NESTED CYLINDER COMPACT BLOWOUT PREVENTER

BACKGROUND OF THE INVENTION

The present invention relates generally to a compact blowout preventer used in the oil and gas industry. Specifically, the invention relates to a compact blowout preventer featuring a nested cylinder actuator and ram system wherein the overall outer diameter of the device is reduced by combining the ram and actuator cylinder, and increasing the actuator piston area with a second nested cylinder and piston.

Blowout preventers are used in the subsea oil and gas production industry to seal the well bore in the event of a blowout. The blowout preventer ("BOP") may be mounted on a subsea wellhead or christmas tree or located on a surface vessel and connected to the subsea wellhead or christmas tree via a riser. During installation and workover operations, a workover string, such as drill pipe, wireline or coiled tubing, may be lowered through the BOP and into the well bore. In the event of a blowout during any of these operations, the BOP must therefore be able to seal the well bore in the presence of the workover string.

Typical ram-type BOP's normally include an elongated housing, a BOP bore which extends axially through the housing and a pair of opposing BOP rams which are movable laterally across the BOP bore toward and away from each other. The BOP rams are normally actuated by respective pistons which move perpendicular to the BOP bore and are therefore mounted in ram housings which extend laterally from the BOP housing. As a result, these types of BOP's tend to be quite large. For example, one known prior art 10,000 psi surface BOP having a 13 5/8" BOP bore comprises an envelope outer diameter of about 120 inches. Such BOP's require that the surface vessel be equipped with a correspondingly large rotary table to enable the BOP to pass through. However, surface vessels of this size are very expensive to operate.

SUMMARY OF THE INVENTION

In accordance with embodiments of the present invention, these and other limitations in the prior art are addressed by providing a blowout preventer which comprises the novel features described and claimed below.

According to an aspect, there is provided a blowout preventer which comprises: an elongated BOP housing; a BOP bore which extends axially through the BOP housing; and a pair of ram assemblies which are mounted on diametrically opposite sides of the BOP housing, each ram assembly comprising: a cylinder housing which comprises a recess that extends generally transversely relative to the BOP bore from a radially inner end of the cylinder housing to a transverse first wall located at a radially outer end of the cylinder housing; a cylinder-ram which is slidably received in the recess and which comprises a cavity that extends from a radially outer end of the cylinder-ram to a transverse second wall located at a radially inner end of the cylinder-ram; a back plate which is connected to or formed integrally with the outer end of the cylinder-ram, the cylinder-ram being sealed to the cylinder housing proximate the back plate; a piston head which is positioned in the cavity between the second wall and the back plate and is sealed to the cylinder-ram, the piston head being connected to the cylinder housing; a first piston chamber which is defined between the back plate and the first wall; and a second piston chamber which is defined between the piston head and the second wall; wherein application of hydraulic pressure to the first and second piston chambers will move the cylinder ram from an open position in which the cylinder-ram is retracted from the BOP bore to a closed position in which the cylinder-ram extends across the BOP bore to approximately the centerline of the BOP bore.

In one illustrative embodiment of the invention, the blowout preventer comprises an elongated BOP housing, a BOP bore which extends axially through the BOP housing, and a pair of ram assemblies which are mounted on

piston head and the back plate. Thus, application of hydraulic pressure to the third piston chamber will move the cylinder ram from the closed position to the open position.

The hydraulic pressure for the third piston chamber may be conveyed through a first fluid passage which extends through the piston head. In addition, in the event the piston head is connected to a corresponding support rod which extends through a hole in the back plate and is connected to the cylinder housing, the hydraulic pressure may be conveyed through a second fluid passage which extends through the support rod and is connected to the first fluid passage.

Thus, the cylinder-ram is moved from its open position to its closed position not only by pumping hydraulic fluid into the first piston chamber, but also by conveying this hydraulic fluid into the second piston chamber. In this manner, a combined actuating force is generated on the cylinder-ram. A first actuating force is generated by the application of hydraulic pressure between the back plate and the cylinder housing. A second actuating force is generated by the application of the hydraulic pressure between the front wall and the internal piston head (which is connected to the cylinder housing). This combined force is substantially greater than can be achieved in prior art pistons of similar size. In effect, the combined force is equivalent to a force generated by application of the hydraulic pressure to a single piston having the combined area of the front wall and the back plate.

Also, the unique design of the ram assemblies of the present invention effectively reduces the outer diameter envelope of the BOP. The combined actuating force acting on the cylinder-ram is achieved through the use of a piston actuator which comprises a nested cylinder arrangement. In this arrangement, the cylinder housing defines a first cylinder and the cylinder-ram defines a second cylinder which is nested within the first cylinder. As a result, the BOP is capable of shearing relatively large diameter workover strings without requiring a correspondingly large outer diameter envelope.

These and other embodiment~~objects~~s and advantages of the present invention will be made apparent from the following detailed description, with reference to the accompanying drawings.