

SUMMARY

[0004] In at least one aspect, the disclosure relates to a monitor for a blowout preventer of a wellbore. The blowout preventer includes a housing, at least one ram slidably positionable in the housing to form a seal about the wellbore, and an actuator. The actuator comprises a cylinder with a piston slidably movable therein. The piston is operatively connectable with the at least one ram and movable therewith. The monitor includes a monitor base operatively connectable to the cylinder, ~~(the monitor base having an interior side inside the cylinder and an exterior side outside the cylinder)~~; an interior plate positionable inside the cylinder about the interior side of the base, ~~(the interior plate operatively connectable to the piston and movable therewith)~~; an exterior plate positionable outside the cylinder about the exterior surface of the monitor base, ~~(the exterior plate coupled by magnets to the interior plate and rotatable therewith)~~; and a trigger sensor operatively connectable about the monitor base and the exterior plate to detect rotation thereof whereby a position of the ram may be determined.

[0005] The monitor may also include a cable operatively connecting the interior plate to the piston. The interior plate may include a pulley wheel, with the cable disposable about the pulley wheel. The interior plate may include a cover with a hole to pass the cable therethrough, and/or a rotary spring. The monitor base may have an interior pocket to receive the interior plate, and may have a shaft operatively connectable to the interior plate. The trigger sensor may include a sensor base and a trigger, the sensor base may be operatively connectable to the monitor base and have a rod extending into the exterior plate, and the trigger may be positionable about the exterior plate to deflect the rod to an offset position detectable by the sensor base as the exterior plate rotates whereby a position of the ram may be determined.

[0006] The exterior plate may have a trigger pocket therein to receive the trigger, the trigger may include a spring and a plunger, with the plunger urged by the spring against the rod, the trigger sensor may include a bearing positionable in the exterior plate and having a hole therethrough to receive the rod, with the trigger engagable with the bearing to deflect the rod, and/or the sensor base may be fixedly positioned in a sensor receptacle of the monitor base with the rod deflectingly extending from the sensor base. The rod tip of the rod may extend from the sensor base into the trigger pocket, and the rod tip may be movable in the trigger pocket as the interior plate rotates.

[0007] The trigger sensor may include a sensor base operatively connectable to the monitor base and having a rod extending to the exterior plate to detect keys along a periphery thereof. The keys may include teeth, and/or black and white portions. The exterior plate may include base plate and the ring, and a dial operatively connectable to the base plate and movable therewith. The exterior plate may be rotatable via the magnets with the interior plate, and the exterior plate may have a dial thereon rotatable with the interior plate. The trigger sensor may include a strain gauge. The magnets may include interior magnets operatively connectable between the interior plate and the monitor base. The magnets may include exterior magnets operatively connectable between the exterior plate and the monitor base. The monitor base may include an end cap of the cylinder. The monitor may also include at least one seal, and/or an accelerometer.

[0008] ~~In yet another aspect, the~~ The disclosure also relates to a monitoring system for a wellbore penetrating a subterranean formation. The system includes a blowout preventer positionable about the wellbore and a monitor operatively connectable with the blowout preventer. The blowout preventer includes a housing, at least one ram slidably positionable in the housing to form a seal about the wellbore, and an actuator comprising cylinders with pistons slidably movable therein. The piston is operatively connectable with the at least one ram and movable therewith. The monitor includes a monitor base, an interior plate, an exterior plate, and a trigger sensor. The monitor base is operatively connectable to the cylinder and has an interior side inside the cylinder and an exterior side outside the cylinder. The interior plate is positioned inside the cylinder about the interior side of the base, and is operatively connectable to the piston and movable therewith. The exterior plate is positioned outside the cylinder about the exterior surface of the monitor base, and is coupled by magnets to the interior plate and is movable therewith. The trigger sensor is operatively connectable to the monitor base, and has a rod positionable about the exterior plate to detect rotation thereof whereby a position of the ram may be determined. The system may include an inspector and/or a controller operatively connectable to the trigger sensor. The inspector may be a remote operated vehicle and/or an operator.

[0009] In yet another aspect, the disclosure relates to a method of monitoring a blowout preventer of a wellbore penetrating a subterranean formation. The blowout preventer includes a housing, at least one ram slidably positionable in the housing to form a seal about the wellbore, and an actuator comprising cylinders with pistons slidably movable therein. The piston is

operatively connectable with the at least one ram and movable therewith. The method involves operatively connecting a monitor including a monitor base, an interior plate, an exterior plate, and a trigger sensor to the blowout preventer by operatively connecting the monitor base to the cylinder, an interior plate about an interior surface of the monitor base, and an exterior plate about an exterior surface of the monitor base. The method further involves rotating the interior plate with the rams via a cable, rotating the exterior plate with the interior plate via the magnets, and determining a position of the rams by sensing rotation of the exterior plate with the trigger sensor.

