

of the center holes of the mounting collet as a mounting collet center position based on the image of the reflected light captured by the frame-side imaging apparatus, and detect a first deviation between the detected mounting collet center position and a reference position in a visual field of the frame-side imaging apparatus, wherein the reflected light is reflected on the surface of the electronic component sucked on the front end of the mounting collet. The control part may adjust a horizontal position of the mounting collet by the mounting collet drive part based on the first deviation.

[0018] Accordingly, the semiconductor die is picked up in the state that the push-up pin, the center position of the semiconductor die to be picked up, and the center position of the mounting collet are aligned. In addition, the first deviation between the mounting collet center position and the reference position in the visual field of the frame-side imaging apparatus is detected, and the horizontal position of the mounting collet is adjusted based on the first deviation. Therefore, when there is deviation in the position relationship between the mounting collet center position and the reference position in the visual field of the frame-side imaging apparatus, the deviation amount can be corrected at any time, and the semiconductor die can be accurately mounted.

[0019] In the electronic component mounting apparatus of the present invention, the frame-side imaging apparatus may capture an image of the mounting object. The image processing part may detect a mounting position for mounting the electronic component based on the image of the mounting object captured by the frame-side imaging apparatus, and detect a second deviation between the detected mounting position and the reference position in the visual field of the frame-side imaging apparatus. The control part may adjust the horizontal position of the mounting collet by the mounting collet drive part based on the first deviation and the second deviation.

[0020] Accordingly, the second deviation between the mounting position of the substrate or a lead frame which is a mounting object and the reference position in the visual field of the frame-side imaging apparatus is detected, and the horizontal position of the mounting collet is adjusted

FIG. 6 is a cross-sectional elevation view showing a state in which a push-up pin is captured by a wafer-side camera from the above in the electronic component mounting apparatus according to the embodiment.

5 FIG. 7 is a diagram showing a visual field of the wafer-side camera in the state of FIG. 6.

FIG. 8 is a cross-sectional elevation view showing a state in which a collet of a pickup head is moved to a position directly above the wafer.

10 FIG. 9 is a diagram showing a visual field of the wafer-side camera in the state shown in FIG. 8.

FIG. 10 is a cross-sectional elevation view showing a state in which a center position of the collet of the pickup head is aligned with a reference position of the wafer-side camera.

FIG. 11 is a diagram showing a visual field of the wafer-side camera in the state shown in FIG. 10.

15 FIG. 12 is a cross-sectional elevation view showing a state in which a semiconductor die is picked up from the wafer.

FIG. 13 is a flow chart showing an operation of the mounting part of the electronic component mounting apparatus according to the embodiment.

20 FIG. 14 is a cross-sectional elevation view showing a state in which a mounting collet having a semiconductor die sucked on a front end is moved to a position directly above a substrate in the electronic component mounting apparatus according to the embodiment.

FIG. 15 is a diagram showing a visual field of a frame-side camera in the state shown in FIG. 14.

25 FIG. 16 is a cross-sectional elevation view showing a state in which a mounting position of the substrate is captured by the frame-side camera.

FIG. 17 is a diagram showing a visual field of the frame-side camera in the state of

[0045] As described above, the optical axis 13 of the wafer-side camera 12 and the pin center PC at the center of the push-up pin 44 are arranged at the same position by design. Therefore, when the optical axis 13 of the wafer-side camera 12 and the push-up pin 44 are in the position as designed, the pin center PC of the push-up pin 44 shown in FIG. 7 is at the same position as a reference position C1 indicated by an intersection of a reference line 16 in the X-direction and a reference line 17 in the Y-direction of a visual field 15 of the wafer-side camera 12. However, as shown in FIG. 7, the position of the pin center PC may deviate from the position of the reference position C1.

[0046] As shown in step S103 of FIG. 5 and in FIG. 7, the control part 81 moves, in the XY-direction, the reference line 16 in the X-direction and the reference line 17 in the Y-direction which determine the reference position C1 in the visual field 15 in order that the reference position C1 is aligned with the pin center PC. Then, the position after the moving is set as the reference position C1 that is an intersection of a center line 45 in the X-direction and a center line 46 in the Y-direction in the visual field 15.

