Steerable Drilling System

This invention relates to a steerable drilling system for use in the formation of boreholes for example for subsequent use in the extraction of hydrocarbons.

GB 2399121 describes a steerable drilling system in which a bottom hole assembly incorporates a swivel or universal joint located between an upper section and a steering section thereof. A downhole motor is located in the upper section and drives a drill bit carried by the steering section for rotation. A series of pistons are provided on the upper section, the pistons being operable to adjust the angle of the axis of the steering section relative to that of the upper section.

It is an object of the invention to provide a steerable drilling system of this general type and which is of simple and convenient form.

According to a first aspect, there is provided a steerable drilling system comprising a bottom hole assembly including an upper section and a steering section for rotating a drill bit, a swivel permitting adjustment of the orientation of an axis of the steering section relative to an axis of the upper section, a downhole motor operative to drive the steering section for rotation relative to the upper section, and a plurality of actuators positioned around the upper section and within the steering section, the plurality of actuators being operable to control the orientation of the axis of the steering section relative to the axis of the upper section, the actuators being mounted upon one of the steering section and the upper section, and being arranged to act in a radial direction against the other of the steering section and the upper section.

A high speed sliding contact may be formed between the actuators and the said other of the steering section of the upper section.

The high speed sliding contact may form a hydrodynamic bearing, thereby avoiding excessive wear of the actuators and/or surfaces contacted thereby.

The actuators preferably comprise pistons, for example arranged to be driven using drilling fluid or mud. Fluid may be supplied through the pistons to lubricate the contact between the pistons and the said other of the steering section and the upper section.

Alternatively, a rolling bearing arrangement may be provided between the actuators and the said other of the steering section and the upper section. A compliant material may be incorporated into the bearing arrangement to accommodate angular movement of the steering section relative to the upper section about the swivel.

The downhole motor may take a range of forms. For example it may comprise a drilling fluid or mud powered motor, a turbine, or an electrically powered motor.

According to a second aspect, there is provided a method for steering during drilling of a wellbore, comprising: providing a bottom hole assembly with an upper section and a steering section; connecting the upper section and the steering section with a swivel which permits adjustment of the orientation of an axis of the steering section relative to an axis of the upper section; using a downhole motor to drive the steering section for rotation relative to the upper section during drilling of the wellbore; and controlling the orientation of the axis of the steering section relative to the axis of the upper section with a plurality of actuators positioned around the upper section and within

the steering section to act in a radial direction between the steering section and the upper section.

The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a drilling rig incorporating a steerable drilling system according to one embodiment of the invention;

CLAIMS

1. A steerable drilling system comprising a bottom hole assembly including an upper section and a steering section for rotating a drill bit, a swivel permitting adjustment of the orientation of an axis of the steering section relative to an axis of the upper section, a downhole motor operative to drive the steering section for rotation relative to the upper section, and a plurality of actuators positioned around the upper section and within the steering section, the plurality of actuators being operable to control the orientation of the axis of the steering section relative to the axis of the upper section, the actuators being mounted upon one of the steering section and the upper section, and being arranged to act in a radial direction against the other of the steering section and the upper section.

2. A system according to claim 1, wherein a high speed sliding contact is formed between the actuators and the said other of the steering section and the upper section.

3. A system according to claim 1, wherein a roller bearing arrangement is provided between the actuators and the said other of the steering section and the upper section.

4. A system according to claim 3, wherein the roller bearing arrangement incorporates a compliant material element.

5. A system according to claim 1, wherein the actuators comprise pistons.

6. A system according to claim 5, wherein the pistons define flow passages.

7. A system according to claim 1, wherein the actuators include lead screw arrangements.

8. A system according to claim 1, wherein the actuators are aligned with one another at a common distance from the swivel.

9. A system according to claim 1, wherein the swivel is adapted to permit the transmission of a weight on bit loading to the steering section.

10. A system according to claim 1, wherein the motor comprises one of a mud motor, a turbine and an electrically powered motor.

11. A system according to claim 1, further comprising a stabilizer mounted on the steering section.

12. A method for steering during drilling of a wellbore, comprising: providing a bottom hole assembly with an upper section and a steering section; connecting the upper section and the steering section with a swivel which permits adjustment of the orientation of an axis of the steering section relative to an axis of the upper section; using a downhole motor to drive the steering section for rotation relative to the upper section during drilling of the wellbore; and controlling the orientation of the axis of the steering section relative to the axis of the upper section with a plurality of actuators positioned around the upper section and within the steering section to act in a radial direction between the steering section and the upper section.

13. The method according to claim 12, further comprising forming a high-speed sliding contact between the plurality of actuators and one of the steering section and the upper section.

14. The method according to claim 12, further comprising utilizing a flexible pipe to provide a supply of fluid through the universal joint to the steering section.

15. The method according to claim 14, further comprising utilizing a valve system to control the supply of fluid to the plurality of actuators.

16. The method according to claim 15, wherein utilizing comprises utilizing a rotary valve.

17. The method according to claim 15, wherein utilizing comprises utilizing at least one bistable valve.

18. The method according to claim 12, further comprising employing an angle sensor to sense the angle of the steering section relative to the upper section.