CLAIMS

1. An apparatus for investigating a formation, comprising:

a caliper adapted to be suspended into a formation such that an axis of the caliper is substantially parallel with the longitudinal axis of the formation, wherein the caliper comprises:

a transmitter for transmitting a transmitted pulse signal;

a detector for detecting a reflected pulse signal, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

a means for determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

a means for rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper, wherein the transmitter comprises a sonar head, wherein the sonar head transmits in the range 50 kHz-300 kHz.

2. The apparatus according to claim 1, wherein the formation is a borehole.

3. The apparatus according to claim 1, further comprising:

a means for raising and lowering the caliper in the formation, wherein raising and lowering the caliper in the formation causes the target location on the surface of the formation to raise and lower, respectively.

4. The apparatus according to claim 3, further comprising:

a means for controlling the rotation of the transmitter and detector and the raising and lowering of the caliper such that the first pulse signal is incident on a plurality of target locations

on the surface of the formation, and a means for producing a representation of a portion of the formation corresponding to the plurality of target locations on the surface of the formation onto which the transmitter signal is incident.

5. The apparatus according to claim 1, wherein the caliper further comprises a compass.

6. The apparatus according to claim 1, wherein the caliper further comprises a gyroscopic stabilizer.

7. The apparatus according to claim 1, further comprising a means for determining the speed of the transmitted pulse signal.

8. The apparatus according to claim 7, wherein the means for determining the speed of the transmitted pulse signal comprises an object a known distance from the transmitter wherein the speed of the transmitted pulse signal is the distance from the transmitter to the object and back to the detector divided by the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal from the object.

9. The apparatus according to claim 1, further comprising a means for determining the density of a fluid the transmitted pulse signal travels into the target location.

10. The apparatus according to claim 9, wherein the means for determining the density of the fluid the transmitted pulse signal travels in comprises a pressure measuring device.

11. The apparatus according to claim 1, wherein the caliper further comprises an inclinometer.

12. The apparatus according to claim 1, further comprising a means for mapping the dimensions and topography of the formation.

13. An apparatus for investigating a formation, comprising:

a caliper adapted to be suspended into a formation such that an axis of the caliper is substantially parallel with the longitudinal axis of the formation, wherein the caliper comprises:

a transmitter for transmitting a transmitted pulse signal;

a detector for detecting a reflected pulse signal, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

a means for determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

a means for rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper, wherein the transmitter comprises a laser light source.

14. An apparatus for investigating a formation, comprising:

a caliper adapted to be suspended into a formation such that an axis of the caliper is substantially parallel with the longitudinal axis of the formation, wherein the caliper comprises:

a transmitter for transmitting a transmitted pulse signal;

a detector for detecting a reflected pulse signal, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

a means for determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

a means for rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper, wherein the transmitter comprises a sonar head, wherein the sonar head transmits in the range 500 kHz-800kHz.

15. An apparatus for investigating a formation, comprising:

a caliper adapted to be suspended into a formation such that an axis of the caliper is substantially parallel with the longitudinal axis of the formation, wherein the caliper comprises:

a transmitter for transmitting a transmitted pulse signal;

a detector for detecting a reflected pulse signal, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

a means for determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

a means for rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper, wherein the transmitter comprises a sonar head, wherein the sonar head transmits in the range 1.0 MHz-1.5 MHz.

16. An method for investigating a formation, comprising:

suspending a caliper into a formation such that an axis of the caliper is substantially parallel with the longitudinal axis of the formation,

transmitting a transmitted pulse signal from a transmitter on the caliper;

detecting a reflected pulse signal with a detector on the caliper, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper, wherein the formation has a diameter in the range 1.5 feet to 20 feet.

17. The method according to claim 16, wherein the formation is a borehole.

18. The method according to claim 16, further comprising:

raising and lowering the caliper in the formation, wherein raising and lowering the caliper in the formation causes the target location on the surface of the formation to raise and lower, respectively.

19. The method according to claim 18, further comprising:

controlling the rotation of the transmitter and detector and the raising and lowering of the caliper such that the first pulse signal is incident on a plurality of target locations on the surface of the formation, and producing a representation of a portion of the formation corresponding to the plurality of target locations on the surface of the formation onto which the transmitter signal is incident.

20. The method according to claim 16, wherein the transmitter comprises a laser light source.

21. The method according to claim 16, wherein the transmitter comprises a sonar head.

22. The method according to claim 16, wherein the caliper further comprises a compass.

23. The method according to claim 16, wherein the caliper further comprises a gyroscopic stabilizer.

24. The method according to claim 16, further comprising determining the speed of the transmitted pulse signal.

25. The method according to claim 24, wherein determining the speed of the transmitted pulse signal comprises positioning an object a known distance from the transmitter wherein the speed of the transmitted pulse signal is the distance from the transmitter to the object and back to the detector divided by the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal from the object.

