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Inventor(s)	Zakharia; Steven et al.

Initiator system providing set confirmation from plug setting tool in downhole well

Abstract

A system for setting a plug in a wellbore includes a setting tool configured, upon activation, to displace the shift the plug in the wellbore from a run-in configuration permitting fluid flow within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug, an initiator including an igniter switch and an igniter assembly including an igniter energetic element, the initiator including a signal interrupter configured to shift automatically from a first state in which signal communication is provided through the signal interrupter between the igniter switch and the igniter assembly to a second state in which signal communication is restricted through the signal interrupter between the igniter switch and the igniter assembly in response to exposing the initiator to a predefined toolstring condition and whereby a surface indication is provided of the shifting of the plug to the set configuration.

Inventors: **Zakharia; Steven (Houston, TX), Ward; Ryan (Tomball, TX), Green; Adam (Houston, TX), Levine; Charles (Houston, TX), Knight; Benjamin (Katy, TX), Wells; Joe Noel (Lindale, TX), Lee; Timmothy Alain (Tomball, TX), Caruana; William (Cypress, TX)**

Applicant: **G&H Diversified Manufacturing, LP** (Houston, TX)

Family ID: **1000008763553**

Assignee: **G&H Diversified Manufacturing LP (Houston, TX)**

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
3246707	12/1965	Bell	175/4.54	E21B 43/117
3264994	12/1965	Leutwyler	166/63	E21B 47/13
3414071	12/1967	Alberts	166/185	E21B 33/13
4100978	12/1977	Boop	102/306	E21B 43/1185
5052489	12/1990	Carisella	337/145	F42D 1/04
6035880	12/1999	Gazda	137/68.16	E21B 21/103
9810035	12/2016	Carr	N/A	E21B 23/065
10036236	12/2017	Sullivan	N/A	E21B 43/11855
10900334	12/2020	Knight	N/A	E21B 43/1185
10900335	12/2020	Knight	N/A	F42D 1/05
10920544	12/2020	Sullivan	N/A	E21B 43/1185
11236591	12/2021	Knight	N/A	E21B 43/119
11708731	12/2022	Zakharia	166/387	E21B 33/134
2005/0022987	12/2004	Green	166/250.17	E21B 47/24
2007/0125540	12/2006	Gerez	166/55	F42D 1/045
2010/0085210	12/2009	Bonavides	340/853.2	E21B 43/11
2017/0175472	12/2016	Carisella	N/A	E21B 27/02
2018/0202249	12/2017	Harrington	N/A	E21B 41/0085
2018/0371859	12/2017	Tøndel	N/A	E21B 36/008
2019/0162057	12/2018	Montoya Ashton	N/A	E21B 43/1185
2020/0225014	12/2019	Maxted	N/A	E21B 43/1185
2020/0256166	12/2019	Knight	N/A	E21B 43/1185
2020/0256168	12/2019	Knight	N/A	E21B 43/1185
2021/0180434	12/2020	Knight	N/A	E21B 23/065
2022/0127937	12/2021	Knight	N/A	E21B 43/119
2022/0282585	12/2021	Zakharia	N/A	E21B 33/1292

2023/0287748	12/2022	Massey	N/A	E21B 23/0414
2024/0209704	12/2023	Morrison	N/A	E21B 23/065
2025/0027390	12/2024	Hoelscher	N/A	E21B 43/1185

FOREIGN PATENT DOCUMENTS

Patent No.	**Application Date**	**Country**	**CPC**
WO-2018227199	12/2017	WO	E21B 17/06

Primary Examiner: MacDonald; Steven A

Attorney, Agent or Firm: Conley Rose, P.C.

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation-in-part of U.S. non-provisional patent application Ser. No. 18/610,952 filed Mar. 20, 2024, and entitled “Downhole Setting Assembly with Switch Module”, which is a continuation of U.S. non-provisional patent application Ser. No. 17/742,185 filed May 11, 2022, and entitled “Downhole Setting Assembly with Switch Module”, now U.S. Pat. No. 11,965,393, issued Apr. 23, 2024, which claims benefit of U.S. provisional patent application No. 63/187,145 filed May 11, 2021, and entitled “Downhole Setting Assembly with Switch Module”.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT
(1) Not applicable.
BACKGROUND
(2) During completion operations for a subterranean hydrocarbon wellbore, it is conventional practice to perforate the wellbore with perforating guns along with any casing tubulars disposed therein along a targeted hydrocarbon bearing formation such that the perforations will provide a path for formation fluids (e.g., hydrocarbons) to flow into the wellbore. To enhance the productivity of each of typically a great many perforations, the wellbore is divided into a plurality of production zones along the targeted formation where the perforations associated with each zone are enlarged and expanded by hydraulic fracturing sometimes referred to as “fracking”. Each production zone is isolated from the next lower downhole zones by installing a frac plug or similar device into the wellbore along with a setting tool at the bottom end of a string or series of perforating guns. Once this tool string is positioned at the designated zone, the plug is set and then the perforating guns are sequentially fired to create the perforations as the string is drawn back toward the surface. With that, the tool string is pulled completely out of the wellbore for the hydraulic fracking system to then connect and pressure up to frack the newest perforations. Once fracking is complete, the process repeats with a new tool string of perforating guns, setting tool and frac plug.
(3) Typically, the string is arranged with the plug attached at the downhole end with a setting tool arrangement arranged to push against the outer periphery of the plug at the top end thereof while also pulling upwardly on a plug mandrel that extends to the bottom of the plug such that the setting tool may squeeze the top and bottom ends together forcing the sealing elements on the plug to spread out and seal against the inside of the casing. The power for setting tool is provided by an energetic device that when ignited provides a large volume of gas that is typically hot combustion gases that pressurizes an internal void space like a cylinder to drive a piston like component that strokes within the setting tool and sets the frac plug.
(4) As the setting tool is powering the setting of the plug, shear pins holding the setting tool to the plug are subjected to forces that eventually break the setting tool from the plug leaving the plug in

place until removed at a later time in a separate operation. The firing head or setting tool initiator is attached at or near the top of the setting tool and includes a switch that is connected through the tool string and wireline cable to a controller at the surface. The switch in the firing head controls electric power access to an igniter that is arranged to ignite a power charge within the setting tool.

(5) One concern with running tool strings with plugs and perforating guns is that the plug must be fully set before any perforations are punched in the casing above or uphole from the intended location of the plug. Not only is it critical that the plug be properly set, it is very helpful to those developing the well that the setting of the plug be confirmed before the perforating guns are fired. Recognizing that the operator at the surface has a high need to know that the sealing device is fully set and sealing off the downhole zones of the wellbore, the wireline operator can attempt to confirm that the plug has set by slowly reeling in wireline on to the wireline truck while the plug is being set and looking at the tension on the wireline cable at the surface expecting to see a slow increase in tension followed by a sudden drop in tension when the shear pins have disconnected the setting tool from the well anchored plug. If that characteristic tension change in the wireline cable is not observed, then the operator may pump additional fluid downhole and see if more wireline is drawn out with little increase in wellbore pressure which would suggest that the plug has not yet set. Conversely, if the plug has been fully set, any further liquid pumping would not push the sealing device farther downhole and wellbore pressure would increase. While these verification techniques provide some degree of confidence, they are time consuming in an operation where every additional minute results in added costs. Thus, the industry would value a better, faster, cheaper means for confirming that the plug has set before creating more perforations in a wellbore.

SUMMARY OF THE DISCLOSURE

(6) An embodiment of a system for setting a plug in a wellbore comprises a setting tool connectable to the plug and comprising a housing, a piston positioned at least partially within the housing, and a setting tool energetic element configured, upon activation, to displace the piston axially relative to the housing and shift the plug in the wellbore from a run-in configuration permitting fluid flow within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug, an initiator comprising an igniter switch and an igniter assembly in signal communication with the igniter switch, wherein the igniter assembly includes an igniter energetic element configured to activate, in response to receiving an ignition signal from the igniter switch, and thereby activate the setting tool energetic element to shift the plug from the run-in configuration to the set configuration, and wherein the initiator comprises a signal interrupter connected between the igniter switch and the igniter assembly and configured to shift automatically from a first state in which signal communication is provided through the signal interrupter between the igniter switch and the igniter assembly to a second state in which signal communication is restricted through the signal interrupter between the igniter switch and the igniter assembly in response to exposing the initiator to a predefined toolstring condition and whereby a surface indication is provided of the shifting of the plug to the set configuration. In some embodiments, the toolstring condition is based on an anticipated toolstring condition associated with at least one of the activations of the igniter energetic element and the setting tool energetic element. In some embodiments, the toolstring condition comprises a threshold wellbore temperature and the anticipated toolstring condition comprises at least one of a first anticipated toolstring temperature associated with the activation of the igniter energetic element, and a second anticipated toolstring temperature different from the first anticipated toolstring temperature and that is associated with the activation of the setting tool energetic element. In certain embodiments, the toolstring condition comprises at least one of a threshold toolstring pressure, a threshold toolstring temperature, a threshold toolstring force, and a threshold toolstring acceleration. In certain embodiments, the system comprises the plug connected to a downhole end of the setting tool. In some embodiments, the system comprises a surface control system is configured to deliver the ignition signal along an enclosed signal communication path to the igniter switch to cause the igniter switch to deliver the

ignition signal to the igniter, wherein the signal communication path is arranged to provide two way signal communication between the surface control system and the igniter switch when the igniter switch is positioned in the wellbore. In some embodiments, the second state of the signal interrupter does not permit electric power or electric signals to pass to the igniter assembly from the igniter switch. In certain embodiments, the first state of the signal interrupter comprises a communicative state and the second state of the signal interrupter comprises a noncommunicative state. In certain embodiments, the igniter assembly includes an activator configured to ignite the igniter energetic element and that is in signal communication with the igniter switch when the signal interrupter is in the first state, and wherein the activator is exposed to combustion products generated from the activation of the igniter energetic element whereby the activator is disconnected from the igniter switch. In some embodiments, the activator comprises an electrical heat resistor. In some embodiments, the signal interrupter comprises an electrical circuit breaker electrically connected to the igniter switch and the igniter assembly when in the first state and electrically disconnected from the igniter switch when in the second state. In certain embodiments, the circuit breaker is configured to remain in the first state until exposed to combustion products from the activation of at least one of the igniter energetic element and the setting tool energetic element. In certain embodiments, the igniter switch is sealed from the igniter assembly when the signal interrupter is in both the first state and the second state.

