WHAT IS CLAIMED IS:

1. A multi-beam apparatus for observing a surface of a sample, comprising:

an electron source;

a condenser lens below said electron source;

a source-conversion unit below said condenser lens;

an objective lens below said source-conversion unit;

a deflection scanning unit below said source-conversion unit;

a sample stage below said objective lens;

a beam separator below said source-conversion unit;

a secondary projection imaging system; and

an electron detection device with a plurality of detection elements,

wherein said electron source, said condenser lens and said objective lens are aligned with a primary optical axis of said apparatus, and said sample stage sustains said sample so that said surface faces to said objective lens,

wherein said source-conversion unit comprises a beamlet-limit means with a plurality of beam-limit openings, and an image-forming means with a plurality of electron optics elements and movable along said primary optical axis,

wherein said electron source generates a primary-electron beam along said primary optical axis and said condenser lens focuses said primary-electron beam,

wherein a plurality of beamlets of said primary-electron beam pass through said plurality of beam-limit openings respectively, and is deflected by said plurality of electron optics elements towards said primary optical axis to form a plurality of virtual images of said electron source respectively,

wherein said plurality of beamlets is focused by said objective lens onto said surface and therefore forms a plurality of probe spots thereon respectively, and said deflection scanning unit deflects said plurality of beamlets to scan said plurality of probe spots respectively over a plurality of scanned regions within an observed area on said surface,

wherein a plurality of secondary electron beams is generated by said plurality of probe spots respectively from said plurality of scanned regions and

directed into said secondary projection imaging system by said beam separator, said secondary projection imaging system focuses and keeps said plurality of secondary electron beams to be detected by said plurality of detection elements respectively, and each detection element therefore provides an image signal of one corresponding scanned region.

2. The apparatus according to claim 1, wherein deflection angles of said plurality of beamlets due to said plurality of electron optics elements are respectively set to reduce off-axis aberrations of said plurality of probe spots.

3. The apparatus according to claim 2, wherein pitches of said plurality of probe spots are varied together by moving said image-forming means along said primary optical axis.

4. The apparatus according to claim 2, wherein said objective lens comprises a magnetic lens and an electrostatic lens.

5. The apparatus according to claim 4, wherein an orientation of said plurality of probe spots is selectable by varying a ratio of focusing powers of said magnetic lens and said electrostatic lens.

6. The apparatus according to claim 2, wherein said deflection angles ensure said plurality of beamlets to land on said surface perpendicularly or substantially perpendicularly.

7. The apparatus according to claim 2, wherein said deflection angles ensure said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

8. The apparatus according to claim 6, wherein said deflection scanning unit is above a front focal plane of said objective lens.

9. The apparatus according to claim 8, wherein said deflection scanning unit tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

10. The apparatus according to claim 6, further comprising a beamlet-tilting deflector between said source-conversion unit and a front focal plane of said objective lens.

11. The apparatus according to claim 10, wherein said beamlet-tilting deflector tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

12. A multi-beam apparatus for observing a surface of a sample, comprising:

an electron source;

a condenser lens below said electron source;

a source-conversion unit below said condenser lens;

an objective lens below said source-conversion unit;

a deflection scanning unit below said source-conversion unit;

a sample stage below said objective lens;

a beam separator below said source-conversion unit;

a secondary projection imaging system; and

an electron detection device with a plurality of detection elements,

wherein said electron source, said condenser lens and said objective lens are aligned with a primary optical axis of said apparatus, and said sample stage sustains said sample so that said surface faces to said objective lens,

wherein said source-conversion unit comprises a beamlet-limit means with a plurality of beam-limit openings, a first image-forming means with a plurality of first electron optics elements and a second image-forming means with a plurality of second electron optics elements, said second image-forming means is below said first image-forming means and movable in a radial direction, and one of said first image-forming means and said second image-forming means is used as an active image-forming means,

wherein said electron source generates a primary-electron beam along said primary optical axis and said condenser lens focuses said primary-electron beam,

wherein a plurality of beamlets of said primary-electron beam pass through said plurality of beam-limit openings respectively, and is deflected by said active image-forming means towards said primary optical axis to form a plurality of virtual images of said electron source respectively,

wherein said plurality of beamlets is focused by said objective lens onto said surface and therefore forms a plurality of probe spots thereon respectively, and said deflection scanning unit deflect said plurality of beamlets to scan said plurality of probe spots respectively over a plurality of scanned regions within an observed area on said surface,

wherein a plurality of secondary electron beams is generated by said plurality of probe spots respectively from said plurality of scanned regions and directed into said secondary projection imaging system by said beam separator, said secondary projection imaging system focuses and keeps said plurality of secondary electron beams to be detected by said plurality of detection elements respectively, and each detection element therefore provides an image signal of one corresponding scanned region.

