a raw rapper alignment plug (*e.g.*, one that does not contain all the necessary through holes) having at least one thread thereon is screwed into vessel passage 9 in vessel wall 4 until the plug 2 reaches a maximum insertion depth and bottoms out due to interaction with, for example, stopping means 18. Once reaching the maximum insertion depth, rapper alignment plug 2 is backed out a suitable amount (*e.g.*, one half turn). Next, as shown in Fig. 3, the top of rapper alignment plug 2 is then given a mark 20. Mark 20 can be formed in any suitable manner, including but not limited to, inscribing, punching, scratching, drawing, or the application of at least one indicia. Mark 20 itself can be any suitable indicia including, but not limited to, a groove, an application, a scratch, an ink marking, a paint marking, a dot, a series of dots, a line, a series of lines, or any other method of marking rapper alignment plug 2 and vessel wall 4 so as to be able to, at a later point in time, properly align the two.

**[0036]** After mark 20 is applied and the custom location of the rapper passage is identified, rapper alignment plug

2 is removed from vessel wall 4 and vessel passage 9. Once marked and removed, rapper alignment plug 2 is altered. In one embodiment alterations to rapper alignment plug 2 can be accomplished via a machining process. In one embodiment the one or more alterations are the construction of one or more rapper passages 7 in rapper alignment plug 2. Such passages 7 are designed to receive and/or permit the passage of a rapper device, or a portion thereof, through rapper alignment plug 2.

**[0037]** One embodiment, as illustrated in Fig. 2, involves a rapper alignment plug 2 designed to accept impact transfer pin 10 from a rapper device. In this embodiment, impact transfer pin 10 and alignment markings 6 on heat transfer unit 8 act as a guide for where the at least one passage 7 is to be formed in rapper alignment plug 2. After alignment plug 2 has been appropriately marked, one or more passages 7 are created therein, such that the one or more passages 7 permit the correct location of one or more devices inserted through the finished rapper alignment plug 2.

**[0038]** In one embodiment the machining markings are aligned with alignment marking 6. In another embodiment the machining markings are measured or made while rapper alignment plug 2 is inserted, completely or partially, in vessel wall 4. In another embodiment, rapper alignment plug 2 is marked after removal from vessel wall 4. In still another embodiment, bolting patterns and/or attachment means are also formed in or on rapper alignment plug 2.

**[0039]** The removal of rapper alignment plug 2 from vessel passages 9, permits the machining of several parts in parallel and allows access to a vessel during construction and/or maintenance. For example, additional time is not required to machine the exact tolerances necessary for impact transfer pin 10 in a wall of a vessel. Due to the present invention, a rapper alignment plug can be marked, removed and machined separately, permitting other work to continue uninterrupted on vessel 4.

**[0040]** Once the changes/modifications to rapper alignment plug 2 are complete, rapper alignment plug 2 is reinserted into vessel passage 9 of vessel wall 4. The reinsertion occurs via one or more threads 16 at the outer edges. Rapper alignment plug 2 is screwed into vessel wall 4 until a predetermined maximum depth is obtained. In one embodiment, the depth to which rapper alignment plug 2 can be inserted into a vessel wall 4 is controlled by stopping means 18 (*e.g.*, a lip 18 formed on the outer surface of vessel passage 9). In this embodiment, once rapper alignment plug 2 becomes seated against stopping means 18, rapper alignment plug 2 is backed out/rotated in the opposite direction a predetermined amount (*e.g.*, one half turn) and alignment mark 20 is created. Upon total removal of alignment plug 2 from vessel wall 4, mark 20 can then be used to properly realign rapper alignment plug 2 upon reinsertion into vessel wall 4. In one instance, rapper alignment plug 2 is totally removed from vessel wall 4 for further processing steps.

**[0041]** Once rapper alignment plug 2 is completed, rapper alignment plug 2 is reinserted into vessel wall 4, properly aligned via mark 20, and optionally secured to/in the vessel via an appropriate attachment means. Appropriate attachment and/or securing means include, but are not limited to, one or more weldments, screws, bolts, adhesives, or combinations thereof. In one embodiment, rapper alignment plug 2 is secured to/in the vessel via a weld 22 formed between rapper alignment plug 2 and vessel 4.

