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(54) **COMMUNICATION AND LOCATION SYSTEM FOR AN AUTONOMOUS FRACK SYSTEM**

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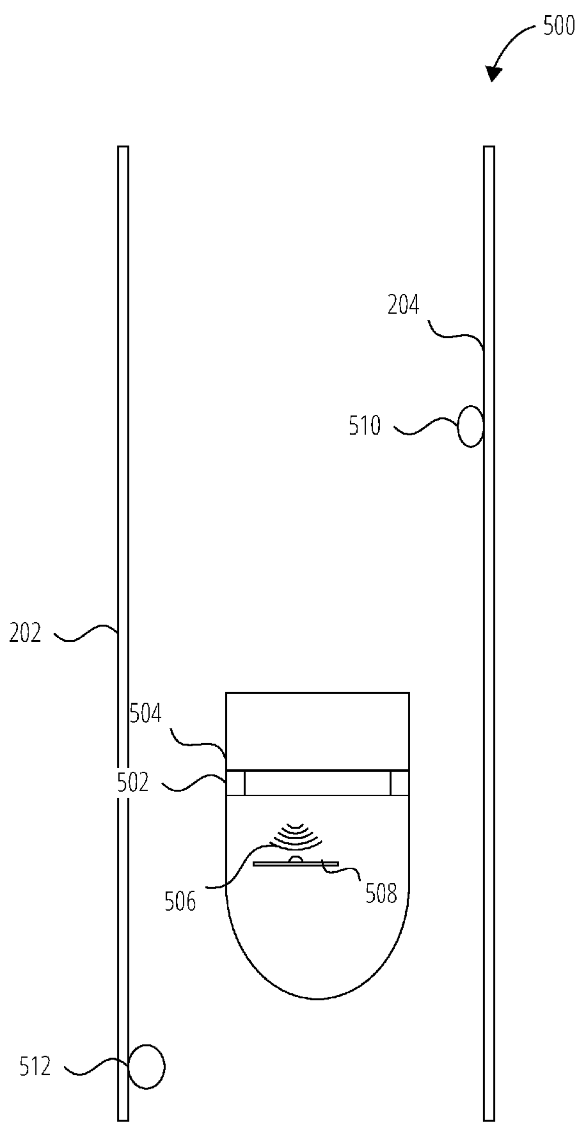
(57) **ABSTRACT**

Embodiments of the disclosure are associated with an autonomous wellbore tool that includes a plug assembly and a positioning system. The positioning system may be provided on the plug assembly. According to an aspect, the positioning system includes a distance measurement system.