(7) An embodiment of a system for setting a plug in a wellbore comprises a setting tool connectable to the plug and comprising a housing, a piston positioned at least partially within the housing, and a setting tool energetic element configured, upon activation, to displace the piston axially relative to the housing and shift the plug in the wellbore from a run-in configuration permitting fluid flow within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug, an initiator comprising an igniter assembly and an igniter switch in signal communication with and sealed from the igniter switch, wherein the igniter assembly includes an igniter energetic element configured to activate, in response to receiving an ignition signal from the igniter switch, and thereby activate the setting tool energetic element to shift the plug from the run-in configuration to the set configuration, and a surface control system in signal communication with the initiator and configured to transmit the ignition signal to the igniter switch, and to provide a surface indication of the shifting of the plug from the run-in configuration to the set configuration with the igniter switch remaining sealed from the igniter assembly. In some embodiments, the initiator is configured to shift automatically from a first state in which signal communication is provided between the igniter switch and the igniter assembly to a second state in which signal communication is restricted between the igniter switch and the igniter assembly in response to exposing the initiator to a predefined toolstring condition. In some embodiments, the igniter switch is in signal communication with the surface control system when the initiator is in both the first state and the second state. In certain embodiments, the igniter assembly is not in signal communication with the surface control system when the initiator is in the second state. In certain embodiments, the toolstring condition comprises at least one of a threshold toolstring pressure, a threshold toolstring temperature, a threshold toolstring force, and a threshold toolstring acceleration. In some embodiments, the system comprises an enclosed signal communication path extending between the surface control system and the initiator and arranged to provide two way signal communication between the surface control system and the igniter switch when the igniter switch is positioned in the wellbore. In some embodiments, the signal communication path comprises an electrical circuit. In certain embodiments, the surface indication corresponds to a disconnection of the igniter assembly from the signal communication path.

(8) An embodiment of a system for setting a plug in a wellbore comprises a setting tool connectable to the plug and comprising a housing, a piston positioned at least partially within the housing, and a setting tool energetic element configured, upon activation, to displace the piston axially relative to the housing and shift the plug in the wellbore from a run-in configuration permitting fluid flow

within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug, an initiator comprising an igniter switch and an igniter assembly in signal communication with the igniter switch, wherein the igniter assembly includes an igniter energetic element configured to activate, in response to receiving an ignition signal from the igniter switch, and thereby activate the setting tool energetic element to shift the plug from the run-in configuration to the set configuration, and wherein the initiator comprises an electrical circuit breaker electrically connected between the igniter switch and the igniter assembly and configured to shift automatically from a first state in which electrical signal communication is provided through the circuit breaker between the igniter switch and the igniter assembly to a second state in which electrical signal communication is restricted through the signal interrupter between the igniter switch and the igniter assembly in response to shifting the plug from the run-in configuration to the set configuration and whereby a surface indication is provided of the shifting of the plug to the set configuration. In certain embodiments, the igniter assembly includes an activator configured to ignite the igniter energetic element and that is in signal communication with the igniter switch when the circuit breaker is in the first state, and wherein the activator is exposed to combustion products generated from the activation of the igniter energetic element whereby the activator is disconnected from the igniter switch. In some embodiments, the circuit breaker is configured to remain in the first state until exposed to combustion products from the activation of at least one of the igniter energetic element and the setting tool energetic element. In some embodiments, the system comprises a surface control system is configured to deliver the ignition signal along an electrical circuit to the igniter switch to cause the igniter switch to deliver the ignition signal to the igniter assembly, wherein the electrical circuit is arranged to provide two way electrical signal communication between the surface control system and the igniter switch when the igniter switch is positioned in the wellbore.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) A more complete understanding of the present disclosure may be obtained from the following detailed description with reference to the attached drawing figures as summarized below, in which:

(2) FIG. **1** is a schematic elevation view of a system for completing a subterranean well;

(3) FIG. **2** is a cross-sectional view of an embodiment of a tool string for completing a subterranean well;

(4) FIG. **3** is a partial cross-sectional view of a conventional setting tool initiator for activating a setting tool;

(5) FIG. **4** is a partial cross-sectional view of an igniter switch assembly installed in a setting tool initiator according to an embodiment of the present disclosure;

(6) FIG. **5** is a partial cross-sectional view of an igniter switch assembly according to an embodiment of the present disclosure;

(7) FIG. **6** is a partial cross-sectional view of an igniter switch assembly according to another embodiment of the present disclosure;

(8) FIG. **7** is a partial cross-sectional view of an igniter switch assembly according to still another embodiment of the present disclosure;

(9) FIG. **8** is a cross-sectional view of a signal sub according to an embodiment of the present disclosure;

(10) FIG. **9** is a partial cross-sectional view of an igniter switch assembly installed in a setting tool initiator according to another embodiment of the present disclosure;

(11) FIG. **10** is a partial cross-sectional view of an igniter assembly installed in a setting tool initiator according to an embodiment of the present disclosure;

(12) FIG. **11** is a partial cross-sectional view of an igniter switch assembly according to a further embodiment of the present disclosure;
(13) FIG. **12** is a partial cross-sectional view of an igniter assembly installed in a setting tool initiator in a second position according to a further embodiment of the present disclosure;
(14) FIG. **13** is fragmentary elevation cross section of a further embodiment of the disclosure;
(15) FIG. **14** is an enlarged fragmentary cross section view of the embodiment shown in FIG. **13**;
(16) FIG. **15** is a further enlargement of the igniter of the embodiment shown in FIGS. **13** and **14**; and
(17) FIG. **16** is fragmentary elevation cross section of a further embodiment of the disclosure.

DETAILED DESCRIPTION

(18) The following discussion is directed to various exemplary embodiments of the present disclosure. However, one skilled in the art will understand that the examples disclosed herein have broad application, and that the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment. Certain terms are used throughout the following description and claims to refer to particular features or components. As one skilled in the art will appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name but not function. The drawing figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.

(19) In the following discussion and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to . . . " Also, the term "couple" or "couples" is intended to mean either an indirect or direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection, or through an indirect connection via other devices, components, and connections. In addition, as used herein, the terms "axial" and "axially" generally mean along or parallel to a central axis (e.g., central axis of a body or a port), while the terms "radial" and "radially" generally mean perpendicular to the central axis. For instance, an axial distance refers to a distance measured along or parallel to the central axis, and a radial distance means a distance measured perpendicular to the central axis. Any reference to up or down in the description and the claims is made for purposes of clarity, with "up", "upper", "upwardly", "uphole", or "upstream" meaning toward the surface of the borehole and with "down", "lower", "downwardly", "downhole", or "downstream" meaning toward the terminal end of the borehole, regardless of the borehole orientation. Further, the term "fluid," as used herein, is intended to encompass both fluids and gasses.

(20) As it relates to setting tools "burning" or "firing" means the chemical reaction within the combustible element or energetic charge which results in the creation of gaseous combustion products and increasing pressure increase within a combustion compartment of the setting tool. Sometimes the terms "initiate" and "ignite" are used to describe the onset of the generation of gaseous pressure. The terms "burning", "igniting," or "firing", all describe the generation of gaseous pressure by the burning of the combustible element.

(21) Referring now to FIGS. **1** and **2**, an embodiment of a system **10** for plugging a wellbore **14** extending from the surface **5** through a subterranean earthen formation **16** is shown. In this exemplary embodiment, plugging system **10** generally includes a surface assembly or servicing rig **12** positioned at the surface **5** that extends over and around the wellbore **14** that penetrates the earthen formation **16** for the purpose of recovering hydrocarbons from a first production zone **18**A and a second production zone **18**B (collectively the production zones "**18**"). The wellbore **14** can be drilled into the subterranean formation **16** using any suitable drilling technique. While shown as extending vertically from the surface in FIG. **1**, the wellbore **14** can also be deviated, horizontal, and/or curved over at least some portions of the wellbore **14**. For example, the wellbore **14**, or a

lateral wellbore drilled off of the wellbore **14**, may deviate and remain within one of the production zones **18**. The wellbore **14** can be cased, open hole, contain tubing, and can generally be made up of a hole in the ground having a variety of shapes and/or geometries as is known to those of skill in the art. In the illustrated embodiment, a casing **20** can be placed in the wellbore **14** and secured at least in part by cement **22**.