13. The apparatus according to claim 12, wherein deflection angles of said plurality of beamlets due to said active image-forming means are respectively set to reduce off-axis aberrations of said plurality of probe spots.

14. The apparatus according to claim 13, wherein pitches of said plurality of probe spots are varied together by changing said active image-forming means between said first image-forming means and said second image-forming means, and when said first image-forming means is selected, said second image-forming means is moved outside so as not to block said plurality of beamlets.

15. The apparatus according to claim 13, wherein said objective lens comprises a magnetic lens and an electrostatic lens.

16. The apparatus according to claim 15, wherein an orientation of said plurality of probe spots is selectable by varying a ratio of focusing powers of said magnetic lens and said electrostatic lens.

17. The apparatus according to claim 13, wherein said deflection angles ensure said plurality of beamlets to land on said surface perpendicularly or substantially perpendicularly.

18. The apparatus according to claim 13, wherein said deflection angles ensure said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

19. The apparatus according to claim 17, wherein said deflection scanning unit is above a front focal plane of said objective lens.

20. The apparatus according to claim 19, wherein said deflection scanning unit tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

21. The apparatus according to claim 17, further comprising a beamlet-tilting deflector between said source-conversion unit and a front focal plane of said objective lens.

22. The apparatus according to claim 21, wherein said beamlet-tilting deflector tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

23. A multi-beam apparatus for observing a surface of a sample, comprising:

an electron source;

a condenser lens below said electron source;

a source-conversion unit below said condenser lens;

an objective lens below said source-conversion unit;

a deflection scanning unit below said source-conversion unit;

a sample stage below said objective lens;

a beam separator below said source-conversion unit;

a secondary projection imaging system; and

an electron detection device with a plurality of detection elements,

wherein said electron source, said condenser lens and said objective lens are aligned with a primary optical axis of said apparatus, a first principal plane of said objective lens is movable along said primary optical axis, and said sample stage sustains said sample so that said surface faces to said objective lens,

wherein said source-conversion unit comprises a beamlet-limit means with a plurality of beam-limit openings, and an image-forming means with a plurality of electron optics elements,

wherein said electron source generates a primary-electron beam along said primary optical axis and said condenser lens focuses said primary-electron beam,

wherein a plurality of beamlets of said primary-electron beam pass through said plurality of beam-limit openings respectively, and is deflected by said plurality of electron optics elements towards said primary optical axis to form a plurality of virtual images of said electron source respectively,

wherein said plurality of beamlets is focused by said objective lens onto said surface and therefore forms a plurality of probe spots thereon respectively, and said deflection scanning unit deflects said plurality of beamlets to scan said plurality of probe spots respectively over a plurality of scanned regions within an observed area on said surface,

wherein a plurality of secondary electron beams is generated by said plurality of probe spots respectively from said plurality of scanned regions and directed into said secondary projection imaging system by said beam separator, said secondary projection imaging system focuses and keeps said plurality of secondary electron beams to be detected by said plurality of detection elements respectively, and each detection element therefore provides an image signal of one corresponding scanned region.

24. The apparatus according to claim 23, wherein deflection angles of said plurality of beamlets due to said plurality of electron optics elements are respectively set to reduce off-axis aberrations of said plurality of probe spots.

25. The apparatus according to claim 24, wherein pitches of said plurality of probe spots are varied together by moving said first principal plane along said primary optical axis.

26. The apparatus according to claim 24, wherein said deflection angles ensure said plurality of beamlets to land on said surface perpendicularly or substantially perpendicularly.