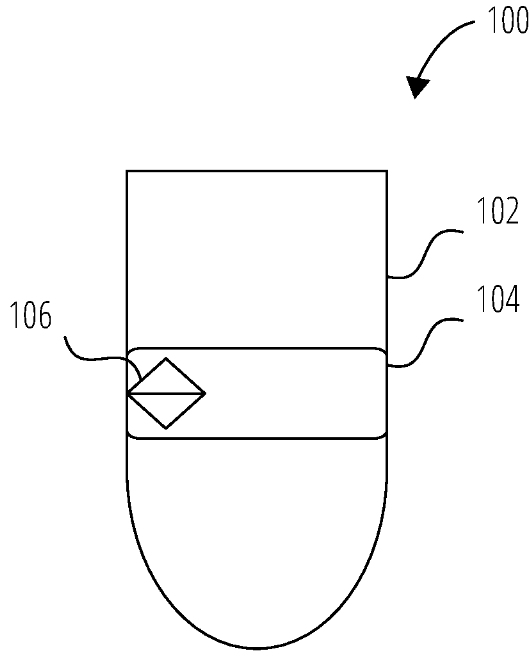


FIG. 1

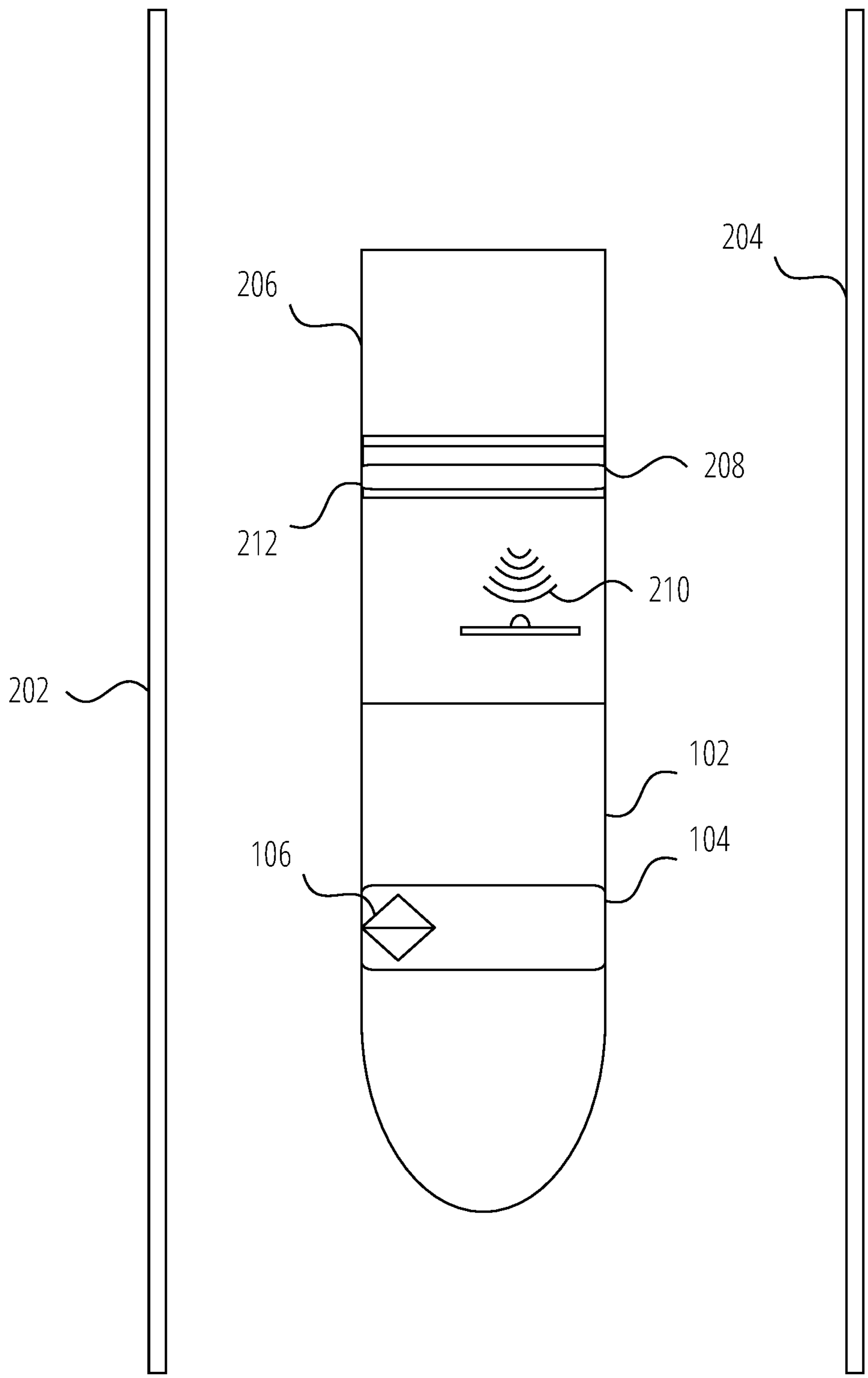


FIG. 2

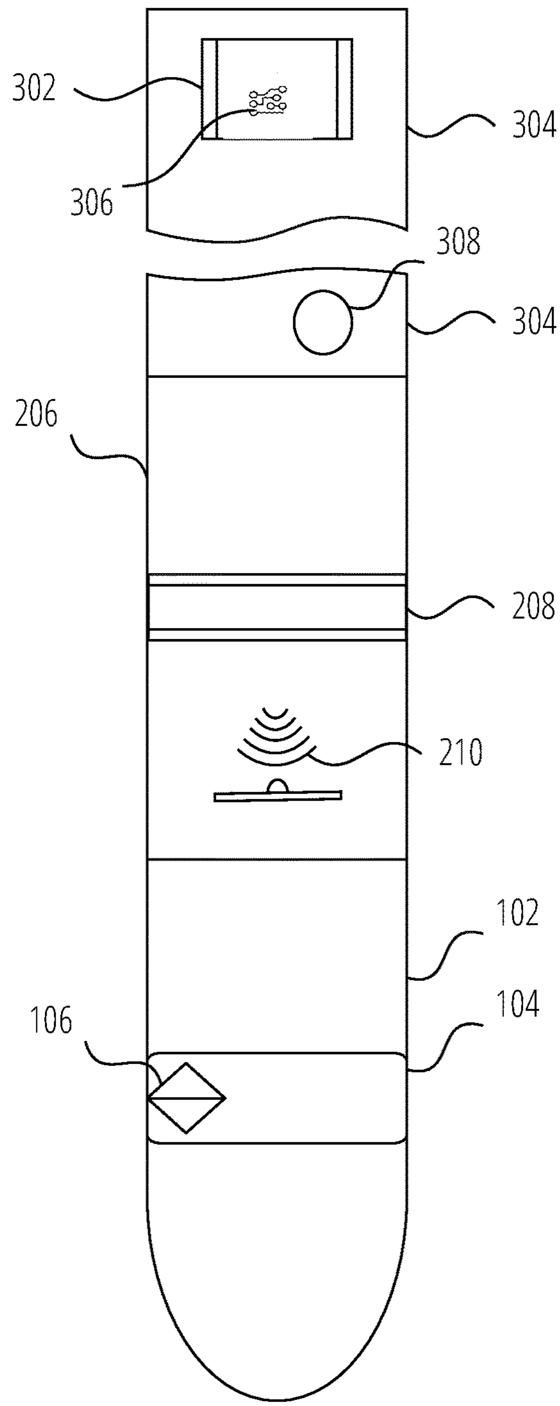


FIG. 3

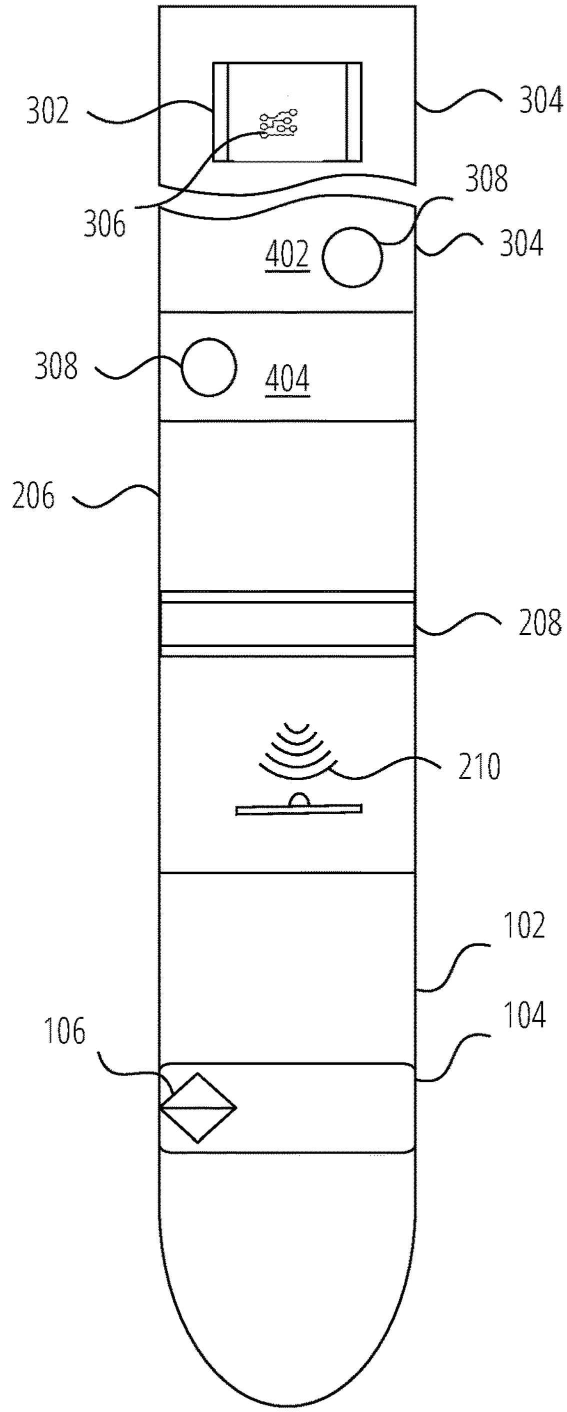


FIG. 4

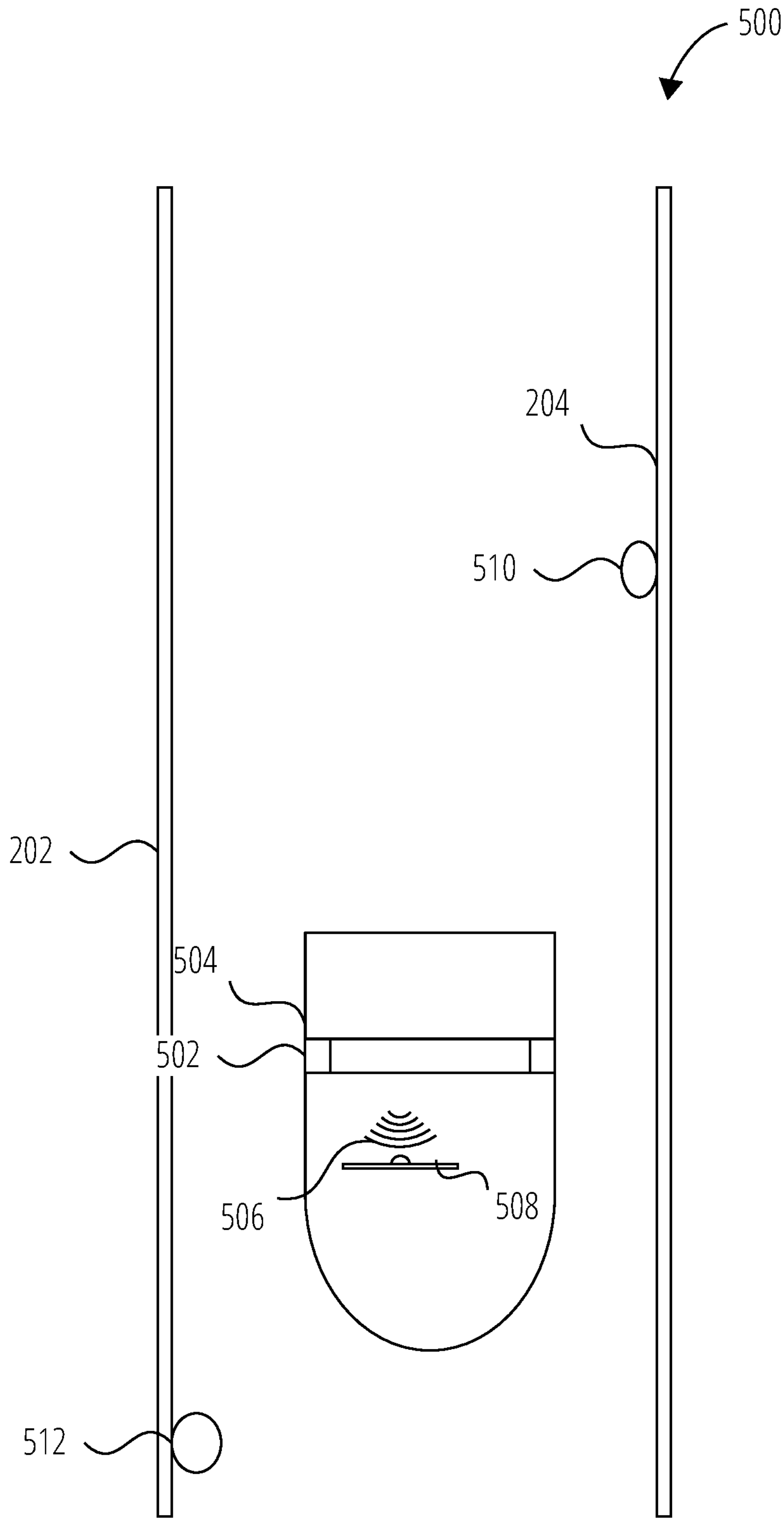


FIG. 5

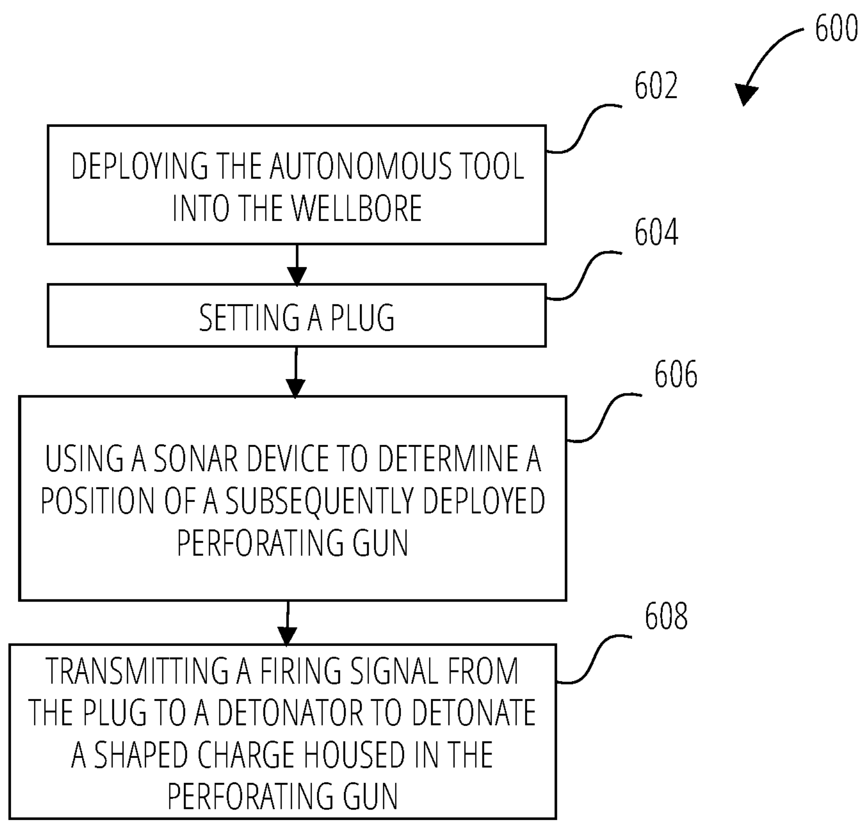

600
602
DEPLOYING THE AUTONOMOUS TOOL INTO THE WELLBORE
604
SETTING A PLUG
606
USING A SONAR DEVICE TO DETERMINE A POSITION OF A SUBSEQUENTLY DEPLOYED PERFORATING GUN
608
TRANSMITTING A FIRING SIGNAL FROM THE PLUG TO A DETONATOR TO DETONATE A SHAPED CHARGE HOUSED IN THE PERFORATING GUN