26. The method according to claim 21, wherein the sonar head transmits in the range 50 kHz-300 kHz.

27. The method according to claim 21, wherein the sonar head transmits in the range 500 kHz-800kHz.

28. The method according to claim 21, wherein the sonar head transmits in the range 1.0 MHz-1.5 MHz.

29. The method according to claim 16, further comprising determining the density of a fluid the transmitted pulse signal travels into the target location.

30. The method according to claim 29, wherein determining the density of the fluid the transmitted pulse signal travels in comprises measuring the pressure in the fluid the transmitted pulse signal travels in.

31. The method according to claim 16, wherein the caliper further comprises an inclinometer.

32. The method according to claim 16, wherein the formation has a diameter in the range 3 feet to 12 feet.

33. The method according to claim 16, further comprising mapping the dimensions and topography of the formation.

34. The apparatus according to claim 1, wherein the longitudinal axis of the formation is vertical, wherein the caliper is adapted to be suspended into the formation such that the axis of the caliper is substantially vertical.

35. The method according to claim 16, wherein the longitudinal axis of the formation is vertical, wherein the caliper is adapted to be suspended into the formation such that the axis of the caliper is substantially vertical.

CLAIMS

1. An apparatus for investigating a formation, comprising:

a caliper adapted to be suspended into a formation such that an axis of the caliper is substantially vertical when the caliper is suspended into the formation, wherein the caliper comprises:

a transmitter for transmitting a transmitted pulse signal;

a detector for detecting a reflected pulse signal, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

a means for determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

a means for rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper; and

a means for mapping the dimensions and topography of the formation.

2. The apparatus according to claim 1, wherein the formation is a borehole.

3. The apparatus according to claim 1, further comprising:

a means for raising and lowering the caliper in the formation, wherein raising and lowering the caliper in the formation causes the target location on the surface of the formation to raise and lower, respectively.

4. The apparatus according to claim 3, further comprising:

a means for controlling the rotation of the transmitter and detector and the raising and lowering of the caliper such that the first pulse signal is incident on a plurality of target locations on the surface of the formation, and a means for producing a representation of a portion of the formation corresponding to the plurality of target locations on the surface of the formation onto which the transmitter signal is incident.

5. The apparatus according to claim 3, further comprising:

one or more guide cables for guiding the caliper as the caliper is raised and/or lowered in the formation, wherein the one or more guide cables allow the position of the caliper to be controlled as the caliper is raised and/or lowered in the formation.

6. The apparatus according to claim 1, wherein the transmitter comprises a laser light source.

7. The apparatus according to claim 1, wherein the transmitter comprises a sonar head.

8. The apparatus according to claim 5, wherein the one or more guide cables are weighted to fall plumb into the formation.

9. The apparatus according to claim 8, wherein at least one of the one or more guide cables is weighted with an inclinometer for providing an output signal indicative of the orientation of the at least one guide cable.

10. The apparatus according to claim 5, further comprising a means for raising and/or lowering the caliper up and down the at least one of the one or more guide cables by gripping on the at least one guide cable.

11. The apparatus according to claim 5, wherein the caliper is attached to at least one of the one or more guide cables, wherein the means for raising and lowering the caliper comprises a means for raising and lowering the at least one guide cable attached to the caliper such that

raising and lowering the at least one guide cable attached to the caliper raises and lowers the caliper.

12. The apparatus according to claim 5, wherein the means for raising and lowering the caliper comprises a cable attached to the caliper.

13. The apparatus according to claim 10, wherein one or more of the one or more guide cables and the cable comprise a conductor for transmitting commands and/or power to the caliper and for receiving data back from caliper.

14. The apparatus according to claim 1, wherein the caliper further comprises a compass.

15. The apparatus according to claim 1, wherein the caliper further comprises a gyroscopic stabilizer.

16. The apparatus according to claim 1, further comprising a means for determining the speed of the transmitted pulse signal.

17. The apparatus according to claim 16, wherein the means for determining the speed of the transmitted pulse signal comprises an object a known distance from the transmitter wherein the speed of the transmitted pulse signal is the distance from the transmitter to the object and back to the detector divided by the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal from the object.