27. The apparatus according to claim 24, wherein said deflection angles ensure said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

28. The apparatus according to claim 26, wherein said deflection scanning unit is above a front focal plane of said objective lens.

29. The apparatus according to claim 28, wherein said deflection scanning unit tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

30. The apparatus according to claim 26, further comprising a beamlet-tilting deflector between said source-conversion unit and a front focal plane of said objective lens.

31. The apparatus according to claim 30, wherein said beamlet-tilting deflector tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

32. The apparatus according to claim 24, wherein said objective lens comprises a lower magnetic lens and an electrostatic lens.

33. The apparatus according to claim 32, wherein said electrostatic lens comprises a field-control electrode and a field-moving electrode, and generates an electrostatic field.

34. The apparatus according to claim 33, wherein a potential of said field-control electrode is set to control said electrostatic field on said surface for said sample free of electrical breakdown.

35. The apparatus according to claim 34, wherein a potential of said field-moving electrode is set to move said electrostatic field for moving said first principal plane.

36. The apparatus according to claim 34, wherein an orientation of said plurality of probe spots is selectable by varying either or both of potentials of said field-control electrode and said field-moving electrode.

37. The apparatus according to claim 32, further comprising an upper magnetic lens above said lower magnetic lens.

38. The apparatus according to claim 37, wherein said first principal plane is moved by varying a ratio of focusing powers of said lower magnetic lens and said upper magnetic lens.

39. The apparatus according to claim 37, wherein an orientation of said plurality of probe spots is selectable by setting polarities of magnetic fields of said upper and lower magnetic lenses same or opposite.

40. A multi-beam apparatus for observing a surface of a sample, comprising:

an electron source;

a condenser lens below said electron source;

a source-conversion unit below said condenser lens;

a transfer lens below said source-conversion unit;

a field lens below said transfer lens;

an objective lens below said field lens;

a deflection scanning unit below said source-conversion unit;

a sample stage below said objective lens;

a beam separator below said source-conversion unit;

a secondary projection imaging system; and

an electron detection device with a plurality of detection elements,

wherein said electron source, said condenser lens, said transfer lens, said field lens and said objective lens are aligned with a primary optical axis of

said apparatus, and said sample stage sustains said sample so that said surface faces to said objective lens,

wherein said source-conversion unit comprises a beamlet-limit means with a plurality of beam-limit openings, and an image-forming means with a plurality of electron optics elements,

wherein said electron source generates a primary-electron beam along said primary optical axis and said condenser lens focuses said primary-electron beam,

wherein a plurality of beamlets of said primary-electron beam pass through said plurality of beam-limit openings respectively, and is deflected by said plurality of electron optics elements towards said primary optical axis to form a plurality of first virtual images of said electron source respectively,

wherein said transfer lens images said plurality of first virtual images onto an intermediate image plane and therefore forms a plurality of second real images respectively thereon, said field lens is placed on said intermediate image plane and bends said plurality of beamlets, said objective lens images said plurality of second real images onto said surface and therefore forms a plurality of probe spots thereon respectively, and said deflection scanning unit deflects said plurality of beamlets to scan said plurality of probe spots respectively over a plurality of scanned regions within an observed area on said surface,

wherein a plurality of secondary electron beams is generated by said plurality of probe spots respectively from said plurality of scanned regions and directed into said secondary projection imaging system by said beam separator, said secondary projection imaging system focuses and keeps said plurality of secondary electron beams to be detected by said plurality of detection elements respectively, and each detection element therefore provides an image signal of one corresponding scanned region.

41. The apparatus according to claim 40, wherein bending angles of said plurality of beamlets due to said field lens are set to reduce off-axis aberrations of said plurality of probe spots.

42. The apparatus according to claim 41, wherein deflection angles of said plurality of beamlets due to said plurality of electron optics elements are adjusted to change pitches of said plurality of probe spots respectively.

43. The apparatus according to claim 41, wherein said objective lens comprises a first magnetic lens and a first electrostatic lens.

44. The apparatus according to claim 43, wherein an orientation of said plurality of probe spots is selectable by varying a ratio of focusing powers of said first magnetic lens and said first electrostatic lens.

45. The apparatus according to claim 41, wherein said transfer lens comprises a second magnetic lens and a second electrostatic lens.