[0047] As shown in FIG. 8, the control part 81 drives the collet 30 directly above the wafer 35 by an XY-direction drive mechanism and the Z-direction drive mechanism of the main body 21 of the pickup head 20 in a manner that a lower surface of the collet main body 33 is positioned at a small height of, for example, about 0.1 mm from the wafer 35. Then, a central axis of the collet 30 and the optical axis 13 of the wafer-side camera 12 are aligned. Next, the control part 81 lights the light source 27 arranged in the pickup head 20. After travelling in the X-direction, the light from the light source 27 is reflected by the beam splitter 28, travels downward in the Z-direction, and is incident to the center hole 32 of the shaft 31 from the root side of the collet 30. The light incident to the center hole 32 passes through the center hole 34 of the collet main body 33 from the center hole 32 and is reflected on the surface of the wafer 35 directly below the collet main body 33. The reflected light reflected on the surface of the wafer 35 travels upward in the Z-direction through the center holes 34 and 32, passes through the beam splitter 28, and is incident

center DC of the semiconductor die 36 to be picked up reaches the reference position C1 in the visual field 15 of the wafer-side camera 12. As described above, the reference position C1 is set to the same position as the position of the pin center PC of the push-up pin 44, and thus the chip center DC, the reference position C1, and the pin center PC can be set to the same position by this operation.

[0055] The control part 81 reads each of the deviations $\Delta X1$ and $\Delta Y1$ from the storage part, and as shown in step S110 of FIG. 5, corrects the position by the deviation $\Delta Y1$ to align the collet center position CC1 with the reference position C1 in the visual field 15 of the wafer-side camera 12. Specifically, if the deviation in the Y-direction between the collet center position CC1 and the reference position C1 is $\Delta Y1$ as shown in FIG. 9, when the control part 81 moves the pickup head 20 toward a positive side in the Y-direction, the control part 81 moves the pickup head 20 to a position where a scale of a linear scale that detects the Y-direction position of the pickup head 20 is greater than a scale corresponding to the reference position C1 by the deviation $\Delta Y1$. Accordingly, the deviation $\Delta Y1$ is corrected, and the Y-direction position of the collet 30 is aligned with the reference position C1. In addition, the deviation $\Delta X1$ is corrected by using the linear guide drive mechanism (not shown) to move the linear guide 14 in the X-direction by the deviation $\Delta X1$.

[0056] Accordingly, by adjusting the positions of the wafer ring 42 and the collet 30, in a state shown in FIG. 10, the chip center DC, the reference position C1, the pin center PC, and the collet center position CC1 can be set to the same position, as shown in FIG. 11.

[0057] In this state, as shown in step S111 of FIG. 5 and in FIG. 12, the control part 81 lowers the collet 30 onto the semiconductor die 36 to be picked up by the Z-direction drive mechanism of the main body 21 of the pickup head 20 to suck the semiconductor die 36 on the surface of the collet main body 33, and the control part 81 moves the push-up pin 44 upward to push up the semiconductor die 36 from below and picks up the semiconductor die 36 from the wafer 35.

effectively suppressed.

[0063] <Operation of mounting part>

Next, an operation of the mounting part 102 is described with reference to FIG. 13 and FIGS. 14 to 22.

5 **[0064]** As shown in step S201 of FIG. 13 and in FIG. 14, the control part 81 operates the Y-direction drive mechanism arranged inside the main body 21 of the pickup head 20 to move the pickup head 20 to the underneath of the frame-side camera 63. At this time, the control part 81 moves the pickup head 20 in order that a collet center position CC2 of the collet 30 is aligned with a position of an optical axis 64 of the frame-side camera 63. In addition, because a focus of the
10 frame-side camera 63 is the surface of the substrate 74, the collet 30 is lowered in order that the surface of the semiconductor die 36 sucked on the front end of the collet 30 is positioned slightly separated from the surface of the substrate 74 for about 0.1 mm for example, and an upper-side surface of the semiconductor die 36 is within the depth of the focus of the frame-side camera 63. The collet 30 is lowered by the Z-direction drive mechanism arranged inside the main body 21 of
15 the pickup head 20.

[0065] As shown in FIG. 15, the position of the optical axis 64 of the frame-side camera 63 is a reference position C2 indicated by the intersection of a center line 66 in the X-direction and a center line 67 in the Y-direction in the visual field 65 of the frame-side camera 63. In addition, in the visual field 65, the collet center position CC2 is the intersection of an X-direction center
20 line 55x and a Y-direction center line 55y. When the collet center position CC2 is aligned with the position of the optical axis 64 of the frame-side camera 63, the collet center position CC2 is aligned with the reference position C2. However, as shown in FIG. 15, the collet center position CC2 may deviate from the reference position C2.

[0066] The control part 81 lights a light source 27 arranged in the pickup head 20 as described
25 above. Light from the light source 27 is incident to the center holes 32 and 34 of the collet 30

and forms a white image of the reflected light reflected on the surface of the wafer 35, and as shown in FIG. 15, around the white image is a black background. The frame-side camera 63 captures the white image of the reflected light that emerges in the middle of the black background. The captured image is output to the image processing part 82.