(22) The servicing rig **12** of plugging system **10** can be one of a drilling rig, a completion rig, a workover rig, a wireline surface system, or other structure and supports a tool string **32** disposed in the wellbore **14**. Servicing rig **12** includes a surface controller **13** in signal communication with one or more downhole tools of tool string **32**. In other embodiments, other surface systems or structures can also support the tool string **32**. The servicing rig **12** can also comprise a derrick with a rig floor through which the tool string **32** extends downward from the servicing rig **12** into the wellbore **14**. It is understood that other mechanical mechanisms, not shown, can control the run-in and withdrawal of the tool string **32** in the wellbore **14**.

(23) In this exemplary embodiment, the tool string **32** generally includes a work string **30**, a perforating gun **46** (hidden from view in FIG. **2**), a signal sub **34**, a setting tool initiator **40**, a setting tool **42**, and an auxiliary tool **44**. It may be understood that in other embodiments the configuration of tool string **32** may vary. For example, in some embodiments, tool string **32** may additionally include a fishneck, one or more weight bars, a release tool, and/or one or more other downhole tools. The work string **30** can be any of a string of jointed pipes, a slickline, a coiled tubing, and a wireline. The tool string **32** can be lowered into the wellbore **14** to position the setting tool **42** to set or actuate a frac plug at a predetermined depth.

(24) As shown particularly in FIG. **2**, in this exemplary embodiment, setting tool **42** generally includes a setting tool housing **43**, a piston **48** slidably disposed in the housing **43**, and a combustible or explosive element **49** positioned in the setting tool housing **43**. Particularly, setting tool housing **43** defines a central passage **51** having a combustion compartment **53** in which the combustible element **49** is received. Piston **48** is configured to impart a setting force against the auxiliary tool **44** in response to combustion of the combustible element **49**. While the setting tool initiator **40** is described herein as separate from the setting tool **42**, it may be understood that in some embodiments the setting tool initiator **40** may comprise a component of the setting tool **42** with the initiator housing comprising a section (e.g., a section housing) of the setting tool housing **43**.

(25) Auxiliary tool **44** is releasably attached to a distal or downhole end of the setting tool **42**. In this exemplary embodiment, the signal sub **34** includes any combination of a cable head **36**, and an instrument sub **38**. The cable head **36** attaches the signal sub **34** to a work string **30** that includes an electrical conductor **28**. For example, a wireline can include one or more electrical conductors wrapped with a braided wire. The cable head **36** can electrically connect the one or more electrical conductors **28** to another component of the signal sub **34** as will be described herein. The perforating gun includes one or more explosive shaped charges configured to perforate casing **20** at the desired location in response to receiving, by a gun switch of the perforating gun, a firing signal from the surface controller **13**. It may be understood that while only a single perforating gun **46** is shown in FIG. **1**, in other embodiments, tool string **32** may include more than one perforating gun **46**.

(26) In this exemplary embodiment, signal sub **34** of tool string **32** includes an instrument sub **38** with environmental sensors **56**. The instrument sub **38** couples to the cable head **36** with an electrical connection **54**. The environmental sensors **56** can include pressure and temperature sensors to measure the pressure and temperature of the wellbore environment, the pressure and temperature of the interior of the instrument sub, or a combination of both. The environmental sensor **56** can include a motion sensor that can be one or more accelerometers. The measurements of the accelerometers can indicate motion of the setting tool **42**. The environmental sensor **56** can include a magnetic sensor commonly referred to as a collar locator used to indicate the location of

the setting tool initiator within the wellbore **14**. In some embodiments, the environmental sensor **56**, of instrument sub **38** may only comprise the magnetic sensor. In some embodiments, other components of the tool string **32** such as perforating gun **46** may be positioned between the instrument sub **38** and setting tool **42**.
(27) The setting tool initiator **40** may connect to the signal sub **34** with an electrical connector sub **60** configured to provide a sealed electrical connection between the setting tool initiator **40** and the signal sub **34**. The upper sealed electrical connection **60** electrically couples the setting tool initiator **40** to the electrical conductors **28** in the work string **30**. The upper sealed electrical connection **60** can also provide pressure isolation between the setting tool initiator **40** and components of tool string **32** positioned uphole from setting tool initiator **40** such as, for example, perforating gun **46**.
(28) Turning now to FIG. **3**, a conventional setting tool initiator **400** is shown. Setting tool initiator **400** generally includes an initiator housing **402**, an igniter **420**, and a setting tool igniter switch **425**. Initiator housing **402** is shown as including a pair of housing sections **403** and **405** which are connected together to form initiator housing **402**. However, it may be understood that initiator housing **402** may comprise only a single housing or more than two housings. Initiator housing **402** defines an internal igniter compartment **404** and an internal switch compartment **406** within the housing **402**. The igniter **420** is located in the igniter compartment **404** while the igniter switch **425** is located in the switch compartment **406**. The igniter switch **425** is electrically connected to the igniter **420** via an electrical connector located in the initiator housing **402**. In this manner, igniter switch **425** may transmit an electrical signal to the igniter **420** through the electrical connector **440** to ignite the igniter **420**. The setting tool initiator **400** may thus activate setting tool **42** (not shown in FIG. **3**) in response to the ignition of igniter **420**.
(29) Conventionally, the igniter **420** is separate from the igniter switch **425** by a bulkhead **415** positioned within initiator housing **402** between the igniter **420** and igniter switch **425**. The bulkhead **415** may be separate from or integrated with the electrical connector **410**. Conventionally, the bulkhead seals and provides a pressure barrier between the switch compartment **406** and the igniter compartment **404** such that hot and highly pressurized combustion gasses produced by the ignition of igniter **420** are prevented from entering the switch compartment **406** and thereby physically compromising or disabling the igniter switch **425**. In this manner, the igniter switch **425** may remain in signal communication with the surface controller **13** following the ignition of igniter **420**. For instance, the igniter switch **425** may be used to perform additional actions such as detonating the one or more shaped charges of the perforating gun **46** following the ignition of igniter **420**.
(30) While the conventional setting tool initiator **400** is configured to permit igniter switch **425** to survive the ignition of igniter **420**, the survival of igniter switch **425** in-turn prevents the destruction or disablement of igniter switch **425** from providing a surface indication to the operator of system **10** that the setting tool **42** has successfully been activated to set the auxiliary tool **44**. Instead, the operator at the surface is forced to rely on more time consuming (and hence costly) and less reliable techniques for discerning whether the auxiliary tool **44** has been successfully set, such as by applying tension to the work string **30** using the servicing rig **12** to determine if the auxiliary tool **44** has anchored against the casing **20**. However, as described above, in some applications (e.g., relatively deep wells, off-shore applications) it is difficult if not impossible to determine whether the auxiliary tool **44** has been successfully set based on tension applied to the work string **30** as observed at the surface.
(31) It may also be understood that if bulkhead **415** were removed from the conventional setting tool initiator **400** to intentionally compromise igniter switch **425** following the ignition of igniter **420**, such a modification would require the combustion products produced by the combustible element of setting tool **42** to fill both the igniter compartment **404** and switch compartment **406**. However, the igniter switch **425** is not positioned proximal igniter **420**, and the switch

compartment **406** has a relatively large volume compared to the volume of igniter compartment **404**. The large volume of switch compartment **406**, when filled with combustion products produced by the combustible element of setting tool **42**, reduces the pressure force imparted by the combustion products against the piston **48** of setting tool **42**, concomitantly reducing the setting force applied by the piston **48** of setting tool **42** to the auxiliary tool **44** for setting or actuating the auxiliary tool **44**. Particularly, the increased volume occupied by the combustion products in the switch compartment **406** reduces the pressure of the combustion products by increasing the volume the products are permitted to expand into, reducing the effectiveness of the setting tool **42** in setting the auxiliary tool **44** by reducing the pressure force exerted by the setting tool **42** during actuation.

(32) Turning now to FIG. **4**, an embodiment according to the current disclosure of the setting tool initiator **40** is shown. As will be explored in further detail below, unlike conventional setting tool initiator **400** shown in FIG. **3**, setting tool initiator **40** of the current disclosure is configured to provide a surface indication of the successful ignition of an igniter **130** of the setting tool initiator **40** by disabling or disconnecting an electrical igniter switch **110** of the setting tool initiator **40**. In this exemplary embodiment, setting tool initiator **40** generally includes an initiator housing **74** and an igniter switch module **70**. The setting tool initiator **40** may connect with uphole components of tool string **32** (e.g., cable head **36**) via the connector sub **60** shown in FIG. **2** and hidden from view in FIG. **4**. As will be described further herein, igniter switch module **70** is configured to place igniter switch **110** in close proximity with igniter **130** whereby combustion products may be communicated to the igniter switch **110** while minimizing the amount of additional volume the combustion products must occupy following the ignition of igniter **130**. In this manner, igniter switch module **70** permits the compromising of igniter switch **110** to serve as a surface indication of the successful actuation of setting tool **42** while also maximizing the effectiveness of setting tool **42** (by maximizing the pressure force exerted by setting tool **42** during actuation) in setting or actuating the auxiliary tool **44**.

(33) In this exemplary embodiment, the initiator housing **74** is a cylindrical shape with an uphole connector **78**, a downhole connector **80**, and a central bore or passage **81** extending between longitudinally opposed uphole and downhole ends of the initiator housing **74**. In this exemplary embodiment, initiator housing **74** comprises a single, integrally or monolithically formed housing and the central passage **81** thereof receives the entirety of the igniter switch module **70**. It may be understood however that in other embodiments initiator housing **74** may comprise a plurality of separate sectional housings which are threaded or otherwise connected together end-to-end.