FIG. 6

COMMUNICATION AND LOCATION SYSTEM FOR AN AUTONOMOUS FRACK SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/247,898 filed Sep. 24, 2021, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] Hydraulic Fracturing (or, "fracking") is a commonly used method for extracting oil and gas from geological formations (i.e., "hydrocarbon bearing formations") such as shale and tight-rock formations. Fracking typically involves, among other things, drilling a wellbore into a hydrocarbon bearing formation, deploying a perforating gun including shaped explosive charges into the wellbore via a wireline or other methods, positioning the perforating gun within the wellbore at a desired area, perforating the wellbore and the hydrocarbon formation by detonating the shaped charges, and pumping high hydraulic pressure fracking fluid into the wellbore to force open perforations, cracks, and imperfections in the hydrocarbon formation to liberate the hydrocarbons and collect them via a wellbore tubing or casing within the wellbore that collects the hydrocarbons and directs them to the surface. In an aspect of a fracking operation, a plug-and-perforate ("plug-and-perf") operation is often used. In a plug-and-perf operation, a tool string including a plug, such as a bridge plug, frac plug, or the like, a setting tool for the plug, and one or more perforating guns are connected together and sent downhole. The plug assembly is located furthest downstream (in a direction further into the wellbore) in the string and is connected to the setting tool which is in turn connected to the bottom (downstream)-most perforating gun. The setting tool is for activating (i.e., expanding) the plug to isolate a portion of the wellbore to be perforated. Isolating these portions, or "zones", makes more efficient use of the hydraulic pressure of the fracking fluid by limiting the volume that the fracking fluid must fill in the wellbore before it is forced into the perforations.

[0003] Using a setting tool for deploying the plug adds length to the tool string as well as potential failure points at the connections to the perforating guns/plug. A typical setting tool may use a pyrotechnic igniter and/or explosive to generate pressure for moving a piston that in turn forces a pressure, which may be a hydraulic pressure, into the plug assembly to expand the plug and shear the plug from the setting tool. Once the plug is expanded it makes contact with an inner surface of the wellbore casing and creates a fluid seal between the plug and the wellbore casing to isolate the zone with respect to the wellbore casing. The setting tool may be retrieved with the spent perforating guns on the tool string, after the perforating operation. Considering that most plugs include a hollow interior for housing components and accepting the pressures that will expand the plug, once the plug is in place a resulting open annulus in the plug must be sealed by, e.g., dropping into the wellbore a ball that is sized to set within the annulus of the plug and thereby fully isolate the zone. This process continues for each zone of the wellbore. Once the perforating operations are complete and the wellbore is ready for production, the balls and/or plugs remaining in the wellbore must be drilled out to allow hydrocarbons to travel to the surface of the wellbore for collection.

[0004] A long horizontal well, drilled through the oil-bearing formation, is virtually divided into several sections (or stages). Each stage is typically fracked individually. Current wellbore systems deploy a tool string including the aforementioned plug and setting tool, multiple perforation guns and one or more additional downhole tools. Such additional downhole tools may include casing collar locators (CCL) or gamma ray. The tool string may be conveyed by wireline and/or pumped into the well until the tool string is at the desired position or zone in the wellbore. Once positioned at the desired zone, the plug is set (with use of the setting tool). The wireline is then used to pull the tool string towards the surface of the wellbore—during this step, the perforation guns are sequentially fired. After that the plug is set, a frac ball is deployed into the wellbore and used to seal an inner flow path of the plug, and pumping can begin in order to frac the formation.

[0005] In an autonomous wellbore system, each plug, or combination of a plug and setting tool, and perforating gun is pumped individually in the well. Each of the plug, the combined plug and setting tool and the perforating gun may include a device or mechanism to facilitate the identification of its position in the wellbore. The device may also facilitate autonomous initiation of the system, when the predefined position or zone in the wellbore is reached.

[0006] A determination of the position can be made in several different ways. One such method, currently used in wireline operations, measures the gamma ray signature of the wellbore formation to identify the position based on comparison of the actual measurement with a previous logging run. Alternatively, the number of casing collars can be counted with a casing collar locator (CCL), and based on the counted number of collars the position of the tool in the wellbore can be determined. Another method may employ the use of radioactive markers or magnets/magnetic markers, which were installed on a wellbore casing before the wellbore tools are deployed into the wellbore. All these methods and equipment require the use of electronics for computing, sensors and a power supply, which all afterwards will remain in the wellbore.

[0007] There is a need for an autonomous wellbore tool that includes a positioning system to determine the location of an object in a wellbore.

BRIEF SUMMARY

[0008] According to an aspect, the exemplary embodiments include an autonomous wellbore tool. The autonomous wellbore tool may include a plug assembly and a positioning system provided on the plug assembly. According to an aspect, the positioning system includes a distance measurement system.

[0009] In another aspect, the exemplary embodiments include an autonomous wellbore tool that includes a transmitter plug assembly. According to an aspect, a sonar device may be secured to the transmitter plug assembly. The sonar device may be configured to find an object in a wellbore casing.

[0010] In a further aspect, the exemplary embodiments include a method of identifying a position of an autonomous tool in a wellbore. The method may include deploying the autonomous tool into the wellbore. The autonomous tool

may further include a perforating gun comprising a detonator, a detonating cord and a shaped charge, a plug, and a sonar device coupled to the plug. According to an aspect, the method further includes setting the plug, and using the sonar device to determine a position of a subsequently deployed perforating gun relative to the plug.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011] A more particular description will be rendered by reference to exemplary embodiments that are illustrated in the accompanying figures. Understanding that these drawings depict exemplary embodiments and do not limit the scope of this disclosure, the exemplary embodiments will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

[0012] FIG. **1** is a cross-sectional side view of an autonomous wellbore tool including a positioning system, according to an embodiment;

[0013] FIG. **2** is a cross-sectional view of the autonomous wellbore tool of FIG. **1**, including a setting tool, according to an embodiment;

[0014] FIG. **3** is a cross-sectional view of the autonomous wellbore tool of FIG. **1**, including a perforating gun coupled to a setting tool, according to an embodiment;

[0015] FIG. **4** is a cross-sectional view of the autonomous wellbore tool of FIG. **1**, including a plurality of perforating guns coupled to a setting tool, according to an embodiment;

[0016] FIG. **5** is a cross-sectional view of an autonomous wellbore tool including a transmitter plug assembly; and

[0017] FIG. **6** is a chart illustrating a method of identifying a position of an autonomous tool in a wellbore.