**[0042]** In another embodiment of the invention, an alignment plate and/or cover can be used in place of rapper alignment plug 2. In this embodiment, the alignment plate and/or cover is temporarily attached via a series of bolts, or other suitable attachment means, to vessel wall 4 and then is marked with one or more appropriate alignment lines 6 and/or machining lines 7. Next, the alignment plate and/or cover is removed, and machined as is needed to create one or more passages in the alignment plate and/or cover. Then, the alignment plate and/or cover is reattached to the outer surface of, for example, vessel wall 4 for use in combination with, for example, a rapper device.

**[0043]** Referring to Fig. 4, there is shown another embodiment of the rapper alignment plug which illustrates the versatility of the concept. In contrast to Fig. 1 which shows the use of a threaded connection to join the plug 2 to the vessel wall 4, a welded connection is shown in Fig. 4 may be required by applicable design codes and/or other design requirements. The welded connection 24 may be a full penetration type weld prep with a lapped nose 26 to aid with plug 2 retainment at fit-up. This joint region could be a ship lap (non full penetration) weld prep, depending upon the application. The balance of the weld 26 would be completed once the initial fit-up was completed.

**[0044]** While a specific embodiment of the present invention has been shown and described in detail to illustrate the application and principles of the invention, it will be understood that it is not intended that the present invention be limited thereto and that the invention may be embodied otherwise without departing from such principles.

**[0045]** For example, while the preferred embodiments have been described in terms of the rapper alignment plug and versions thereof, the present invention is not limited thereto. Other rapper alignment plugs and other marking plugs can be utilized in conjunction with the present invention, including cover plates and other closely related variations thereof so long as such devices permit for insertion/application, removal, marking and reinsertion/reapplication. In addition, while the rapper alignment plug is described as the apparatus for creating the passage in the vessel body, any other plug or cover could be utilized in the practice of the present invention.

## Claims

1. An alignment plug comprising:

   a body element;
   at least one thread element formed on at least one surface of the body element; and
   at least one passage located within the body element, wherein the at least one passage permits the insertion of at least one object through the body element of the alignment plug,

   wherein the alignment plug is capable of being inserted into at least one threaded opening in a vessel wall, and the alignment plug acts to align the at least one object that is capable of being inserted therethrough.

2. The alignment plug of claim 1, wherein the body element is substantially cylindrical.

3. The alignment plug of claim 1 or 2, wherein the body element has a cylindrically shaped threaded portion that is capable of being inserted into the at least one opening in a vessel wall.

4. The alignment plug of claim 1, 2, or 3, wherein the body element is formed from one or more metal compounds, one or more ceramic compounds, or combinations of thereof.

5. The alignment plug of claim 4, wherein the body element is formed from a high temperature metal alloy or from one or more ceramic compounds.

6. The alignment plug of any preceding claim, wherein the alignment plug is capable of withstanding a temperature of at least about 300°C.

7. The alignment plug of any preceding claim, wherein the alignment plug is capable of withstanding a temperature of at least about 400°C.

8. The alignment plug of any preceding claim, wherein the alignment plug is designed to act as a rapper alignment plug.

9. A process of forming an alignment plug comprising the steps of:

   (a) providing an alignment plug comprising a body element capable of being inserted into at least one threaded opening in a vessel wall, wherein the body element contains thereon at least one thread element formed on at least one surface thereof;
   (b) inserting the alignment plug into the at least one threaded opening in a vessel wall to a predetermined depth;
   (c) removing the alignment plug a predetermined amount from the at least one threaded opening in a vessel wall, wherein the amount the alignment plug is removed is less than the insertion amount;
   (d) marking the alignment plug so as to create a alignment mark; and
   (e) forming at least one passage in the body element of the alignment plug, wherein the at least one passage permits the insertion of at least one object through the body element of the alignment plug.

10. The process of claim 9, comprising the step providing a substantially cylindrical body element.

11. The process of claim 9 or 10, comprising the step of providing a cylindrically shaped threaded portion on the body element that is capable of being inserted into the at least one opening in a vessel wall.

12. The process of claim 9, 10 or 11, comprising the step of providing a body element formed from one or more metal compounds, one or more ceramic compounds, or combinations thereof.

13. The process of claim 12, comprising the step of providing a body element formed from a high temperature metal alloy.

14. The process of any of claims 9 to 13, comprising the step of providing an alignment plug is capable of withstanding a temperature of at least about 300°C.