(34) In this exemplary embodiment, central passage **81** of initiator housing **74** includes a switch compartment **82**, and an igniter compartment **86** that is connected to the switch compartment **82** by an unabridged interrupt flowpath **85** extending from the igniter compartment **86** to the switch compartment **82**. In some embodiments, the interrupt flowpath **85** extends from the combustion compartment **53** and to the switch compartment **82** such that combustion products may be conveyed from the combustion compartment **53** to the switch compartment **82**. The switch compartment **82** has an inner housing surface **98**, a grounding surface **88**, and transitions to the igniter compartment **86**. The uphole connector **78** includes an upper seal surface **92** to seal against a corresponding seal assembly of the connector sub **60** to prevent well bore fluids from entering the initiator housing **74**. The downhole connector **80** includes a seal assembly **96** configured to seal against a corresponding seal surface defining the combustion compartment **53** of the setting tool **42**. The igniter switch module **70** can be installed inside the switch compartment **82** of the initiator housing **74**. The igniter attached to the igniter switch module **70** installs into the igniter compartment **86**. Initiator housing **74** is configured to minimize the volume of switch compartment **82** such that the volume occupied by the combustion products generated by setting tool **42** during actuation is low enough such that the combustion products may maintain a pressure sufficient to fully set or actuate the auxiliary tool **44**. In this exemplary embodiment, the switch compartment **82** has a maximum inner diameter of 1.50 inches (in) or less to thereby minimize the volume of switch

compartment **82**; however, it may be understood that the maximum inner diameter of switch compartment **82** may vary in other embodiments.

(35) The igniter switch module **70** can be tested by the operator for electric connectivity before being installed into the switch compartment **82**. As an example, the operator may measure electrical resistance of the igniter **130** after being installed into the igniter switch module **70** by contacting a first lead of a resistance meter to downhole electrical contact **120** and contacting a second lead of the meter to tube **132**. Turning now to FIG. **5**, in this exemplary embodiment, the igniter switch module **70** generally includes a main body or switch chassis **112**, igniter switch **110**, an igniter adapter **140**, and igniter **130**. Igniter switch module **70** allows for the igniter switch **110** and igniter **130** to be pre-connected and installed together as a single unit into the initiator housing **74**. As described above, igniter switch module **70** places the igniter switch **110** into close proximity with the igniter **130** so as to maximize the effectiveness of setting tool **42** during actuation. The igniter switch module **70** has a maximum length **111** extending from an uphole end of the switch chassis **112** to a downhole end of the igniter adapter **140**. In this exemplary embodiment, the maximum length **111** of igniter switch module **70** is approximately 6.5 in or less; however, it may be understood that the maximum length **111** of igniter switch module **70** may vary in other embodiments.

(36) The switch chassis **112** of igniter switch module **70** may be made of a non-electrically conductive material (e.g., plastic) such as glass filled nylon. Switch chassis **112** has an uphole electrical contact **114** and a downhole electrical contact **120** for communicating signals to the igniter **130** as will be disclosed further herein. In this exemplary embodiment, igniter adapter **140** includes a tube **132**, a flange **124**, and a ground or flange spring **136**. The tube **132** may be connected or attached to a flange **124** by a weld **138**, by fasteners, or by other means. Flange spring **136** may be connected or attached to the flange **124** by a weld **138**, by a bent tab, by fasteners, or by other means.

(37) In this exemplary embodiment, igniter switch module **70** additionally includes an igniter spring **128** and a shoulder washer **126**. Igniter spring **128** and shoulder washer **126** are installed between the switch chassis **112** and the igniter adapter **140**. Tube **132** comprises one or more tabs that bend outwards to secure the tube **132** to the switch chassis **112** and to secure the flange spring **136**. The igniter adapter **140** may be attached to the switch chassis **112** with fasteners such as screws. In this exemplary embodiment, igniter **130** is installed into the tube **132** of the igniter adapter **140** and secured in place with a snap ring **134** or any other suitable fastener. Igniter switch **110** is connected to the uphole electrical contact **114** with an uphole switch wire **116**. Additionally, igniter switch **110** is connected to the downhole electrical contact **120** with a downhole switch wire **118**. A grounding wire **122** from the igniter switch **110** may be connected to a screw or similar location on the front of the igniter adapter **140**. The uphole switch wire **116**, downhole switch wire **118**, and igniter switch **110** collectively form a switch circuit **115** (shown in FIG. **5**) which is electrically disconnected in response to the circulation of combustion products to the switch compartment **82** and the concomitant exposure of the switch circuit **115** to the combustion products. For example, one or more of the wires **116** and **118** and igniter switch **110** may be physically compromised following circulation of the combustion products to the switch compartment **82**. Additionally, while in this exemplary embodiment the igniter switch **110** is positioned in the switch compartment **82**, in other embodiments, igniter switch **110** may be positioned external the switch compartment **82** with another portion of the switch circuit **115** (e.g., downhole switch wire **118**) positioned in the switch compartment **82**.

(38) The igniter switch **110** has an operational state in which the igniter switch **110** is configured to receive electrical signals from the surface **5** and an inoperable state in which the igniter switch **110** is not configured to receive electrical signals from the surface **5**. Setting tool initiator **40** is configured to shift igniter switch **110** from the operational state to the inoperable state in response to the ignition of the igniter **130** which results in the communication of combustion products to the

switch chamber **82**. For example, the igniter switch **110** may be shifted to the inoperable state by rendering electrically inoperable (e.g., physically compromising) the igniter switch **110** itself or another component of the switch circuit **115** such as uphole switch wire **116**.

(39) Igniter switch module **70** positions the igniter switch **110** at a predefined distance **113** from the igniter **130**, where the predefined distance is contingent or based on the length of the switch chassis **112**, and the length of igniter switch **128** when compressed by the igniter **130**. It may be understood that a limited degree of movement may be permitted between igniter switch **110** and igniter **130** and thus the predefined distance **113** may comprise a predefined range. For example, in some embodiments, the predefined distance **113** is approximately 1.75 in or less; however, it may be understood that in other embodiments the predefined distance **113** may vary.

(40) Signals transmitted from an operator at the surface can be communicated to the igniter **130** as will be described herein. For example, the operator may transmit an igniter signal down the electrical conductor **28** within the work string **30** to the tool string **32** shown in FIG. **2**. The igniter signal is communicated from the electrical conductor **28** within the work string **30**, through the electrical contacts within the signal sub **34**, and to the setting tool initiator **40** shown in FIG. **4** via the connector sub **60**. From connector sub **60**, the igniter signal travels to the igniter switch module **70**. The transmitted signal passes through the uphole contact **114** and, the uphole switch wire **116**, and to the igniter switch **110**. In some embodiments, the igniter switch **110** comprises an addressable switch, including, for example, a printed circuit board, a processor (e.g., a microprocessor or central processing unit (CPU)), and a memory device including instructions stored therein defining the operation of igniter switch **110**. The igniter switch **110** has an operational state or configuration in which the igniter switch can receive signals transmitted from surface. For example, when in the operational state, igniter switch **110** may identify an address and a command within the signal, compare the transmitted address to the programmed address within the memory of the igniter switch **110**, and execute the command if the transmitted address matches the address in memory. If the transmitted address matches the address in memory, a firing circuit of the igniter switch **110** is opened and permits the voltage and current to be provided to the igniter **130** via the downhole switch wire **118**, the downhole contact **120**, and the igniter spring **128**. As will be discussed further herein, igniter switch **110** additionally includes a disabled or compromised state or configuration in which the switch **110** is not configured to receive signals transmitted from the surface. For example, in the disabled state the igniter switch **110** may be damaged or otherwise physically compromised. As another example, in the disabled state, the circuit connecting igniter switch **110** to the surface controller **13** may be physically damaged or otherwise compromised. It may also be understood that in other embodiments the configuration of igniter switch **110** may vary. For example, in other embodiments, igniter switch **110** may comprise a diode-based switch and may not include a processor or a memory device.

(41) The igniter **130** is grounded to the igniter adapter **140** via biasing members or springs integral to the body of the igniter **130** that contact the inner surface **142** of the tube **132** of the igniter adapter **140**. The igniter adapter **140** is grounded to initiator housing **74** of the setting tool initiator **40**, as shown in FIG. **4**, via the flange spring **136** in contact with the grounding surface **88** of the initiator housing **74**. The igniter switch **110** may also be grounded to the grounding surface **88** of the initiator housing **74** via grounding wire **122** that is connected to the igniter adapter **140**.