[0018] Various features, aspects, and advantages of the exemplary embodiments will become more apparent from the following detailed description, along with the accompanying drawings in which like numerals represent like components throughout the figures and detailed description. The various described features are not necessarily drawn to scale in the drawings but are drawn to aid in understanding the features of the exemplary embodiments.

[0019] The headings used herein are for organizational purposes only and are not meant to limit the scope of the disclosure or the claims. To facilitate understanding, reference numerals have been used, where possible, to designate like elements common to the figures.

DETAILED DESCRIPTION

[0020] Reference will now be made in detail to various exemplary embodiments. Each example is provided by way of explanation and is not meant as a limitation and does not constitute a definition of all possible embodiments. It is understood that reference to a particular "exemplary embodiment" of, e.g., a structure, assembly, component, configuration, method, etc. includes exemplary embodiments of, e.g., the associated features, subcomponents, method steps, etc. forming a part of the "exemplary embodiment".

[0021] For purposes of this disclosure and without limitation, "autonomous" means without a physical connection or manual control. For purposes of this disclosure, "connected" means joined and may include, without limitation, attached by known mechanisms. For purposes of this disclosure, a "drone" is a self-contained, autonomous or semi-autonomous vehicle for downhole delivery of one or more wellbore tools.

[0022] For purposes of this disclosure, the phrases "devices," "systems," and "methods" may be used either individually or in any combination referring without limitation to disclosed components, grouping, arrangements, steps, functions, or processes.

[0023] An autonomous system is contemplated whereby a plug assembly is equipped with a positioning system for deployment in a wellbore. It is contemplated that the plug may be deployed in the wellbore with a setting tool. When the plug is set at the desired location in the wellbore (i.e., by at least one component of the plug expanding outwardly to affix to an inner surface of a wellbore casing), subsequent autonomous perforating guns are pumped down or otherwise deployed into the wellbore. The autonomous perforating guns are configured to communicate with a communication system housed in the plug. The communication system of the plug may be able to uniquely identify which autonomous perforating gun is inside the wellbore.

[0024] The autonomous system may include a sonar device. The sonar device finds objects in the wellbore, such as the perforating guns or the plug using sound waves. In an exemplary embodiment, the sonar device may be secured to the plug. The plug may be provided with a communication system configured to transmit a firing signal to a perforating gun, which may be equipped with a receiver and electronics configured to receive and interpret the firing signal. After the plug is set, the sonar is used to determine a position of a subsequently deployed perforating gun relative to the plug. When the perforating gun reaches a firing position, a firing signal is transmitted from the plug to the perforating gun, thereby causing the perforating gun to fire.

[0025] Alternatively, the sonar device may be secured to each autonomous perforating gun deployed in the wellbore. When the sonar device is positioned on each autonomous perforating gun, the position of the autonomous perforating gun relative to the plug is determined by the sonar device. When the gun is at the desired zone of perforating in the wellbore, a firing signal is sent, and shaped charges housed in the autonomous perforating gun are detonated.

[0026] In an embodiment, a plurality of autonomous perforating guns may be connected to each other and deployed in the wellbore as a single unit. In this configuration, the plurality of perforating guns may include a single sonar device.

[0027] It is further contemplated that the autonomous system may utilize other suitable distance measurement technology instead of sonar, such as a wellbore fluid pressure telemetry system. The wellbore fluid pressure telemetry system may be configured as a mud pressure telemetry system.

[0028] In an alternate embodiment, the plug is a transmitter plug. The transmitter plug may be deployed into the wellbore and positioned at a desired location with the help of seats, anchors or similar mechanisms that were preinstalled in the wellbore casing. The transmitter plug may include a communication system and a sonar device, as described hereinabove.

[0029] The various embodiments described herein reduces the electronic need for an autonomous wellbore system, which can also substantially reduce the amount of debris remaining in the wellbore.

[0030] FIG. **1** illustrates an autonomous wellbore tool **100**. The autonomous wellbore tool **100** includes a plug assembly **102**, and a positioning system **104** provided on the plug assembly **102**.

[0031] The plug assembly **102** may include a self-setting plug that does not require a setting tool. Alternatively, the plug assembly **102** include a micro set plug. Alternatively, the plug assembly **102** may include an eliminator bridge plug.

[0032] According to an exemplary embodiment, the plug tool **106** may be a ballistically actuated plug. The ballistically actuated plug includes an outer carrier having a first end and a second end opposite the first end, and a hollow interior chamber within the outer carrier and defined by the outer carrier. The hollow interior chamber may extend from the first end to the second end of the outer carrier. An initiator, such as a detonator, is positioned within the hollow interior chamber and one or more ballistic components are also housed within the hollow interior chamber. The initiator and the one or more ballistic components are relatively positioned for the initiator to initiate the one or more ballistic components, and the one or more ballistic components include an explosive charge for expanding the outer carrier from an unexpanded form to an expanded form upon initiation of the one or more ballistic components. An exemplary embodiment of a ballistic instantaneous setting plug is described in International Application No. PCT/EP2020/070291 filed Jul. 17, 2020, published as WO 2021/013731 on Jan. 28, 2021, which is commonly owned and assigned to DynaEnergetics Europe GmbH, the entire contents of which are incorporated by reference herein. Other suitable types of plugs may be used as appropriate.

[0033] It is contemplated that the plug assembly **102** may be disposable such that the remains of the plug assembly **102** may be left in the wellbore. This eliminates the need for the plug assembly **102** or any associated debris from other components of the autonomous wellbore tool **100** from having to be withdrawn from the wellbore using tool retrieval mechanisms, such as a wireline.

[0034] According to an aspect and as illustrated in FIG. **1**, the positioning system **104** includes a distance measurement system **106**. The distance measurement system **106** includes a sonar device. According to an aspect, the sonar device is configured to transmit a sonar beam that scans the wellbore casing **202** to identify one or more objects in the wellbore. The sonar beam may include at least one target point to identify one or more objects in the wellbore. In an aspect, the sonar beam may include a hundred or several hundreds of target points in order to identify the one or more objects. It is contemplated that for each beam transmitted, an echo is returned (due to the present of the object, for example) in order to detect whether the one or more objects is present. The strength of the returned echo may be indicative of the location and distance of the one or more objects from the distance measurement system **106**.