46. The apparatus according to claim 45, wherein an orientation of said plurality of probe spots is selectable by varying a ratio of focusing powers of said second magnetic lens and said second electrostatic lens.

47. The apparatus according to claim 41, wherein said field lens comprises a third magnetic lens and a third electrostatic lens.

48. The apparatus according to claim 47, wherein an orientation of said plurality of probe spots is selectable by varying a ratio of focusing powers of said third magnetic lens and said third electrostatic lens.

49. The apparatus according to claim 41, wherein said bending angles and deflection angles of said plurality of beamlets due to said plurality of electron optics elements ensure said plurality of beamlets to land on said surface perpendicularly or substantially perpendicularly.

50. The apparatus according to claim 41, wherein said bending angles and deflection angles of said plurality of beamlets due to said plurality of electron optics elements ensure said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

51. The apparatus according to claim 49, wherein said deflection scanning unit is above a front focal plane of said objective lens.

52. The apparatus according to claim 51, wherein said deflection scanning unit tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

53. The apparatus according to claim 49, further comprising a beamlet-tilting deflector between said source-conversion unit and a front focal plane of said objective lens.

54. The apparatus according to claim 53, wherein said beamlet-tilting deflector tilts said plurality of beamlets to obliquely land on said surface with same or substantially same landing angles.

55. A method to configure a multi-beam apparatus for observing a surface of a sample, comprising steps of:

configuring an image-forming means of a source-conversion unit movable along a primary optical axis thereof, wherein said image-forming means comprises a plurality of electron optics elements;

setting deflection angles of a plurality of beamlets due to said plurality of electron optics elements;

using said image-forming means to form a plurality of virtual images of an electron source respectively;

using an objective lens to image said plurality of virtual images onto said surface and form a plurality of probe spots thereon; and

moving said image-forming means to vary pitches of said plurality of probe spots.

56. A method to configure a multi-beam apparatus for observing a surface of a sample, comprising steps of:

configuring a source-conversion unit with a first image-forming means and a second image-forming means, wherein said second image-forming means is farther away from an electron source than said first image-forming means and movable in a radial direction of said apparatus;

using one of said first image-forming means and said second image-forming means as an active image-forming means, wherein when said first image-forming means is used, said second image-forming means is moved away;

using said active image-forming means to form a plurality of virtual images of said electron source respectively;

using an objective lens to image said plurality of virtual images onto said surface and form a plurality of probe spots thereon;

setting said active image-forming means respectively to reduce off-axis aberrations of said plurality of probe spots; and

changing said active image-forming means between said first image-forming means and said second image-forming means to vary pitches of said plurality of probe spots.

57. A method to configure a multi-beam apparatus for observing a surface of a sample, comprising steps of:

configuring an objective lens with a first principal plane movable along a primary optical axis of said apparatus;

using an image-forming means of a source-conversion unit to form a plurality of virtual images of an electron source respectively, wherein said image-forming means comprises a plurality of electron optics elements;

setting deflection angles of a plurality of beamlets due to said plurality of electron optics elements;

using said objective lens to image said plurality of virtual images onto said surface and form a plurality of probe spots thereon; and

moving said first principal plane to vary pitches of said plurality of probe spots.

58. A method to configure a multi-beam apparatus for observing a surface of a sample, comprising steps of:

configuring an objective lens with a lower magnetic lens and an electrostatic lens in said apparatus;

using an image-forming means of a source-conversion unit to form a plurality of virtual images of an electron source respectively, wherein said image-forming means comprises a plurality of electron optics elements;

setting deflection angles of a plurality of beamlets due to said plurality of electron optics elements;

using said objective lens to image said plurality of virtual images onto said surface and form a plurality of probe spots thereon; and

changing a ratio of focusing powers of said magnetic lens and said electrostatic lens to select an orientation of said plurality of probe spots.

59. The method according to claim 58, further comprising a step of configuring said objective lens with an upper magnetic lens farther away from said surface than said lower magnetic lens.

60. The method according to claim 59, further comprising a step of changing polarities of magnetic fields of said upper and lower magnetic lenses to select said orientation.