15. The process of any of claims 9 to 14, comprising the step of providing an alignment plug is capable of withstanding a temperature of at least about 400°C.

16. The process of any of claims 9 to 15, further comprising the steps of:

   (f) reinserting the alignment plug with at least one passage located therein back into the at least one opening in a vessel wall; and
   (g) securing the alignment plug to the vessel wall.

17. A process for forming an alignment plate and/or cover comprising the steps of:

   (i) providing an alignment plate and/or cover comprising a body element capable of covering at least one opening in a vessel wall, wherein the body element contains thereon at least one attachment means for attaching the body element to the vessel wall;
   (ii) temporarily attaching the alignment plate

and/or cover to the vessel wall;
(iii) marking the alignment plate and/or cover so as to create a alignment mark; and
(iv) forming at least one passage in the body element of the alignment plate and/or cover, wherein the at least one passage permits the insertion of at least one object through the body element of the alignment plate and/or cover.

**18.** The process of claim 17, comprising the step of providing attachment means selected from at least one of a weldment, screw, bolt, or any combination of two or more thereof.

**19.** The process of claim 17 or 18, comprising the step of providing the alignment plate and/or cover formed from a high temperature metal alloy.

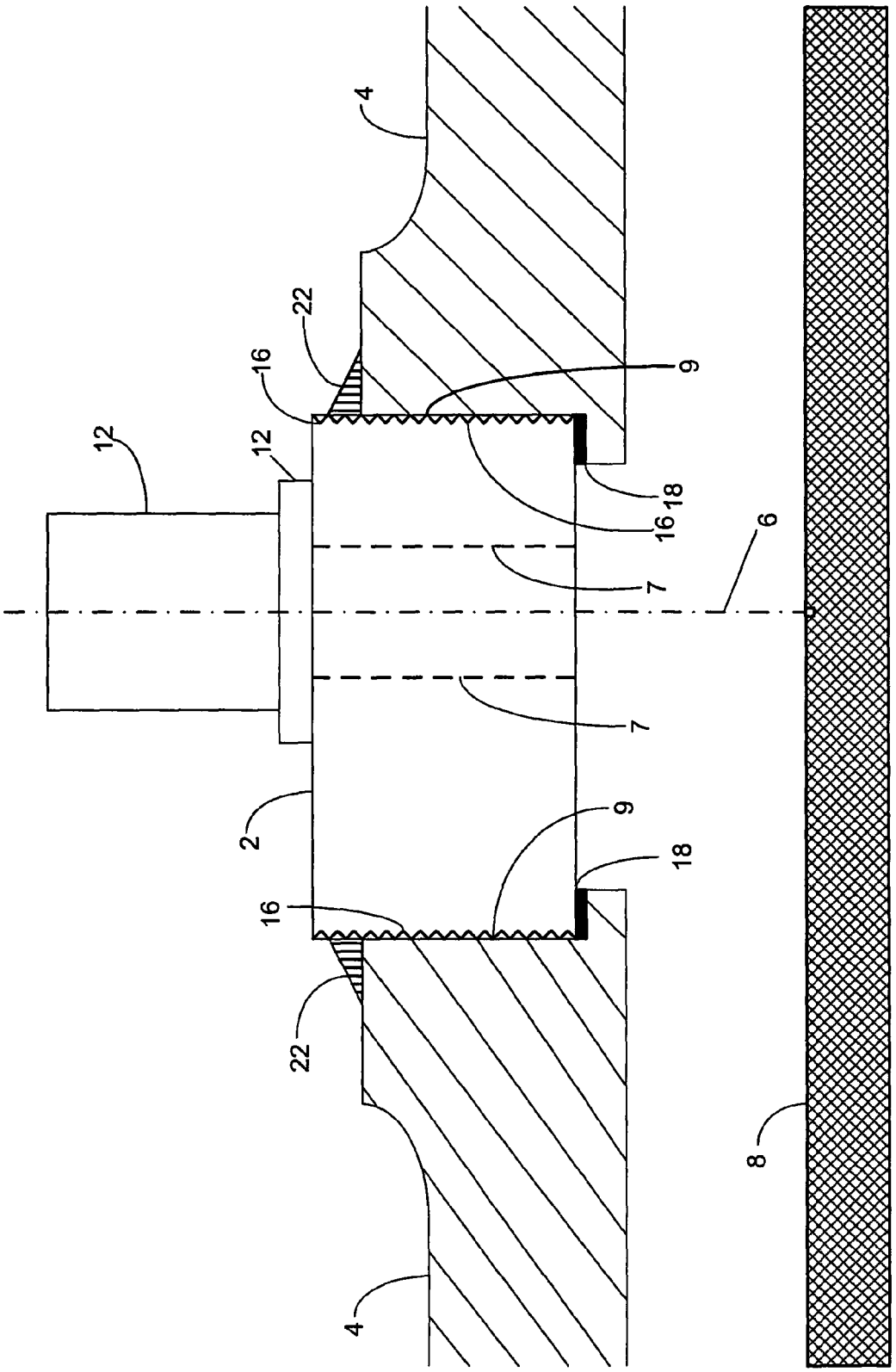



FIG. 1

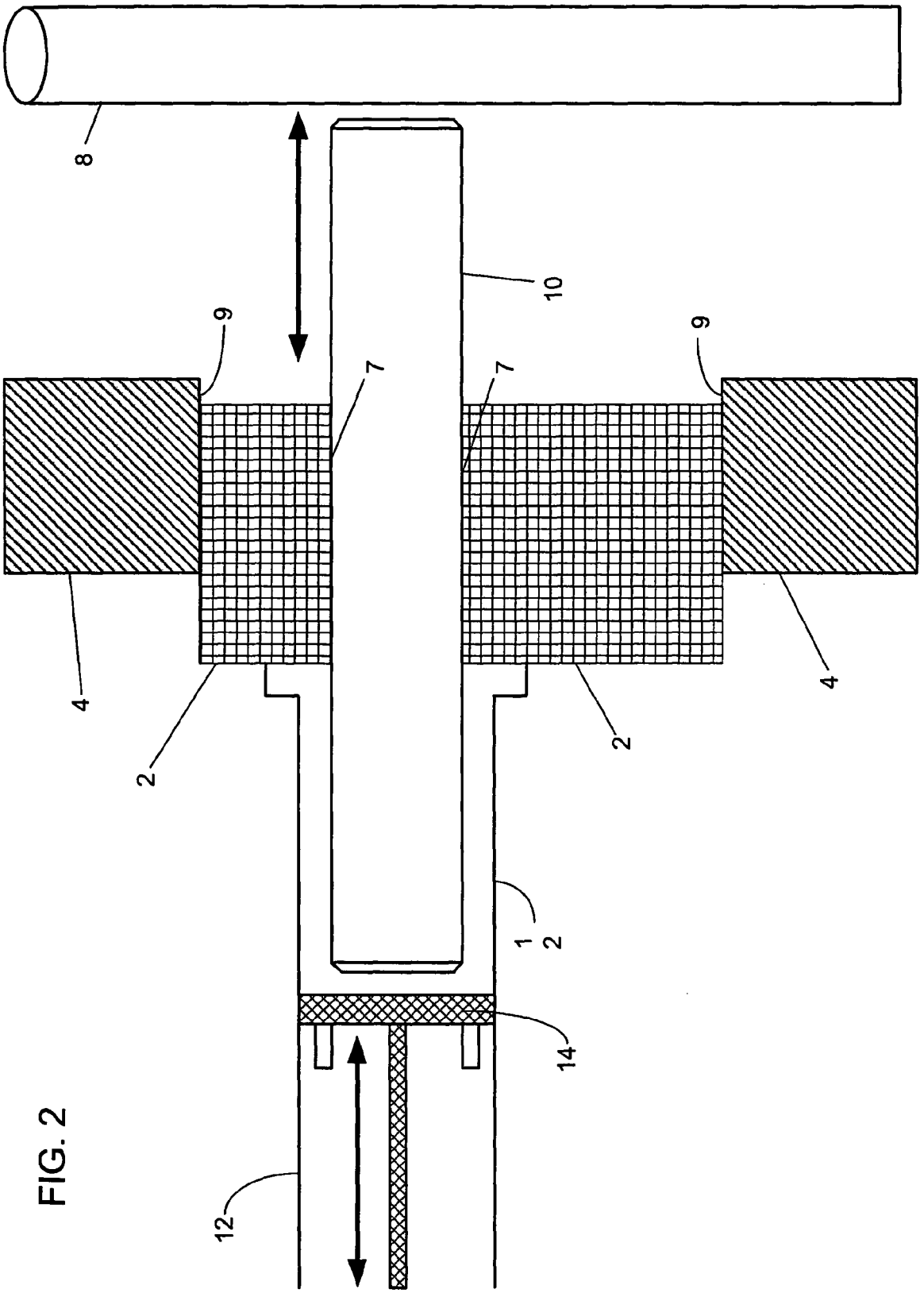



FIG. 2

FIG. 3

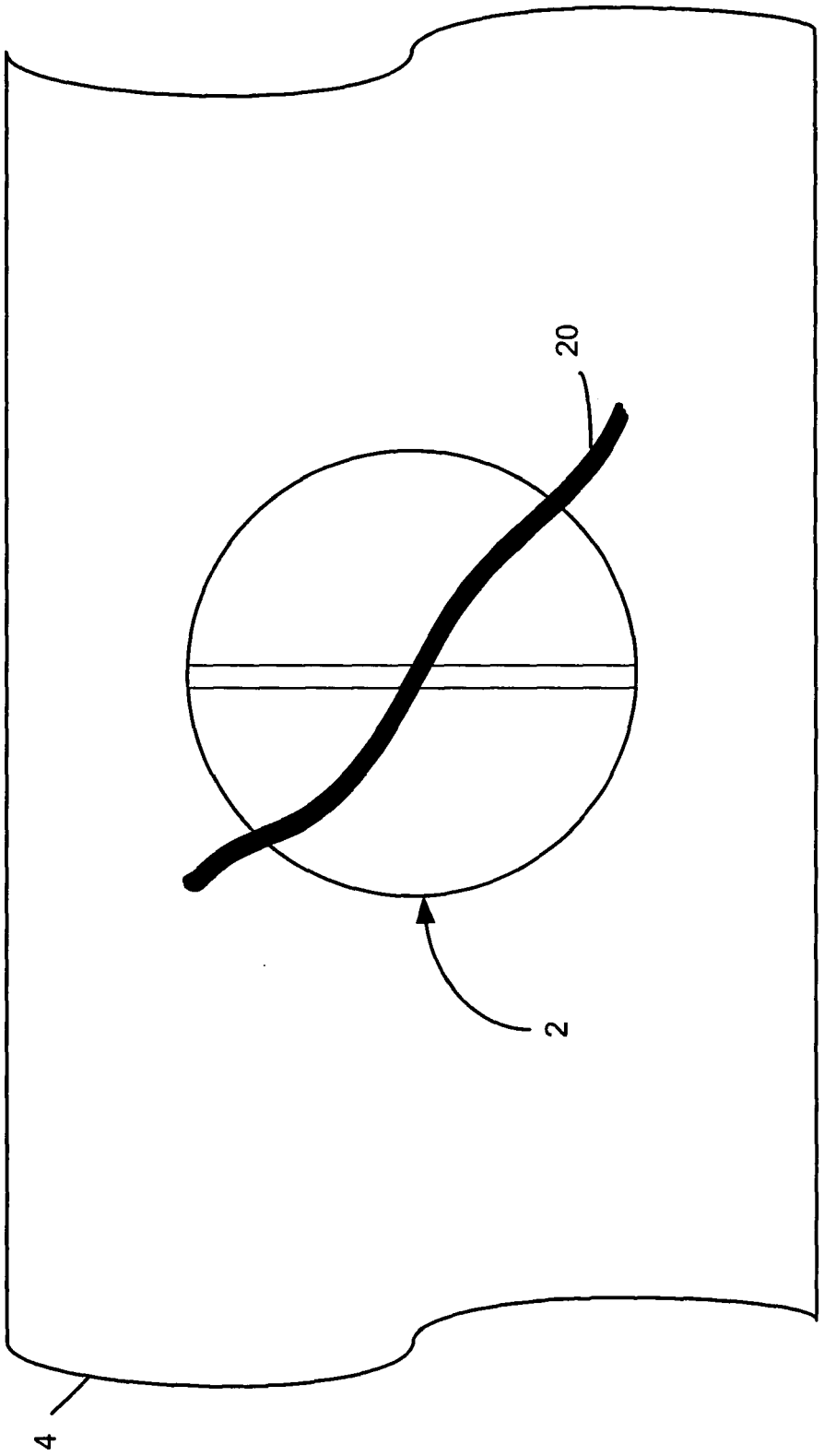
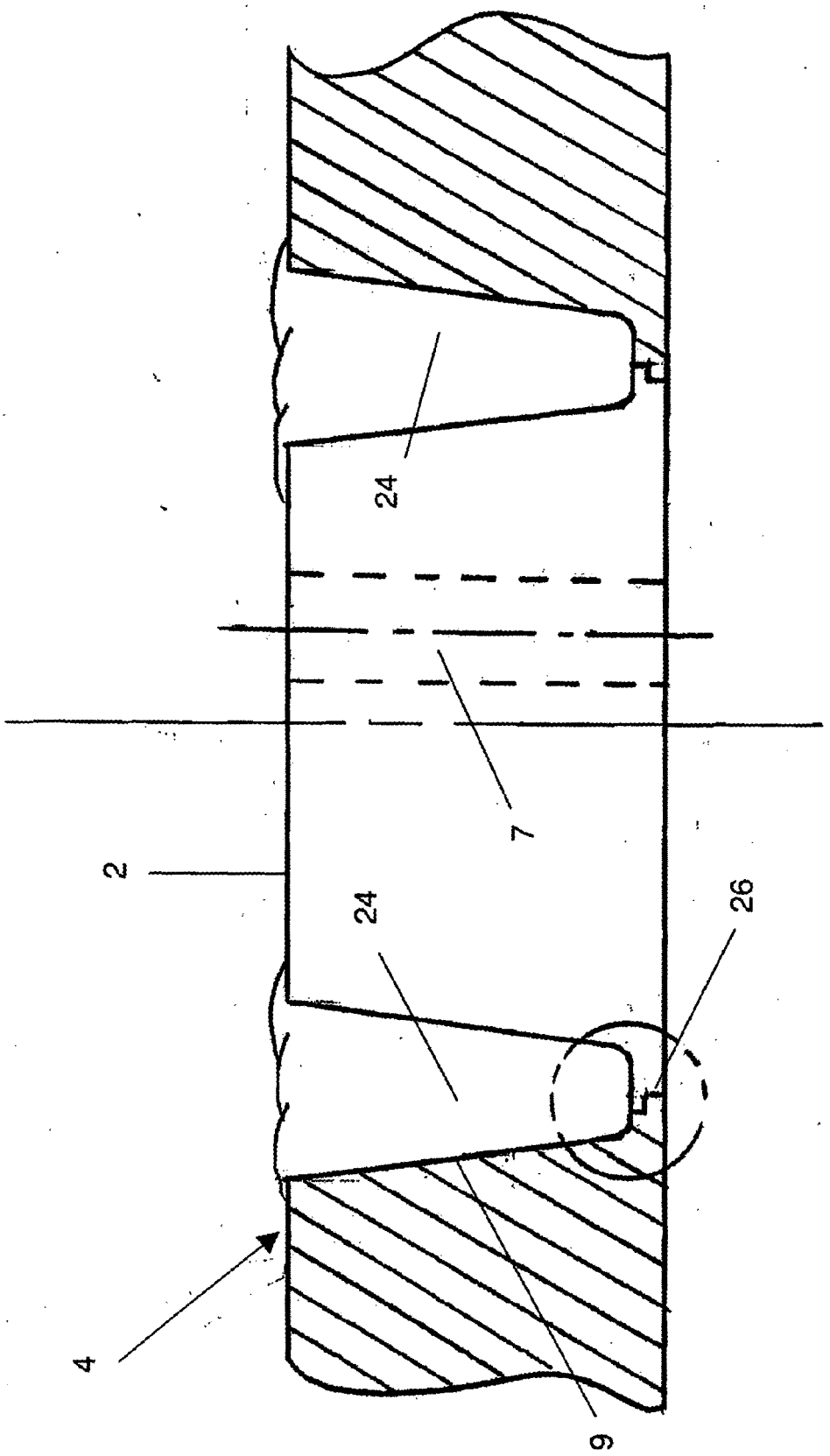


FIG. 4



## REFERENCES CITED IN THE DESCRIPTION

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