[0035] According to an aspect, the sonar device includes one or more sensors. The one or more sensors may be positioned along a longitudinal axis of a body of the sonar device. Each sensor of the one or more sensors may include a transmitter that emits a signal towards the interior of the wellbore casing **202**. Each sensor of the one or more sensors may further include a receiver that is configured to detect a reflection (such as from the target points) of the transmitted signal from the wellbore casing **202**. It is contemplated that the signal may include an acoustic signal. It is further contemplated that that the one or more sensors may be configured substantially similar to piezo-electrical sensors. According to an aspect, the receiver and transmitter may be separate or different from each another. In another aspect, the sensor may be provided as a unitary component including the receiver and transmitter.

[0036] According to an aspect, the distance measurement system **106** includes a wellbore fluid pressure telemetry system or a wellbore fluid pressure pulse transmission system. The wellbore fluid pressure telemetry system maybe configured to use variations in pressure in a wellbore fluid disposed in the wellbore casing **202** to determine the location of the one or more objects in the wellbore casing **202**. It is contemplated that any such variations in pressure may be sensed and analyzed to determine the location of, for example, a perforating gun in the wellbore casing **202**.

[0037] According to an aspect, and as illustrated in at least FIG. **2**, the plug assembly **102** is configured to be secured in the wellbore casing **202**. The plug assembly **102** may be secured in the wellbore casing **202** via a pre-installed securing mechanism comprising at least one of a plurality of seats, and a plurality of anchors.

[0038] According to an aspect, the plug assembly **102** includes an expansion element **208**. The expansion element **208** may be a portion of the plug assembly **102**. According to an aspect, the expansion element **208** is configured to expand outwardly to affix to an inner surface **204** of the wellbore casing **202**. As would be understood by one of ordinary skill in the art, the expansion element **208** is so named because it is adapted to expand in volume (in an outward direction) as a result of either an explosive element that deforms the expansion element **208** in an outward direction or axial movement of a sleeve or housing relative to the expansion element **208** to deform the expansion element **208** of force it in an outward direction. The expansion element **208** may include one or more pre-installed securing mechanism **502** as described in further detail hereinbelow.

[0039] According to an aspect, the pre-installed securing mechanism includes a plurality of external gripping teeth formed on an outer surface of the plug assembly **102**. The plug assembly **102** is dimensioned such that the gripping teeth will contact and/or penetrate an inner surface **204** of the wellbore casing **202** when the plug assembly **102** is in an expanded form. The gripping teeth may be shaped to frictionally grip the inner surface **204** of the wellbore casing **202** and thereby position the ballistically actuated plug **100** within the wellbore casing **202** and form a partial or total seal between the gripping teeth and the inner surface **204** of the wellbore casing **202**, when the plug assembly **102** is in the expanded form.

[0040] According to an aspect, the plug assembly **102** includes a sealing element **212** that is formed from a material and in a configuration such that, in operation, the sealing element **212** will expand outwardly when the expansion element **208** transitions to its expanded form. The sealing element **212** may be disposed so that it is adjacent the expansion element **208**. In an aspect, the sealing element **212** may extend around a portion of or an entire outer circumference or perimeter of the plug assembly **102**. According to an aspect, the sealing element **212** is a portion of the expansion element **208**. It is contemplated that the sealing element **212** may be dimensioned such that it will contact the inner surface **204** of the wellbore casing **202** and form a seal between the inner surface **204** of the wellbore casing **202** and the sealing element when the plug assembly **102** is in the expanded form. The sealing element **212** may be composed of rubber or a similar material that can provide a seal when positioned against a surface when, for example, the expansion element **208** expands outwardly to contact the inner surface **204** of the wellbore casing **202**.

[0041] According to an aspect, the autonomous wellbore tool **100** further includes a setting tool **206**. The plug assembly **102** may be secured to the setting tool **206** such that the plug assembly **102** is deployed in the wellbore casing **202** while secured to the setting tool **206**.

[0042] According to an aspect, the setting tool **206** may be configured as a single use setting tool for actuating a tool in the wellbore casing **202**. An exemplary embodiment of a single use setting tool is described in U.S. application Ser. No. 17/381,701 filed Jul. 21, 2021, published as US 2021/355,773 on Nov. 19, 2021, which is commonly owned and assigned to DynaEnergetics Europe GmbH, the entire contents of which are incorporated by reference herein. The single use setting tool may include an inner piston having a piston proximal end, a piston distal end opposite the piston proximal end, and a piston inner wall. The piston proximal end may include a seal adapter portion and the piston inner wall may define a piston cavity. The single use setting tool may further include an outer sleeve having a sleeve proximal end, a sleeve distal end, and a sleeve central bore extending from the sleeve proximal end to the sleeve distal end. A portion of the inner piston including the piston cavity may be positioned within the sleeve central bore, a portion of the inner piston may extend beyond the sleeve distal end, and the inner piston and the outer sleeve may be configured for axially sliding relative to one another. The outer sleeve may include a shear element aperture extending from an outer surface of the outer sleeve to the sleeve central bore and the inner piston may include a shear element groove circumferentially extending in an outer surface of the inner piston. The shear element aperture and the shear element groove may together be configured for receiving a shear element extending between and positioned within each of the shear element aperture and the shear element groove, when the inner piston is at a first position relative to the outer sleeve.

[0043] According to an aspect, the autonomous wellbore tool **100** may further include a communication system **210** housed in the plug assembly **102**. The communication system **210** may include at least one of an initiator, a conductive detonating cord, a feed through wire that serves to transfer electrical signals/communication, and a bulkhead assembly. As would be understood by one of ordinary skill in the art, the initiator, conductive detonating cord, and bulkhead assembly may transmit communication signals between the plug assembly **102** and at least one of a setting tool and a perforating gun. In an aspect, one or each of a setting tool and a perforating gun provided in the autonomous wellbore tool **100** may include its own communication device that is configured for transmitting communication signals between it and the communication system **210** of the plug assembly **102**.

[0044] FIG. **3** illustrates the autonomous wellbore tool **100** including a perforating gun **304**. The perforating gun **304** includes one or more of an initiator, an igniter, or a detonator assembly (collectively, "detonator **302**"). The detonator **302** is equipped with an electronic circuit board **306**. According to an aspect, the communication system **210** is configured to communicate with the electronic circuit board **306** of the detonator **302**.