[0010] The method may also include collecting data from the trigger sensor, passing data from the trigger sensor to a surface unit, and/or adjusting the blowout preventer based on the determining. The trigger sensor may include a sensor base positionable in the monitor base and a rod extending from the sensor base into the exterior plate and the determining may involve detecting a position of the exterior plate by deflecting the rod and measuring a position of the rod with the sensor base during the rotating. The trigger sensor may include a sensor base positionable in the monitor base and a rod extending from the sensor base into the exterior plate, and the determining may involve detecting a position of the exterior plate by detecting keys along a periphery of the exterior plate with the trigger sensor.

[0011] ~~In another aspect, the~~ The invention disclosure also relates to a blowout preventer for sealing a tubular of a wellbore. The wellbore penetrates a subterranean formation. The blowout preventer has a housing having a bore therethrough for receiving the tubular, at least one ram slidably positionable in the housing (each of the rams having a ram block for sealing engagement about the tubular), an actuator for selectively driving the ram block (the actuator having a piston slidably positionable in a cylinder), and a monitor for detecting the piston therein. The monitor includes a visual indicator on an exterior of the cylinder. The visual indicator is operatively coupled to the piston for displaying a position of the piston as the piston travels within the cylinder whereby a position of the ram may be determined.

[0012] The visual indicator may have a cable operatively connected to the piston. The cable may be operatively connectable to a dial via a pulley and rotatable thereby as the piston moves within the cylinder. The visual indicator may also have at least one gear for operatively coupling the pulley to the dial. The visual indicator may have a magnetic coupler for coupling the dial to the pulley. The visual indicator may have a housing integral with the cylinder. The visual

indicator may also have a plurality of flags positioned on a flag rod. The plurality of flags may be selectively raisable as the piston passes adjacent thereto. The visual indicator may have a magnet slidably positionable on a guide in response to a magnet on the piston passing adjacent thereto. The visual indicator may have a transparent case with a plurality of metal filings movably positionable therein in response to a magnet on the piston passing adjacent thereto. The visual indicator may have a transparent case with a magnetic indicator movably positionable therein in response to a magnet on the piston passing adjacent thereto. The blowout preventer may also have a visual sensor for detecting the visual indicator.

[0013] The blowout preventer may also have an electrical indicator for detecting a position of the piston. The electrical indicator may have a magnet slidably positionable on a guide in response to a magnet on the piston passing adjacent thereto, and at least one Hall Effect sensor for detecting a position of the magnet on the guide. The electrical indicator may be an inductive resistance sensor comprising a coil disposed about the cylinder. The electrical indicator may have a top end ultrasonic sensor at a top end of the cylinder and a bottom end ultrasonic sensor at a bottom end of the cylinder for detecting the piston when adjacent thereto. The electrical indicator may have an ultrasonic limit sensor. The electrical indicator may be a laser sensor. The electrical indicator may have a capacitive displacement sensor. The electrical indicator may be a sonar sensor for emitting sonar waves and sensing the waves rebounded by the piston. The electrical indicator may have at least one proximity sensor. The electrical indicator may have a flow sensor for detecting the flow of fluid through a chamber of the cylinder as the piston passes therein.

[0014] ~~In yet another aspect, the~~ The invention disclosure also relates to a system for sealing a tubular of a wellbore. The system has a blowout preventer and an inspector for inspecting visual indicator. The blowout preventer has a housing having a bore therethrough for receiving the tubular, at least one ram slidably positionable in the housing (each of the rams having a ram block for sealing engagement about the tubular), an actuator for selectively driving the ram block (the actuator having a piston slidably positionable in a cylinder), and a monitor for detecting the piston therein. The monitor includes a visual indicator on an exterior of the cylinder. The visual indicator is operatively coupled to the piston for displaying a position of the piston as the piston travels within the cylinder whereby a position of the ram may be determined.

[0015] The blowout preventer has a housing having a bore therethrough for receiving the tubular, at least one ram slidably positionable in the housing (each of the rams having a ram block for sealing engagement about the tubular), an actuator for selectively driving the ram block (the actuator having a piston slidably positionable in a cylinder), and a monitor for detecting the piston therein. The monitor includes a visual indicator on an exterior of the cylinder. The visual indicator is operatively coupled to the piston for displaying a position of the piston as the piston travels within the cylinder whereby a position of the ram may be determined.