5 **[0067]** As shown in step S203 of FIG. 13, the image processing part 82 processes, as described above, the input image and detects the center positions of the center holes 32 and 34 of the collet 30 as the collet center position CC2.

10 **[0068]** As shown in FIG. 15, position deviation may occur between the reference position C2 in the visual field 65 of the frame-side camera 63 and the collet center position CC2. As shown in step S204 of FIG. 13, the image processing part 82 detects an X-direction first deviation $\Delta X2$ and a Y-direction first deviation $\Delta Y2$ between the detected collet center position CC2 and the reference position C2 in the visual field 65, and outputs the first deviations $\Delta X2$ and $\Delta Y2$ to the control part 81. The control part 81 stores the X-direction first deviation $\Delta X2$ and the Y-direction first deviation $\Delta Y2$ which are input in the storage part.

15 **[0069]** In addition, as shown in FIG. 16, the control part 81 moves the frame-side camera 63 in a manner that the reference position C2 in the visual field 65 of the frame-side camera 63 is consistent with a position where a mounting position BC of a center of a mounting region 75 for mounting the semiconductor die 36 on the substrate 74 enters the visual field. The movement in the Y-direction is performed by the Y-direction drive mechanism arranged in the arm 62.

20 **[0070]** Then, as shown in step S205 of FIG. 13, the control part 81 operates the frame-side camera 63 to capture the mounting region 75. The captured image is input to the image processing part 82. As shown in step S206 of FIG. 13, the image processing part 82 processes the acquired image, detects the mounting position BC at the center of the mounting region 75, and outputs the image to the control part 81. The control part 81 stores the input mounting position BC in the storage part. As for the image processing, for example, the recognized image of the
25

surface of the semiconductor die 36 sucked on the front end of the collet 30 is lowered to the position slightly separated from the surface of the substrate 74 for about 0.1 mm for example. The result is stored in the storage part of the control part 81, and in the subsequent mounting, the first deviation stored in the storage part is used for the correction, and the mounting can be performed a predetermined number of times.

[0079] Similar to the detection of the first deviation, the detection of the second deviation is performed after the mounting is performed several times, and the result is stored in the storage part of the control part 81. In the subsequent mounting, the second deviation stored in the storage part can be used for the correction, and the mounting can be performed a predetermined number of times.

[0080] Therefore, even if there is a change over time, the first deviation and the second deviation can be corrected every time the mounting is performed several times, and the mounting can be continued. Therefore, the bonding efficiency can be suppressed from decreasing and the decrease in the precision of mounting the semiconductor die 36 on the substrate 74 when there is a change over time can be effectively suppressed.

[0081] Moreover, in the electronic component mounting apparatus 100 according to the embodiment, the pickup head 20 for picking up and mounting the semiconductor die 36 is guided by the linear guide 14 extending between the pickup part 101 and the mounting part 102, and the position in the X-direction is adjusted by moving the linear guide 14 in the X-direction. Therefore, when the X-direction first deviation $\Delta X2$ and the X-direction second deviation $\Delta X3$ are adjusted in the mounting part 102, deviation may occur between the collet center position CC1 in the X-direction in the pickup part 101 and the reference position C1 and the pin center PC. In this case, when the pickup operation is performed returning from the mounting part 102 to the pickup part 101, a difference between the deviation $\Delta X1$ and the X-direction first deviation $\Delta X2$ or the X-direction second deviation $\Delta X3$ may be used to correct the position of the collet 30.

mounting head 50 in the Y-direction and an X-direction drive mechanism for driving the mounting collet 55 in the X-direction. The Y-direction drive mechanism may be, for example, a linear motor, and the Z-direction drive mechanism may be configured by, for example, a voice coil motor. The mounting head 50 configures a mounting collet drive part that drives the mounting collet 55 in the Y-direction.

[0092] The mounting collet 55 is configured by a shaft 56 on a root side and a mounting collet main body 58 on a front end side. The shaft 56 is made of metal, and the mounting collet main body 58 is made of, for example, metal, ceramics, or the like. At the centers of the shaft 56 and the mounting collet main body 58, circular center holes 57 and 59 are arranged coaxially. The upper end of the shaft 56 is attached to a part on the upper side of the arm 53 in which a recess 53a is arranged, and the center hole 57 of the shaft 56 communicates with the recess 53a on the upper part of the arm 53 and is open upward in the Z-direction from the recess 53a. The center hole 59 of the mounting collet main body 58 communicates with the center hole 57 of the shaft 56 and is open downward in the Z-direction from a lower end surface. A light source 27a and a beam splitter 28a are arranged above the recess 53a on the upper part of the arm 53.