(42) The igniter **130** ignites in response to the igniter switch **110** conveying the signal (e.g., the necessary voltage and current) necessary to initiate the pyrotechnic material of the igniter **130**. The resultant flame jets out of the downhole end of the igniter **130** to ignite the combustible element **49** within the combustion compartment **53** of the setting tool **42**. The burning or detonation of the combustible element **49** creates a high pressure and high temperature gaseous pressure within the combustion compartment **53** that strokes the piston **48** of the setting tool **42** to set or actuate the auxiliary tool **44**. The high pressure and high temperature gases pass between the outer surface **74** of the tube **132** on the igniter adapter **140** and the inner surface **90** of the igniter compartment **86** of

the initiator housing **74** to fill the switch compartment **82** of the setting tool initiator **40**. In this manner, the environment within the switch compartment **82** of the setting tool initiator **40** changes from a pressure near atmospheric pressure (e.g., 14.7 psi) to a substantially elevated pressure (e.g., a pressure exceeding 10,000 pounds per square inch (PSI)).
(43) As a result of ignition, the igniter switch **110** breaks the circuit, e.g., creates an open circuit, due the change in environmental conditions within the switch compartment **82**, e.g., high pressure and high temperature of the gases within the switch compartment **82**. Hot pressurized combustion products generated by the ignition of igniter **130** and of the combustible element **49** of the setting tool **42** (the combustible element **49** being in fluid communication with igniter **130**) are communicated or flow along flowpath **85** shown in FIG. **4** from the igniter compartment **86** to the switch compartment **82** where the combustion products contact the igniter switch **110** and shift the igniter switch **110** from the operational state to the disabled state. Particularly, the combustion products physically damage or otherwise compromise the physical integrity of igniter switch **110** and/or other circuitry connected thereto (e.g., uphole switch wire **116**) whereby igniter switch **110** is no longer connected to surface controller **13** or configured to send or receive signals.
(44) The operator at surface may register the short circuit, i.e., end of communication, as a positive and mechanical surface indication that the combustible element **49** within the setting tool **42** has burned and actuated the setting tool **42** to activate the auxiliary tool **44**. In this manner, the operator need not rely on the unreliable practice of applying tension to work string **30** at the surface to determine whether the auxiliary tool **44** has been set. Moreover, igniter switch module **70** places the combustible element **49** and particularly igniter **130** into close proximity with igniter switch **110**, thereby ensuring the destruction of igniter switch **110** while minimizing the volume of the central passage **81** of initiator housing **74** and thus the volume which is occupied by the combustion products following the ignition of the igniter **130**. Minimizing the volume occupied by the combustion products generated by the ignition of igniter **130** and the combustible element **49** maximizes the pressure force imparted by the combustion products to the piston **48** of the setting tool **42** which strokes in response to the ignition of the igniter **130**. The minimization of the volume of central passage **81** may thus assist in ensuring the piston **48** of setting tool **42** fully strokes to thereby fully and successfully set the auxiliary tool **44**.
(45) In an embodiment, a circuit breaker in the igniter switch module **70** disconnects the communication path to the igniter switch **110**. Turning now to FIG. **6**, in this embodiment, an igniter switch module **80** comprises the igniter switch **110**, a main body **154** housing the igniter switch **110**, a circuit breaker **156**, the igniter adapter **140**, and the igniter **130**. The circuit breaker **156** can be a thermal switch, pressure switch, or an impact switch. The circuit breaker **156** is electrically connected within the circuit between the uphole contact **114** and the igniter switch **110**. An electronic signal transmitted from surface controller **13** is communicated through the electrical conductor **28** in the work string **30**, through the signal sub **34**, and to the uphole contact **114** on the igniter switch module **80**. In this exemplary embodiment, the signal from surface controller **13** passes through the uphole contact, a second switch wire **82**, the circuit breaker **156**, the uphole switch wire **88**, to the igniter switch **110**. The electronic signal from surface controller **13** may pass through the circuit breaker **156** until a predetermined value is reached and the circuit breaker **156** cuts off communication to the igniter switch. If the circuit breaker **156** is a thermal switch, the thermal switch breaks communication with the igniter switch **110** when the temperature exceeds a predetermined value (e.g., 500 degrees Fahrenheit (° F.). If the circuit breaker **156** is an impact switch, the impact switch (i.e., accelerometer) breaks communication with the igniter switch **110** when the impact force (i.e., acceleration) exceeds a predetermined value (e.g., 10 g).
(46) In this exemplary embodiment, when the surface controller **13** transmits an electronic signal to the igniter switch **110** and the transmitted address matches the address in memory, the igniter switch **110** opens the firing circuit thereof to permit the transmission of the voltage and current to the igniter **130** via the downhole switch wire **118**, the downhole contact **120**, and the igniter spring

128. The igniter **130** ignites and the resultant flame jets out to ignite the combustible element **49** within the combustion compartment **53** of the setting tool **42**. The burning or detonation of the combustible element **49** creates a high pressure and high temperature gaseous pressure within the combustion compartment **53** that strokes the piston **48** on the setting tool **42** to set or actuate the auxiliary tool **44**. The high pressure and high temperature gases pass between the outer surface **74** of the tube **132** on the igniter adapter **140** and the inner surface **90** of the igniter compartment **86** of the initiator housing **74** to fill the switch compartment **82** of the setting tool initiator **40**. The circuit breaker **156** disconnects or breaks communication with the igniter switch **110** when a predetermined value is reached or exceeded. For example, if the circuit breaker **156** is a pressure switch, the pressure switch breaks communication with the igniter switch **110** when the pressure exceeds a predetermined value (e.g., 10,000 PSI). The operator may register the end of communication, or a break in communication, with the igniter switch **110** at surface controller **13** as an indication that the setting tool **42** has functioned to set the auxiliary tool **44**.

(47) In an embodiment, an environmental sensor within the switch module indicates the setting tool **42** has functioned. Turning to FIG. **7**, in this embodiment, an igniter switch module **160** comprises the igniter switch **166**, an environmental sensor **162**, the igniter adapter **140**, and the igniter **130**. The environmental sensor **162** can be a thermometer, a pressure transducer, an accelerometer, or an acoustic sensor. The igniter switch module **160** can have any combination of one or more environment sensors **162**. The environmental sensors **162** are electrically connected to the igniter switch **166** with a sensor wire **164**. In this exemplary embodiment, an electronic signal transmitted from surface controller **13** is communicated through the electrical conductor **28** in the work string **30**, through the signal sub **34**, and to the uphole contact **114** on the igniter switch module **160**. The signal transmitted from surface controller **13** passes through the uphole contact **114**, the uphole switch wire **116**, to the igniter switch **166**. As previously described, the igniter switch **166** can be an addressable switch. Likewise, the one or more environmental sensors **162** can be addressable through the addressable igniter switch **166**.

(48) An electronic signal from surface controller **13** can command the igniter switch **166** to transmit one or more measurements at a predetermined periodic rate from the environmental sensors **162**. For example, the environmental sensor **162** can be a temperature sensor (e.g., thermocouple) that measures the temperature within the switch compartment **82** of the initiator housing **74**. For example, the environmental sensor **162** can be a pressure sensor (e.g., pressure transducer) that measures the pressure within the switch compartment **82** of the initiator housing **74**. As another example, the environmental sensor **162** can be an accelerometer that measures the acceleration (e.g., motion) of the initiator housing **74**. As another example, the environmental sensor **162** can be an acoustic sensor (e.g., microphone, piezoelectric transducer) that measures the acoustic waves or sound levels within the switch compartment **82** of the initiator housing **74**. The surface controller **13** may transmit an electronic signal with a command to activate to the igniter **130** and a second command to transmit the measurements at a predetermined periodic rate from the environmental sensor **162**.

(49) When the igniter switch **110** receives the commands, the igniter switch **110** transmits a signal (e.g., a predetermined voltage and current) to the igniter **130** via the downhole switch wire **118**, the downhole contact **120**, and the igniter spring **128**. The igniter switch **166** can measure and transmit the measured data from the one or more environmental sensors **162**. The igniter **130** ignites and the resultant flame jets out the distal end to ignite the combustible element **49** within the combustion compartment **53** of the setting tool **42**. The burning or detonation of the combustible element **49** creates a high pressure and high temperature gaseous pressure within the combustion compartment **53** that strokes the piston **48** of the setting tool **42** to set or actuate the auxiliary tool **44**. The service personnel receive the transmitted data from the one or more environmental sensors **162**. The change of measured data, for example an increase in the temperature, observed at surface can indicate that the setting tool **42** has functioned to set the auxiliary tool **44**.

(50) In an embodiment, the signal sub **34** has a plurality of environmental sensors in two or more locations that provide feedback to the operator at the surface that the setting tool **42** has functioned to set or activate an auxiliary tool **44**. The setting tool initiator **40** can include the igniter switch module **160** with one or more environmental sensors **162**. The instrument sub **38** can include one or more environmental sensors **56**. The environmental sensors can have an internal sensor **172**, an external sensor **174**, or any combination thereof. The internal sensor **172** can provide measurements at a predetermined periodic rate of the environment inside the instrument compartment **176**. The external sensor **174** can provide measurements at a predetermined periodic rate of the wellbore environment exterior of the instrument sub **38**. The environmental sensor **56** can be one or more of a temperature sensor, a pressure transducer, an accelerometer, a magnetic sensor, or an acoustic sensor. The environmental sensor **56** can include pressure and temperature sensors to measure the pressure and temperature of the wellbore environment, the pressure and temperature of the instrument compartment **176** of the instrument sub **38**, or any combination thereof. The environmental sensor **56** can include a motion sensor that can be one or more accelerometers. The measurements of the accelerometers can indicate motion of the setting tool. The environmental sensor **56** can include a magnetic sensor commonly referred to as a collar locator. The magnetic sensor measures the magnetic response of the casing, liner, or tubing. The collars that connect the casing, liner, or tubing have a different magnetic signature than the tubing bodies. The collar locator measures and counts the collars. The number of collars counted can be correlated to a tubing tally to indicate the location of the setting tool initiator within the wellbore. The environmental sensor **56** can include an acoustic sensor (e.g., microphone, piezoelectric transducer) that measures the acoustic waves or sound levels within the instrument compartment **176** of the instrument sub **38** or the acoustic waves external to the instrument sub **38**.
(51) As previously described, the surface controller **13** transmit a signal to the igniter switch module **160** to ignite the igniter **130** and subsequently ignite the combustible element **49** in the setting tool **42**. The surface controller **13** can also transmit a signal to the environmental sensor **162** on the igniter switch module **160** and the environmental sensor **56** within the instrument sub **38**. The environmental sensor **162** and environmental sensor **56** can measure at a predetermined periodic rate and transmit the measurements to service personnel at surface. Any combination of measured data from the instrument sub **38** or the igniter switch module **160** observed at surface by the operator can indicate the that the setting tool **42** has set the auxiliary tool **44**. For example, an increase in the temperature measured by the environmental sensor **162** within the igniter switch module **160** along with motion measured by the environmental sensor **56** within the instrument sub **38** can indicate that the setting tool **42** has functioned to set the auxiliary tool **44**.
(52) In an embodiment, the signal sub **34** can comprise an instrument sub **38** with one or more environmental sensors **56**, and the setting tool initiator **40** may include circuit breaker **156**. As previously described, the surface controller **13** can transmit a signal to the igniter switch module **160** to ignite the igniter **130** and subsequently ignite the combustible element **49** in the setting tool **42**. The service personnel can also transmit a signal to the environmental sensor **56** within the instrument sub **38**. The environmental sensor **56** can measure at a predetermined periodic rate and transmit the measurements to the operator at surface. The operator can monitor communication with the igniter switch module **160** within the setting tool initiator **40**. The circuit breaker **156** will end electrical communication with the igniter switch module **160** when a predetermined environmental condition is met. Any combination of measured data from the instrument sub **38** or loss of electrical communication with the igniter switch module **160** observed at surface by the operator can indicate the that the setting tool **42** has set the auxiliary tool **44**.
(53) The pressure within the combustion compartment **53** of the setting tool **42** after the combustible element **49** is ignited can actuate a piston **48** to ground out the igniter switch assembly. In an embodiment shown in FIG. **9**, the setting tool initiator **200** includes a movable isolator that grounds out the igniter switch assembly. In this exemplary embodiment, the setting tool initiator