[0045] It is contemplated that the perforating gun **304** may be an autonomous perforating gun. The autonomous perforating gun may be pumped downhole with wellbore fluid, without conventional conveyance methods such as a wireline, e-line, coiled tubing or e-coil, or communicative connections with the surface of the wellbore.

[0046] According to an aspect, and as illustrated in FIG. **4**, the perforating gun **304** includes a first perforating gun **402** and a second perforating gun **404**. According to an aspect, the first perforating gun **402** and the second perforating gun **404** may be directly connected to each other. For example, the first perforating gun **402** and the second perforating gun **404** may each include a perforating gun housing. The perforating gun housing may be configured substantially as described in U.S. Pat. No. 10,458,213, which is commonly owned and assigned to DynaEnergetics Europe GmbH, and is incorporated herein by reference in its entirety.

[0047] According to an aspect, the perforating gun housing includes a housing wall extending between a first housing portion including a first housing end and a second housing portion including a second housing end. The first housing portion defines a housing chamber and the second housing portion defines a bore. According to an aspect, the housing wall further includes a first outer surface extending from the first housing end and defining at least a portion of an outer wall of the housing chamber, a second outer surface extending from the second housing end toward the first housing end, and a face extending substantially perpendicularly to the second outer surface between the first outer surface and the second outer surface. The perforating gun housing may further include an exterior depression provided on the second housing portion configured for receiving a sealing mechanism, a first threaded portion formed on an inner circumferential surface of the housing chamber adjacent the first housing end for attachment to a first adjacent gun housing, and a second threaded portion formed on the second outer surface of the housing wall for attachment to a second adjacent gun housing. Alternatively, and in accordance with an embodiment, the first perforating gun **402** and the second perforating gun **404** may be coupled together using a sub or an adapter (not shown).

[0048] According to an aspect, the communication system **210** housed in the plug assembly **102** is configured to distinguish between the first perforating gun **402** and the second perforating gun **404**. For example, the communication system **210** may communicate with the detonator **302** in the first perforating gun **402** when the first perforating gun **402** is the bottommost perforating gun **304** in the wellbore, before communicating with the detonator **302** of the second perforating gun **404**.

[0049] Additional embodiments of the disclosure may be associated with an autonomous wellbore tool **500** that includes a transmitter plug assembly **504**. According to an aspect, the transmitter plug assembly **504** is configured to be secured to an inner surface **204** in a wellbore casing **202** through the use of a pre-installed securing mechanism **502**. The pre-installed securing mechanism **502** may include, for example, at least one of a plurality of seats, and a plurality of anchors.

[0050] According to an aspect, the autonomous wellbore tool **500** includes a sonar device **506**. The sonar device **506**

is configured to find an object in a wellbore casing **202**. The sonar device **506** may be directly secured to or within the transmitter plug assembly **504**. Alternatively, the sonar device **506** may be housed in a separate structure or housing that is coupled or otherwise secured to the transmitter plug assembly **504**. For example, the sonar device **506** may be provided on or in a sub or housing that is coupled or otherwise attached or secured to the transmitter plug assembly **504** using threads or other fastening mechanisms for the housings or wellbore tools.

[0051] The sonar device **506** may include an active sonar transducer **508** that emits an acoustic signal or a pulse of sound when the autonomous wellbore tool **100** is positioned in the wellbore casing **202**. According to an aspect, the active sonar transducer **508** is configured to determine the range and orientation of an object **510**, **512** in the wellbore casing **202**. The object **510**, **512** may include, for example, a perforating gun **304**. The active sonar transducer **508** may be configured to receive a return signal from the object **510**, **512** in the wellbore casing **202**. According to an aspect, the active sonar transducer **508** is configured to measure a strength of the return signal, determine a difference between the time the acoustic signal or the pulse of sound was emitted and the time the return signal is received.

[0052] Further embodiments of the disclosure are associated with a method **600** of identifying a position of an autonomous tool in a wellbore or wellbore casing **202**. The method includes deploying the autonomous tool in the wellbore. The autonomous tool may be configured substantially as illustrated in any one of FIG. **1** to FIG. **5**, and described hereinabove. According to an aspect, the autonomous tool includes a perforating gun **304** comprising a detonator **302**, a detonating cord and a shaped charge. The autonomous tool may further include one or more of a plug assembly **102** and a distance measurement system **106** coupled to the plug assembly **102**, and a transmitter plug assembly **504** and a sonar device **506** coupled to the transmitter plug assembly **504**.

[0053] The method further includes setting **604** the plug assembly **102** or the transmitter plug assembly **504**. According to an aspect, the method further includes using the distance measurement system **106** or the sonar device **506** to determine **606** a position of a subsequently deployed perforating gun relative to the plug assembly **102** or the transmitter plug assembly **504**.

[0054] The method further includes transmitting **608** a firing signal from the plug assembly **102** or the transmitter plug assembly **504** to the detonator in order to detonate the shaped charge. According to an aspect, the firing signal is transmitted from the communication system of the plug to the perforating gun **304**. As described hereinabove, the perforating gun **304** may include a first perforating gun and a second perforating gun coupled to the first perforating gun. In this configuration, the method further includes transmitting a first firing signal from the plug to the detonator of the first perforating gun prior transmitting a second firing signal to the detonator of the second perforating gun.

[0055] This disclosure, in various embodiments, configurations and aspects, includes components, methods, processes, systems, and/or apparatuses as depicted and described herein, including various embodiments, sub-combinations, and subsets thereof. This disclosure contemplates, in various embodiments, configurations and aspects, the actual or optional use or inclusion of, e.g., components or processes as may be well-known or understood in the art and consistent with this disclosure though not depicted and/or described herein.

[0056] The phrases "at least one", "one or more", and "and/or" are open-ended expressions that are both conjunctive and disjunctive in operation. For example, each of the expressions "at least one of A, B and C", "at least one of A, B, or C", "one or more of A, B, and C", "one or more of A, B, or C" and "A, B, and/or C" means A alone, B alone, C alone, A and B together, A and C together, B and C together, or A, B and C together.

[0057] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term such as "about" or "approximately" is not to be limited to the precise value specified. Such approximating language may refer to the specific value and/or may include a range of values that may have the same impact or effect as understood by persons of ordinary skill in the art field. For example, approximating language may include a range of +/−10%, +/−5%, or +/−3%. The term "substantially" as used herein is used in the common way understood by persons of skill in the art field with regard to patents, and may in some instances function as approximating language. In some instances, the approximating language may correspond to the precision of an instrument for measuring the value.