18. The apparatus according to claim 7, wherein the sonar head transmits in the range 50 kHz-300 kHz.

19. The apparatus according to claim 7, wherein the sonar head transmits in the range 500 kHz-800kHz.

20. The apparatus according to claim 7, wherein the sonar head transmits in the range 1.0 MHz-1.5 MHz.

21. The apparatus according claim 1, further comprising a means for determining the density of a fluid the transmitted pulse signal travels into the target location.

22. The apparatus according to claim 21, wherein the means for determining the density of the fluid the transmitted pulse signal travels in comprises a pressure measuring device.

23. The apparatus according to claim 1, wherein the caliper further comprises an inclinometer.

24. An method for investigating a formation, comprising:

suspending a caliper into a formation such that an axis of the caliper is substantially vertical when the caliper is suspended into the formation,

transmitting a transmitted pulse signal from a transmitter on the caliper;

detecting a reflected pulse signal with a detector on the caliper, wherein the reflected pulse signal is the transmitted pulse signal reflected from a target location on a surface of the formation onto which the transmitted pulse signal is incident;

determining the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal, wherein the distance from the transmitter to the target location on the surface of the formation and back to the detector is the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal times the speed of the first pulse signal;

rotating the transmitter and the detector with respect to the axis of the caliper, wherein rotation of the transmitter and the detector causes the target location on the surface of the formation onto which the transmitted pulse signal is incident to rotate with respect to the axis of the caliper; and

mapping the dimensions and topography of the formation.

25. The method according to claim 24, wherein the formation is a borehole.

26. The method according to claim 24, further comprising:

raising and lowering the caliper in the formation, wherein raising and lowering the caliper in the formation causes the target location on the surface of the formation to raise and lower, respectively.

27. The method according to claim 26, further comprising:

controlling the rotation of the transmitter and detector and the raising and lowering of the caliper such that the first pulse signal is incident on a plurality of target locations on the surface of the formation, and producing a representation of a portion of the formation corresponding to the plurality of target locations on the surface of the formation onto which the transmitter signal is incident.

28. The method according to claim 26, further comprising:

guiding the caliper on one or more guide cables as the caliper is raised and/or lowered in the formation, wherein the one or more guide cables allow the position of the caliper to be controlled as the caliper is raised and/or lowered in the formation.

29. The method according to claim 24, wherein the transmitter comprises a laser light source.

30. The method according to claim 24, wherein the transmitter comprises a sonar head.

31. The method according to claim 28, wherein the one or more guide cables are weighted to fall plumb into the formation.

32. The method according to claim 31, wherein at least one of the one or more guide cables is weighted with an inclinometer for providing an output signal indicative of the orientation of the at least one guide cable.

33. The method according to claim 28, further comprising raising and/or lowering the caliper up and down the at least one of the one or more guide cables by gripping on the at least one guide cable.

34. The method according to claim 28, wherein the caliper is attached to at least one of the one or more guide cables, wherein raising and lowering the caliper comprises raising and lowering the at least one guide cable attached to the caliper such that raising and lowering the at least one guide cable attached to the caliper raises and lowers the caliper.

35. The method according to claim 28, wherein raising and lowering the caliper comprises raising and lowering the caliper via a cable attached to the caliper.

36. The method according to claim 33, further comprising transmitting commands and/or power to the caliper and for receiving data back from caliper via a conductor in one or more of the one or more guide cables and/or the cable.

37. The method according to claim 24, wherein the caliper further comprises a compass.

38. The method according to claim 24, wherein the caliper further comprises a gyroscopic stabilizer.

39. The method according to claim 24, further comprising determining the speed of the transmitted pulse signal.

40. The method according to claim 39, wherein determining the speed of the transmitted pulse signal comprises positioning an object a known distance from the transmitter wherein the speed of the transmitted pulse signal is the distance from the transmitter to the object and back to the detector divided by the time interval between the transmission of the transmitted pulse signal and the detection of the reflected pulse signal from the object.

41. The method according to claim 30, wherein the sonar head transmits in the range 50 kHz-300 kHz.

42. The method according to claim 30, wherein the sonar head transmits in the range 500 kHz-800kHz.

43. The method according to claim 30, wherein the sonar head transmits in the range 1.0 MHz-1.5 MHz.

44. The method according to claim 24, further comprising determining the density of a fluid the transmitted pulse signal travels into the target location.

45. The method according to claim 44, wherein determining the density of the fluid the transmitted pulse signal travels in comprises measuring the pressure in the fluid the transmitted pulse signal travels in.

46. The method according to claim 24, wherein the caliper further comprises an inclinometer.

47. The method according to claim 24, wherein the formation has a diameter in the range 1.5 feet to 20 feet.

48. The method according to claim 24, wherein the formation has a diameter in the range 3 feet to 12 feet.