200 generally includes a switch housing **202**, an igniter retainer **204**, a movable isolator **208**, and an igniter switch module **270**. The switch housing **202** is a cylindrical shape with an uphole connector **78**, a downhole connector **80**, an inner thread **212**, a switch compartment **220**, and an igniter compartment **222** connected to the switch compartment **220** by an uninterrupted fluid flowpath. In this exemplary embodiment, the switch compartment **220** has an inner housing surface **224**, and an isolator port **226**. The uphole connector **78** includes an upper seal surface **92**. The downhole connector **80** includes a lower seal assembly **96**. The housing connector **72** sealingly couples to the switch housing **202** to form a seal to prevent well bore fluids from entering the switch compartment **220**. The downhole connector **80** and seal assembly couple the setting tool initiator **200** to the combustion compartment **53** of the setting tool **42**. The installation of the igniter switch module **270** and the igniter will be explained in more detail herein.
(54) Turning to FIG. **10**, the igniter assembly **240** can be installed into the igniter compartment **222**. In this exemplary embodiment, the igniter assembly **240** generally include an insulated pin connector **242**, a retaining spring **244**, movable isolator **208**, and an igniter **246**. The insulated pin connector **242** and movable isolator have an electrically conductive core to communicate electrical signals to the igniter **246**. The insulated pin connector **242** has an outer shell of insulating material. The movable isolator has a seal assembly **248** that can comprise one or more seals with various seal retaining structures. The igniter **246** includes a grounding spring **250** that electrically couples to the igniter compartment **222** of the switch housing **202**. The insulated pin connector **242** is coupled to the movable isolator **208** by threads, fasteners, welding, or similar joining methods. The retaining spring **244** can be installed over the insulated pin connector **242** and movable isolator **208**. The retaining spring **244**, insulated pin connector **242**, and movable isolator **208** with seal assembly **248** can be installed into the igniter compartment **222**. The igniter **246** can be installed into the igniter compartment **222** and retained with the igniter retainer **204**.
(55) The igniter switch module can be tested by the operator for electric conductivity before being installed into the setting tool initiator. Turning now to FIG. **11**, the igniter switch module **270** can comprise, a main body **272**, an igniter switch **274**, an upper pin assembly **276**, a lower pin assembly **278**, and a grounding point assembly. The main body **272** can be made of a non-electrically conductive material (e.g., plastic) such as a glass filled nylon. The upper pin assembly **276** comprises a pin connector **300**, a connector post **280**, a connector spring **282**, and a spring retainer **284**. The connector spring **282** and spring retainer **284** slidingly fit over the connector post **280** with an allowance fit. The pin connector **300** can couple to the connector post **280** with threads, fasteners, or any other method of joining. The upper pin assembly **276** can threadingly connect to the main body **272** with a threaded connection **310**. In this exemplary embodiment, the lower pin assembly **278** comprises a pin connector **288**, a connector post **290**, a connector spring **292**, and a spring retainer **294**. The lower pin assembly **278** can threadingly connect to the main body **272** with a thread connection **296**. In this exemplary embodiment, the igniter switch module **270** includes a grounding point assembly **314** comprising a washer **316**, a fastener **318**, and a grounding wire connector **320**. The fastener **318** can thread into a port **308** to attach the grounding point assembly **314** onto the main body **272**. The igniter switch **274** can be connected to the upper pin assembly **276** with an uphole switch wire **302** and connected to the lower pin assembly **278** with a downhole switch wire **304**. A grounding wire **306** from the igniter switch **274** can be connected to the grounding wire connector **320** of the grounding point assembly **314**.
(56) The pressure inside the setting tool **42** will ground out the igniter switch **274**. Returning to FIG. **9**, the setting tool initiator is assembled by installing the igniter assembly **240** into the igniter compartment **222** and threadingly connecting the igniter retainer **204** to the switch housing **202**. The igniter switch module **270** can be tested before installing into the switch compartment **220** of the switch housing **202**. The housing connector **72** is threadingly connected to the switch housing **202**. The switch housing **202** is threadingly coupled to the setting tool **42** with the downhole connector **80** and seal assembly **96** of switch housing **202**. Turning to FIG. **10**, the retaining spring

244 bias the movable isolator **208** towards the isolator port **226**. The igniter **246** is pushed into contact with the igniter retainer **204** by the spring force of the retaining spring **244**. The atmospheric pressure on either side of the seal assembly **248** on the movable isolator **208** is approximately equal. The pressure uphole of the seal assembly **248** is the pressure inside the switch compartment **220** that is approximately atmospheric pressure. The pressure downhole of the seal assembly **248** is the pressure inside the setting tool **42** that is approximately atmospheric pressure. Therefore, the movable isolator **208** is pressure balanced.

(57) The ignition of the combustible element **49** inside the setting tool **42** by the igniter **246** will produce high pressure gas. Turning now to FIG. **12**, pressure within the setting tool **42** is greater than pressure within the switch compartment **220** which unbalances the movable isolator **208** and bias the movable isolator towards the switch compartment **220**. For clarity, the inner bore **312** of the igniter retainer **204** is fluidly connected to the setting tool **42** and therefore the pressure within the setting tool **42** is also the pressure within the inner bore **312**. The fluid pressure within the inner bore **312** urges the movable isolator **208** and seal assembly **248** towards the switch compartment **220**. The movement of the movable isolator **208** within the igniter compartment **222** towards the switch compartment **220** compresses the retaining spring **244** and extends the insulated pin connector **242** into the switch compartment **220**. The movement of the insulated pin connector **242** into the switch compartment **220** pushes the connector post **290** of the lower pin assembly **278** towards the spring retainer **294**, compresses the connector spring **292**, and moves the pin connector **288** into contact with the washer **316** of the grounding point assembly **314**. The contact of the pin connector **288** of the lower pin assembly **278** to the washer **316** of the grounding point assembly **314** grounds the igniter switch **274**. The grounding of the igniter switch **274** breaks communication with the surface personnel.

(58) Turning to a further embodiment of the present disclosure, FIGS. **13-15** illustrates a system **500** for setting a plug in a wellbore (e.g., setting plug **44** in the wellbore **14** shown in FIG. **1**). System **500** generally includes a setting tool **510** and a setting tool initiator **540** coupled to the setting tool **510**. System **500** may comprise additional equipment in other embodiments such as a plug (e.g., plug **44**) and/or other equipment of a wellbore deployable tool string (e.g., tool string **32** shown in FIG. **1**) not shown in FIGS. **13-15**.

(59) Setting tool **510** of system **500** generally includes a setting tool housing **512** and a piston **520** positioned within the setting tool housing **512** for axial or telescoping movement with respect to one another. Piston **520** defines an interior bore or opening that forms a combustion chamber **522** and receives a combustible element **530** configured, upon activation, to shift a plug from a first or run-in configuration that permits fluid flow around the plug within the wellbore and a second or set configuration that restricts fluid flow around the plug within the wellbore.

(60) Setting tool initiator **540** of system **500** generally includes an initiator housing **542**, a setting tool igniter switch **550**, and an igniter **560**. In this exemplary embodiment, a downhole end **543** of initiator housing **542** is connectable to an uphole end **574** of piston **520** and includes setting tool igniter switch **550** positioned within a central opening or passage **544** of initiator housing **542**. Generally, igniter **560** is configured to ignite or activate the combustible element **530** of setting tool **510** upon receiving a predefined ignition signal from the igniter switch **550** to thereby actuate setting tool **510** (driving the piston **520** axially relative to the setting tool housing **510**) and shift a corresponding plug coupled to setting tool **510** from the run-in configuration to the set configuration.