61. A method to configure a multi-beam apparatus for observing a surface of a sample, comprising steps of:

using an image-forming means of a source-conversion unit to deflect a plurality of beamlets from an electron source to form a plurality of first virtual images thereof respectively;

using an objective lens to image said plurality of virtual images onto said surface and form a plurality of probe spots thereon; and

setting deflection angles of said plurality of beamlets due to said image-forming means so that said plurality of beamlets lands on said surface with same or substantially same landing angles.

62. The method according to claim 61, further comprising a step of changing said deflection angles to equally vary said landing angles.

63. The method according to claim 61, further comprising a step of using a deflection scanning unit to tilt said plurality of beamlets so as to equally vary said landing angles.

64. The method according to claim 61, further comprising a step of using a beamlet-tilting deflector to tilt said plurality of beamlets so as to equally vary said landing angles.

65. A method to configure a multi-beam apparatus for observing a surface of a sample, comprising steps of:

using an image-forming means of a source-conversion unit to deflect a plurality of beamlets from an electron source to form a plurality of first virtual images thereof respectively;

using a transfer lens to image said plurality of first virtual images onto an intermediate image plane and forms a plurality of second real images respectively;

placing a field lens on said intermediate image plane to bend said plurality of beamlets; and

using an objective lens to image said plurality of second real images onto said surface and form a plurality of probe spots thereon; and

changing deflection angles of said plurality of beamlets due to said image-forming means to vary pitches of said plurality of probe spots.

66. The method according to claim 65, further comprising a step of changing deflection angles of said plurality of beamlets due to said image-forming means to vary pitches of said plurality of probe spots.

67. The method according to claim 65, further comprising a step of setting deflection angles of said plurality of beamlets due to said image-forming means and bending angles of said plurality of beamlets due to said field lens so that said plurality of beamlets lands on said surface with same or substantially same landing angles.

68. The method according to claim 67, further comprising a step of varying said deflection angles to equally change said landing angles.

69. The method according to claim 67, further comprising a step of using a deflection scanning unit to tilt said plurality of beamlets to equally change said landing angles.

70. The method according to claim 67, further comprising a step of using a beamlet-tilting deflector to tilt said plurality of beamlets to equally change said landing angles.

71. The method according to claim 65, further comprising a step of configuring said objective lens with a first magnetic lens and a first electrostatic lens.

72. The method according to claim 71, further comprising a step of changing a ratio of focusing powers of said first magnetic lens and said first electrostatic lens to select an orientation of said plurality of probe spots.

73. The method according to claim 65, further comprising a step of configuring said transfer lens with a second magnetic lens and a second electrostatic lens.

74. The method according to claim 73, further comprising a step of changing a ratio of focusing powers of said second magnetic lens and said second electrostatic lens to select an orientation of said plurality of probe spots.

75. The method according to claim 65, further comprising a step of configuring said field lens with a third magnetic lens and a third electrostatic lens.

76. The method according to claim 75, further comprising a step of changing a ratio of focusing powers of said third magnetic lens and said third electrostatic lens to select an orientation of said plurality of probe spots.

77. An apparatus, comprising:

a source for providing a primary charged particle beam;

a source-conversion unit for dividing the primary charged particle beam into a plurality of charged particle beamlets and using which to form a plurality of images of the source respectively;

an objective lens below said source-conversion unit for projecting the plurality of images onto a sample surface;

wherein pitches of the plurality of charged particle beamlets on the sample surface are adjustable by changing deflection angles of the plurality of charged particle beamlets prior entering the objective lens.

78. An apparatus, comprising:

a source for providing a primary charged particle beam;

means for using a plurality of beamlets of the primary charged particle beam to form a plurality of images of the source;

an objective lens for projecting the plurality of images onto a sample surface to form a plurality of probe spots; and

means for adjusting pitches of the plurality of probe spots on the sample surface.

79. A method for observing a sample surface, said method comprising steps of:

providing a plurality of charged particle beams with a plurality of crossovers respectively;

projecting the plurality of crossovers onto the sample surface to form a plurality of probe spots thereon;

scanning the plurality of probe spots on the sample surface; and

changing deflection angles of the plurality of charged particle beams such that pitches of the plurality of spots can be adjusted.