[0016] The inspector may be a human or a remote operated vehicle (ROV). The system may also have a surface unit for receiving data from the monitor, an electrical indicator for detecting a position of the piston, a receiver for communicating signals with the electrical indicator, and/or at least one sensor for detecting wellsite parameters.

[0017] ~~In yet another aspect, the~~ The invention disclosure also relates to a method of monitoring a blowout preventer. The method involves positioning the blowout preventer about a tubular, activating at least one of the visual indicators of the monitor as the piston passes adjacent thereto, and inspecting the visual indicators. The blowout preventer has a housing having a bore therethrough for receiving the tubular, at least one ram slidably positionable in the housing (each of the rams having a ram block for sealing engagement about the tubular), an actuator for selectively driving the ram block (the actuator having a piston slidably positionable in a cylinder), and a monitor for detecting the piston therein. The monitor includes a visual indicator on an exterior of the cylinder. The visual indicator is operatively coupled to the piston for displaying a position of the piston as the piston travels within the cylinder whereby a position of the ram may be determined. The method may also involve sensing a position of the piston with an electrical indicator, manually viewing the visual indicators, sensing the visual indicator for activation, and/or passing data from the monitor to a surface unit.

[0018] ~~Finally, in yet another aspect, the~~ The invention disclosure also relates to a blowout preventer for sealing a tubular of a wellbore. The blowout preventer includes a housing having a bore therethrough for receiving the tubular, at least one ram slidably positionable in the housing (each of the at least one rams having a ram block for sealing engagement about the tubular), an actuator for selectively driving the ram block (the actuator comprising a piston slidably positionable in a cylinder), and a monitor for detecting the piston. The monitor has a housing with a cable therein. The cable is operatively connectable to the piston and movable therewith

- ~~24. — A monitoring system for a wellbore penetrating a subterranean formation, the system comprising:~~
- ~~a blowout preventer positionable about the wellbore, the blowout preventer comprising:~~
 - ~~a housing;~~
 - ~~at least one ram slidably positionable in the housing to form a seal about the wellbore; and~~
 - ~~an actuator comprising cylinders with pistons slidably movable therein, the piston operatively connectable with the at least one ram and movable therewith;~~
 - ~~a monitor operatively connectable with the blowout preventer, comprising:~~
 - ~~a monitor base operatively connectable to the cylinder, the monitor base having an interior side inside the cylinder and an exterior side outside the cylinder;~~
 - ~~an interior plate positioned inside the cylinder about the interior side of the base, the interior plate operatively connectable to the piston and movable therewith;~~
 - ~~an exterior plate positionable outside the cylinder about the exterior surface of the monitor base, the exterior plate coupled by magnets to the interior plate and rotatable therewith; and~~
 - ~~a trigger sensor operatively connectable about the monitor base and the exterior plate to detect rotation thereof whereby a position of the ram may be determined.~~
- ~~25. — The system of Claim 24, further comprising an inspector.~~
- ~~26. — The system of Claim 25, wherein the inspector is one of a remote operated vehicle, an operator, and combinations thereof.~~
- ~~27. — The system of Claim 24, further comprising a controller operatively connectable to the trigger sensor.~~

29.24. A method of monitoring a blowout preventer of a wellbore penetrating a subterranean formation, the blowout preventer comprising a housing, at least one ram slidably positionable in the housing to form a seal about the wellbore, and an actuator comprising cylinders with pistons slidably movable therein, the piston operatively connectable with the at least one ram and movable therewith, the method comprising:

operatively connecting a monitor comprising a monitor base, an interior plate, an exterior plate, and a trigger sensor to the blowout preventer by operatively connecting the monitor base to the cylinder, an interior plate about an interior surface of the monitor base, and an exterior plate about an exterior surface of the monitor base; rotating the interior plate with the rams via a cable; rotating the exterior plate with the interior plate via the magnets, and determining a position of the rams by sensing rotation of the exterior plate with the trigger sensor.

~~30. The method of Claim 29, further comprising collecting data from the trigger sensor.~~

~~31. The method of Claim 29, further comprising passing data from the trigger sensor to a surface unit.~~

~~32. The method of Claim 29, further comprising adjusting the blowout preventer based on the determining.~~

~~33. The method of Claim 29, wherein the trigger sensor comprises a sensor base positionable in the monitor base and a rod extending from the sensor base into the exterior plate and wherein determining comprises detecting a position of the exterior plate by deflecting the rod and measuring a position of the rod with the sensor base during the rotating.~~

~~34. The method of Claim 29, wherein the trigger sensor comprises a sensor base positionable in the monitor base and a rod extending from the sensor base into the exterior plate and wherein determining comprises detecting a position of the exterior plate by detecting keys along a periphery of the exterior plate with the trigger sensor.~~