(61) In this exemplary embodiment, igniter **560** generally includes an igniter housing **562** and an igniter assembly **570** coupled to the igniter housing **562** and located downhole from the igniter switch **550** in the wellbore upon deployment. Igniter assembly **570** is in signal communication with igniter switch **550** and is positioned in an igniter compartment **564** formed within the igniter housing **562** as shown particularly in FIGS. **14** and **15**. In this exemplary embodiment, igniter assembly **570** is sealed within the igniter compartment **564** by one or more annular sealing

members or elements **566** (e.g., O-rings or other elastomeric seals) of igniter **560** that are positioned in the igniter compartment **564** radially between the outer diameter or periphery of the igniter assembly **570** and the inner diameter or surface defining the igniter compartment **564**. In this configuration, sealing elements **566** seal igniter switch **550** from igniter assembly **570** while also isolating the igniter switch **550** from the pressure and temperature created by the activation of igniter assembly **570** and combustible element **530**. In this manner, igniter switch **550** may survive the activation of igniter assembly **570**/combustible element **530** and the subsequent setting of the plug coupled therewith such that signal communication is preserved between the igniter switch **550** and a surface controller or control system (e.g., surface controller **13** shown in FIG. **1**) of system **500** along a signal communication path **501** of system **500** extending therebetween following the setting of the plug.

(62) In this exemplary embodiment, system **500** additionally includes a signal interrupter **580** interposed between the igniter switch **550** and igniter assembly **570** and in signal communication with both switch **550** and signal interrupter **580**. Generally, signal interrupter **580** is configured to break the signal connection or connectivity between the igniter switch **550** and the igniter assembly **570** in response to signal interrupter **580** encountering a predefined tool or toolstring condition. The predefined toolstring condition comprises one or more predefined physical conditions encountered by a tool string (e.g., tool string **32** shown in FIG. **1**) in a wellbore. In some embodiments, the toolstring condition comprises one or more physical conditions encountered by the signal interrupter **580** of a toolstring.

(63) The predefined toolstring condition may vary in different embodiments. For example, including, for example, a threshold toolstring pressure, a threshold toolstring temperature, a threshold toolstring force (e.g., a linear force, a rotational force or torque), a threshold toolstring acceleration, (e.g., in terms of G-forces and in the form of vibration, shock, and the like) encountered by the tool string/signal interrupter **580**. The predefined toolstring condition may correspond to anticipated conditions to be encountered by the signal interrupter **580** during the setting of the plug coupled to setting tool **510**, such as a result of the activation of igniter **570** and/or combustible element **530**. In other words, the toolstring condition may be generated through or in response to the setting of the plug coupled to setting tool **510** such as a rapid increase or spike in pressure, temperature, and/or vibration encountered by signal interrupter **580** in the wellbore. In this manner, signal interrupter **580** may act as a sensor configured to transition automatically from a first state (e.g., communicative—providing signal connectivity thereacross) to a second state (e.g., noncommunicative—preventing signal connectivity thereacross) in response to encountering the predefined toolstring condition without requiring destruction or physical damaging of the igniter switch **550** such that the igniter switch **550** may be reused in subsequent perforating operation or stage of a multi-stage perforating operation thereby minimizing the number of igniter switches **550** that must be acquired in order to perform a given perforating operation. Although signal interrupter **580** is shown as a separate component in FIGS. **13-15**, in other embodiments, signal interrupter **580** may comprise a component or feature of the resistor **574**.

(64) In some embodiments, igniter switch **550**, igniter assembly **570**, and signal interrupter **580** comprise electrical equipment with signal communication path **501** comprising an electrical circuit extending between the surface control system and downhole equipment including, for example, setting tool **510** and setting tool initiator **540**. In some embodiments, signal interrupter **580** comprises an electrical switch or circuit breaker configured to break the electrical circuit formed between igniter switch **550** and igniter assembly **570** upon encountering the predefined toolstring condition.

(65) As shown particularly in FIG. **15**, igniter assembly **570** has a central or longitudinal axis **575** and includes combustible element **572** and an activator in the form of a resistor **574** (e.g., a heat resistor) for selectably igniting or activating the combustible element **572** in response to the igniter assembly **570** receiving the ignition signal. Particularly, in this exemplary embodiment, resistor **574**

is for rapidly heating within the combustible element **572** of the igniter assembly **570**. The resistor **574** is an electrical element as known in the art heat up when sufficient electric power (carried by the ignition signal) is directed through resistor **574** to ignite the combustible element **572**.

(66) In this exemplary embodiment, igniter assembly **570** additionally includes an igniter bulkhead **590** and an igniter tube **594** that receives the combustible element **572** therein and is coupled to the igniter bulkhead **590**. Particularly, igniter bulkhead **590** is located at a longitudinal first or uphole end of igniter assembly **570** with igniter tube **594** extending from bulkhead **590** to a longitudinal second or downhole end of igniter assembly **570**. Igniter bulkhead **590** comprises materials configured to obstruct or minimize signal connectivity thereacross while igniter tube **594** may conversely comprise materials configured to enhance or maximize signal connectivity therethrough. For example, igniter bulkhead **590** may comprise an electrical resistor (e.g., comprising electrically resistive materials) while igniter tube **594** may comprise an electrical conductor (e.g., comprising electrically conductive materials).

(67) Igniter assembly **570** comprises a first or uphole signal connector **591** and a second or downhole signal connector **593** each coupled to the igniter bulkhead **590**. For example, signal connectors **591** and **593** may be arranged on opposing (e.g., uphole and downhole) ends of igniter bulkhead **590** for communicating signals (e.g., electrical signals) across the igniter bulkhead **590**. Particularly, in this exemplary embodiment, signal interrupter **580** is connected between the pair of signal connectors **591** and **593** such that signal connectors **591** and **593** are in signal communication through the signal interrupter **580** when signal interrupter **580** is in the first state but signal connectors **591** and **593** are not in signal communication (e.g., signal connectivity between connectors **591** and **593** is severed or broken) when signal interrupter **580** is in the second state (e.g., due to igniter bulkhead **590** comprising signal connectivity minimizing materials). In this exemplary embodiment, signal interrupter **580** is coupled to igniter bulkhead **590** and is radially offset from the central axis **575** of igniter assembly **570**.

(68) In this exemplary embodiment, prior to activation of igniter assembly **570**, signal communication path **501** of system **500** extends from the igniter switch **550** through an initiator signal connector **552** of setting tool initiator **540**, through uphole connector **591** of igniter assembly **570**, signal interrupter **580** and downhole signal connector **593**, and to the resistor **574** encapsulated within the combustible element **572** of igniter assembly **570**. From resistor **574**, signal communication path **501** extends to the igniter tube **594** (e.g., via a signal conductor extending therebetween) and from the igniter tube **594** to the igniter housing **562** via one or more radial signal connectors (e.g., electrical ground springs) **596** of the igniter tube **594** that are biased (e.g., via a biasing element) radially outwards into contact with the inner diameter or surface defining igniter compartment **564** of igniter housing **562**. In some embodiments, igniter housing **562** is grounded back to the surface along the periphery of the work string **30**.

(69) In some embodiments, signal interrupter **580** is configured to automatically shift from the first state to the second state and thereby disconnect signal connectors **591** and **593** (in-turn disconnecting igniter switch **550** from igniter assembly **570**) upon the signal interrupter **580** encountering a predefined threshold wellbore temperature. In certain embodiments, the threshold wellbore temperature corresponds to a first temperature anticipated to be encountered by the signal interrupter **580** in response to activation of the combustible element **572** of igniter assembly **570**. In other embodiments, the threshold wellbore temperature corresponds to a second temperature anticipated to be encountered by the signal interrupter **580** in response to activation of the combustible element **530** of setting tool **510** which may exceed the first temperature. In other words, the threshold wellbore temperature may, in some embodiments, be linked in some embodiments to activation of combustible element **572** whereby signal interrupter **580** is configured to shift from the first state to the second state in response to the activation of combustible element **572**. Conversely, in other embodiments the threshold wellbore temperature may instead be linked to activation of combustible element **530** whereby signal interrupter **580** is

configured to shift from the first state to the second state in response to the activation of combustible element **530** which follows the activation of combustible element **572** and generates significantly greater heat (and consequently greater wellbore temperatures) than the activation of combustible element **572**.

(70) It should be noted that igniter bulkhead **590** is preferably electrically non-conductive in some embodiments. However, an electric circuit is preferably arranged in some embodiments to extend around the igniter bulkhead **590** with a conductive electric first or lead-in connector **591** arranged to receive electric power and electric signals from the initiator signal connector **552**. In certain embodiments, the electric lead-in connector **591** is electrically connected to signal interrupter **580** by known means including conventional wiring. Similarly, in certain embodiments, the signal interrupter **580** is electrically connected to the conductive electric pass-through connector **593** which is itself electrically connected to the heat resistor **574**. In certain embodiments, resistor **574** is further electrically connected to the electrically conductive igniter tube **594** which is grounded to the igniter housing **562**.

(71) By shifting the signal interrupter **580** from the first state to the second state, the successful activation of combustible element **530**/**572** (depending on the configuration of the signal interrupter **580**) may be confirmed at the surface such as at the surface control system via the change that occurs to signal communication path **501** as a result of the shifting of signal interrupter **580** from the first state to the second state. Particularly, shifting of the signal interrupter **580** from the first state to the second state disconnects at least some components of igniter assembly **570** (e.g., resistor **574**) from signal communication path **501**, which may be detected at the surface control system that is connected to the signal communication path **501**. In addition, igniter switch **550** is protected from the effects of the activation of combustible element **530** and **572**, and thus may be reused in future operations in subsequent wellbores.