[0058] In this specification and the claims that follow, reference will be made to a number of terms that have the following meanings. The terms "a" (or "an") and "the" refer to one or more of that entity, thereby including plural referents unless the context clearly dictates otherwise. As such, the terms "a" (or "an"), "one or more" and "at least one" can be used interchangeably herein. Furthermore, references to "one embodiment", "some embodiments", "an embodiment" and the like are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term such as "about" is not to be limited to the precise value specified. In some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Terms such as "first," "second," "upper," "lower" etc. are used to identify one element from another, and unless otherwise specified are not meant to refer to a particular order or number of elements.

[0059] As used herein, the terms "may" and "may be" indicate a possibility of an occurrence within a set of circumstances; a possession of a specified property, characteristic or function; and/or qualify another verb by expressing one or more of an ability, capability, or possibility associated with the qualified verb. Accordingly, usage of "may" and "may be" indicates that a modified term is apparently appropriate, capable, or suitable for an indicated capacity, function, or usage, while taking into account that in some circumstances the modified term may sometimes not be appropriate, capable, or suitable. For example, in some circumstances an event or capacity can be expected, while in other circumstances the event or capacity cannot occur - this distinction is captured by the terms “may” and “may be.”

[0060] As used in the claims, the word “comprises” and its grammatical variants logically also subtend and include phrases of varying and differing extent such as for example, but not limited thereto, “consisting essentially of” and “consisting of.” Where necessary, ranges have been supplied, and those ranges are inclusive of all sub-ranges therebetween. It is to be expected that the appended claims should cover variations in the ranges except where this disclosure makes clear the use of a particular range in certain embodiments.

[0061] The terms “determine”, “calculate” and “compute,” and variations thereof, as used herein, are used interchangeably and include any type of methodology, process, mathematical operation or technique.

[0062] This disclosure is presented for purposes of illustration and description. This disclosure is not limited to the form or forms disclosed herein. In the Detailed Description of this disclosure, for example, various features of some exemplary embodiments are grouped together to representatively describe those and other contemplated embodiments, configurations, and aspects, to the extent that including in this disclosure a description of every potential embodiment, variant, and combination of features is not feasible. Thus, the features of the disclosed embodiments, configurations, and aspects may be combined in alternate embodiments, configurations, and aspects not expressly discussed above. For example, the features recited in the following claims lie in less than all features of a single disclosed embodiment, configuration, or aspect. Thus, the following claims are hereby incorporated into this Detailed Description, with each claim standing on its own as a separate embodiment of this disclosure.

[0063] Advances in science and technology may provide variations that are not necessarily express in the terminology of this disclosure although the claims would not necessarily exclude these variations.

What is claimed is:

1. An autonomous wellbore tool comprising:
a plug assembly; and
a positioning system provided on the plug assembly, wherein the positioning system comprises:
a distance measurement system.

2. The autonomous wellbore tool of claim **1**, wherein the distance measurement system comprises a sonar device.

3. The autonomous wellbore tool of claim **1**, wherein the distance measurement system comprises a wellbore fluid pressure telemetry system.

4. The autonomous wellbore tool of claim **1**, further comprising:
a setting tool,
wherein the plug assembly is secured to the setting tool such that the plug assembly is deployed in the wellbore while secured to the setting tool.

5. The autonomous wellbore tool of claim **1**, wherein the plug assembly comprises:
an expansion element, wherein the expansion element is configured to expand outwardly to affix to an inner surface of a wellbore casing.

6. The autonomous wellbore tool of claim **1**, further comprising:
a communication system housed in the plug assembly.

7. The autonomous wellbore tool of claim **6**, further comprising:
a perforating gun comprising a detonator including an electronic circuit board **306**,
wherein the communication system is configured to communicate with the electronic circuit board.

8. The autonomous wellbore tool of claim **7**, wherein the perforating gun **304** further comprises:
a first perforating gun; and
a second perforating gun,
wherein the communication system is configured to distinguish between the first perforating gun and the second perforating gun.

9. The autonomous wellbore tool of claim **7**, wherein the perforating gun is an autonomous perforating gun.

10. The autonomous wellbore tool of claim **1**, wherein the plug assembly is configured to be secured in a wellbore casing via a pre-installed securing mechanism comprising at least one of a plurality of seats, and a plurality of anchors.

11. An autonomous wellbore tool comprising:
a transmitter plug assembly; and
a sonar device secured to the transmitter plug assembly, wherein the sonar device **506** is configured to find an object in a wellbore casing.

12. The autonomous wellbore tool of claim **11**, wherein the transmitter plug assembly is configured to be secured to an inner surface in a wellbore casing via a pre-installed securing mechanism.

13. The autonomous wellbore tool of claim **11**, wherein the pre-installed securing mechanism comprises at least one of a plurality of seats, and a plurality of anchors.

14. The autonomous wellbore tool of claim **11**, wherein the sonar device comprises:
an active sonar transducer that emits an acoustic signal or pulse of sound when the autonomous wellbore tool is positioned in the wellbore casing.

15. The autonomous wellbore tool of claim **14**, wherein the active sonar transducer is configured to determine the range and orientation of an object in the wellbore casing.

16. The autonomous wellbore tool of claim **15**, wherein the active sonar transducer is configured to receive a return signal from the object in the wellbore casing.

17. The autonomous wellbore tool of claim **16**, wherein the active sonar transducer is configured to measure a strength of the return signal, and determine a difference between the time the acoustic signal or the pulse of sound is emitted and the time the return signal is received.

18. A method of identifying a position of an autonomous tool in a wellbore, the method comprising:
deploying the autonomous tool in the wellbore, wherein the autonomous tool comprises a plug; and
a sonar device coupled to the plug;
setting the plug; and
using the sonar device, determining a position of a subsequently deployed perforating gun relative to the plug.

19. The method of claim **18**, wherein the autonomous tool further comprises a perforating gun secured to an upper end of the plug, the perforating gun comprising a detonator, a detonating cord and a shaped charge, and the method further comprises:
transmitting **608** a firing signal from the plug to the detonator to detonate the shaped charge, wherein the firing signal is transmitted from the communication system of the plug.

20. The method of claim **19**, wherein the perforating gun comprises a first perforating gun and a second perforating gun coupled to the first perforating gun, and the method further comprises:

transmitting a first firing signal from the plug to the detonator of the first perforating gun; and

transmitting a second firing signal from the detonator of the first perforating gun to the detonator of the second perforating gun.

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