(72) Turning to another, but similar, embodiment shown in FIG. **16**, another system **600** for setting a plug in a wellbore (e.g., setting plug **44** in the wellbore **14** shown in FIG. **1**). System **600** generally includes a setting tool **610** and a setting tool initiator **640** coupled to the setting tool **610**. System **600** may comprise additional equipment in other embodiments such as a plug (e.g., plug **44**) and/or other equipment of a wellbore deployable tool string (e.g., tool string **32** shown in FIG. **1**) not shown in FIG. **16**.

(73) Setting tool **610** includes a setting tool housing **612** and a piston **620** positioned within the setting tool housing **612** for axial or telescoping movement with respect to one another. Piston **620** defines an interior bore or opening that forms a combustion chamber **622** and receives combustive element **530** configured, upon activation, to shift a plug coupled to setting tool **610** from a first or run-in configuration that permits fluid flow around the plug within the wellbore and a second or set configuration that restricts fluid flow around the plug within the wellbore.

(74) In this exemplary embodiment, setting tool initiator **640** comprises an igniter housing **642**, an igniter assembly **650** received in the igniter housing **642**, and a setting tool igniter switch or switch pod **660**. The igniter assembly **650** is connected to switch pod **660** by an igniter signal connector **616** positioned therebetween. In some embodiments, igniter assembly **650** is configured similarly as igniter assembly **570** shown in FIGS. **13-15**. For example, igniter assembly **650** annular sealing elements (e.g., sealing elements **566** shown in FIG. **15**) and a bulkhead (e.g., igniter bulkhead **590** shown in FIG. **15**) to protect the switch pod **660** for possible re-use in a subsequent tool string.

(75) While several embodiments have been provided in the present disclosure, it should be understood that the disclosed systems and methods may be embodied in many other specific forms without departing from the spirit or scope of the present disclosure. The present examples are to be considered as illustrative and not restrictive, and the intention is not to be limited to the details given herein. For example, the various elements or components may be combined or integrated in another system or certain features may be omitted or not implemented.

(76) Also, techniques, systems, subsystems, and methods described and illustrated in the various

embodiments as discrete or separate may be combined or integrated with other systems, modules, techniques, or methods without departing from the scope of the present disclosure. Other items shown or discussed as directly coupled or communicating with each other may be indirectly coupled or communicating through some interface, device, or intermediate component, whether electrically, mechanically, or otherwise. Other examples of changes, substitutions, and alterations are ascertainable by one skilled in the art and could be made without departing from the spirit and scope disclosed herein.

Claims

1. A system for setting a plug in a wellbore, the system comprising: a setting tool connectable to the plug and comprising a housing, a piston positioned at least partially within the housing, and a setting tool energetic element configured, upon activation, to displace the piston axially relative to the housing and shift the plug in the wellbore from a run-in configuration permitting fluid flow within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug; an initiator comprising an igniter switch and an igniter assembly in signal communication with the igniter switch, wherein the igniter assembly includes an igniter energetic element configured to activate, in response to receiving an ignition signal from the igniter switch, and thereby activate the setting tool energetic element to shift the plug from the run-in configuration to the set configuration; and wherein the initiator comprises a signal interrupter connected between the igniter switch and the igniter assembly and configured to shift automatically from a first state in which signal communication is provided through the signal interrupter between the igniter switch and the igniter assembly to a second state in which signal communication is restricted through the signal interrupter between the igniter switch and the igniter assembly in response to exposing the initiator to a predefined toolstring condition and whereby a surface indication is provided of the shifting of the plug to the set configuration.
2. The system according to claim 1, wherein the toolstring condition is based on an anticipated toolstring condition associated with at least one of the activations of the igniter energetic element and the setting tool energetic element.
3. The system according to claim 2, wherein the toolstring condition comprises a threshold wellbore temperature and the anticipated toolstring condition comprises at least one of a first anticipated toolstring temperature associated with the activation of the igniter energetic element, and a second anticipated toolstring temperature different from the first anticipated toolstring temperature and that is associated with the activation of the setting tool energetic element.
4. The system according to claim 1, wherein the toolstring condition comprises at least one of a threshold toolstring pressure, a threshold toolstring temperature, a threshold toolstring force, and a threshold toolstring acceleration.
5. The system according to claim 1, further comprising the plug connected to a downhole end of the setting tool.
6. The system according to claim 1, further comprising a surface control system is configured to deliver the ignition signal along an enclosed signal communication path to the igniter switch to cause the igniter switch to deliver the ignition signal to the igniter, wherein the signal communication path is arranged to provide two-way signal communication between the surface control system and the igniter switch when the igniter switch is positioned in the wellbore.
7. The system according to claim 1, wherein the second state of the signal interrupter does not permit electric power or electric signals to pass to the igniter assembly from the igniter switch.
8. The system according to claim 1, wherein the first state of the signal interrupter comprises a communicative state and the second state of the signal interrupter comprises a noncommunicative state.
9. The system according to claim 1, wherein the igniter assembly includes an activator configured

to ignite the igniter energetic element and that is in signal communication with the igniter switch when the signal interrupter is in the first state, and wherein the activator is exposed to combustion products generated from the activation of the igniter energetic element whereby the activator is disconnected from the igniter switch.

10. The system according to claim 9, wherein the activator comprises an electrical heat resistor.

11. The system according to claim 9, wherein the signal interrupter comprises an electrical circuit breaker electrically connected to the igniter switch and the igniter assembly when in the first state and electrically disconnected from the igniter switch when in the second state.

12. The system according to claim 11, wherein the circuit breaker is configured to remain in the first state until exposed to combustion products from the activation of at least one of the igniter energetic element and the setting tool energetic element.

13. The system according to claim 1, wherein the igniter switch is sealed from the igniter assembly when the signal interrupter is in both the first state and the second state.

14. A system for setting a plug in a wellbore, the system comprising: a setting tool connectable to the plug and comprising a housing, a piston positioned at least partially within the housing, and a setting tool energetic element configured, upon activation, to displace the piston axially relative to the housing and shift the plug in the wellbore from a run-in configuration permitting fluid flow within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug; an initiator comprising an igniter assembly and an igniter switch in signal communication with and sealed from the igniter switch, wherein the igniter assembly includes an igniter energetic element configured to activate, in response to receiving an ignition signal from the igniter switch, and thereby activate the setting tool energetic element to shift the plug from the run-in configuration to the set configuration; and a surface control system in signal communication with the initiator and configured to transmit the ignition signal to the igniter switch, and to provide a surface indication of the shifting of the plug from the run-in configuration to the set configuration with the igniter switch remaining sealed from the igniter assembly.

15. The system according to claim 14, wherein the initiator is configured to shift automatically from a first state in which signal communication is provided between the igniter switch and the igniter assembly to a second state in which signal communication is restricted between the igniter switch and the igniter assembly in response to exposing the initiator to a predefined toolstring condition.

16. The system according to claim 15, wherein the igniter switch is in signal communication with the surface control system when the initiator is in both the first state and the second state.

17. The system according to claim 15, wherein the igniter assembly is not in signal communication with the surface control system when the initiator is in the second state.

18. The system according to claim 15, wherein the toolstring condition comprises at least one of a threshold toolstring pressure, a threshold toolstring temperature, a threshold toolstring force, and a threshold toolstring acceleration.

19. The system according to claim 14, further comprising an enclosed signal communication path extending between the surface control system and the initiator and arranged to provide two-way signal communication between the surface control system and the igniter switch when the igniter switch is positioned in the wellbore.

20. The system according to claim 19, wherein the signal communication path comprises an electrical circuit.

21. The system according to claim 19, wherein the surface indication corresponds to a disconnection of the igniter assembly from the signal communication path.

22. A system for setting a plug in a wellbore, the system comprising: a setting tool connectable to the plug and comprising a housing, a piston positioned at least partially within the housing, and a setting tool energetic element configured, upon activation, to displace the piston axially relative to the housing and shift the plug in the wellbore from a run-in configuration permitting fluid flow

within the wellbore around the plug to a set configuration restricting fluid flow in the wellbore around the plug; an initiator comprising an igniter switch and an igniter assembly in signal communication with the igniter switch, wherein the igniter assembly includes an igniter energetic element configured to activate, in response to receiving an ignition signal from the igniter switch, and thereby activate the setting tool energetic element to shift the plug from the run-in configuration to the set configuration; and wherein the initiator comprises an electrical circuit breaker electrically connected between the igniter switch and the igniter assembly and configured to shift automatically from a first state in which electrical signal communication is provided through the circuit breaker between the igniter switch and the igniter assembly to a second state in which electrical signal communication is restricted through the signal interrupter between the igniter switch and the igniter assembly in response to shifting the plug from the run-in configuration to the set configuration and whereby a surface indication is provided of the shifting of the plug to the set configuration.

23. The system according to claim 22, wherein the igniter assembly includes an activator configured to ignite the igniter energetic element and that is in signal communication with the igniter switch when the circuit breaker is in the first state, and wherein the activator is exposed to combustion products generated from the activation of the igniter energetic element whereby the activator is disconnected from the igniter switch.

24. The system according to claim 22, wherein the circuit breaker is configured to remain in the first state until exposed to combustion products from the activation of at least one of the igniter energetic element and the setting tool energetic element.

25. The system according to claim 22, further comprising a surface control system is configured to deliver the ignition signal along an electrical circuit to the igniter switch to cause the igniter switch to deliver the ignition signal to the igniter assembly, wherein the electrical circuit is arranged to provide two-way electrical signal communication between the surface control system and the igniter switch when the igniter switch is positioned in the wellbore.