[0093] The beam splitter 28a is disposed directly above the center hole 57 of the shaft 56 of the mounting collet 55, reflects the light from the light source 27a, and makes the light from a root side of the mounting collet 55 incident into the center hole 57 of the shaft 56 and the center hole 59 of the mounting collet main body 58. In addition, the beam splitter 28a transmits, upward in the Z-direction, the reflected light reflected on the surface of the semiconductor die 36 sucked on a front end of the mounting collet main body 58 of the mounting collet 55, and makes the light incident to the frame-side camera 63. The light source 27a and the beam splitter 28a configure a frame-side illumination part 29a. Here, the light source 27a may be a high-intensity LED or a laser light source. In addition, a half mirror may be used instead of the beam splitter 28a.

[0094] As shown in FIGS. 25 and 26, the intermediate stage 48 is guided by a linear guide 47

WHAT IS CLAIMED IS:

1. An electronic component mounting apparatus, comprising:

a wafer ring which holds a wafer;

a collet which has center holes and picks up an electronic component from the wafer;

5 a collet drive part which drives the collet in a horizontal direction;

a wafer-side illumination part which makes light incident to the center holes of the collet from a root side of the collet;

a wafer-side imaging apparatus which captures an image of the collet from the root side of the collet;

10 an image processing part which processes the image captured by the wafer-side imaging apparatus; and

a control part which adjusts a position of the collet,

wherein the wafer-side imaging apparatus captures an image of a reflected light which is the light incident to the center holes of the collet and reflected on a surface of the wafer directly

15 below the collet,

the image processing part detects a center position of the center holes of the collet as a collet center position based on the image of the collet and the image of the reflected light reflected by the surface of the wafer which are captured by the wafer-side imaging apparatus, and detects deviations between the detected collet center position and a reference position in a visual field of

20 the wafer-side imaging apparatus, and

the control part makes the collet move with respect to the wafer-side imaging apparatus to adjust a horizontal position of the collet by the collet drive part based on the deviations.

2. The electronic component mounting apparatus according to claim 1, comprising

a push-up pin which pushes up the electronic component picked up by the collet from

25 below the wafer,

wherein the wafer-side imaging apparatus captures an image of the push-up pin from above; and

the image processing part

detects a center position of the push-up pin as a pin center based on the image of the

5 push-up pin captured by the wafer-side imaging apparatus, and

sets the detected pin center as the reference position in the visual field of the wafer-side imaging apparatus.

3. The electronic component mounting apparatus according to claim 2, comprising

a wafer ring drive part which drives the wafer ring in the horizontal direction,

10 wherein the wafer-side imaging apparatus captures an image of the electronic component picked up by the collet from above the wafer;

the image processing part

detects a center position of the electronic component picked up by the collet as a chip center based on the image of the electronic component picked up by the collet captured by the

15 wafer-side imaging apparatus; and

the control part adjusts a horizontal position of the wafer ring by the wafer ring drive part in a manner that the chip center reaches the reference position in the visual field of the wafer-side imaging apparatus.

4. The electronic component mounting apparatus according to any one of claims 1 to

20 3, comprising:

a frame-side illumination part which makes light incident from the root side of the collet to the center holes of the collet; and

a frame-side imaging apparatus which captures an image of the collet from the root side of the collet,

25 wherein the collet mounts the electronic component sucked on a front end of the collet

on a mounting object;

the image processing part processes the image captured by the frame-side imaging apparatus;

the frame-side imaging apparatus captures, in a state that the electronic component is sucked on the front end of the collet, an image of the reflected light which is the light incident to the center holes of the collet and reflected on the surface of the electronic component sucked on the front end of the collet;

the image processing part detects the center position of the center holes of the collet as the collet center position based on the image of the reflected light captured by the frame-side imaging apparatus, and detects a first deviation between the detected collet center position and a reference position in a visual field of the frame-side imaging apparatus, wherein the reflected light is reflected on the surface of the electronic component sucked on the front end of the collet; and

the control part adjusts the horizontal position of the collet by the collet drive part based on the first deviation.

5. The electronic component mounting apparatus according to claim 4, wherein the frame-side imaging apparatus captures an image of the mounting object;

the image processing part detects a mounting position for mounting the electronic component based on the image of the mounting object captured by the frame-side imaging apparatus, and detects a second deviation between the detected mounting position and the reference position in the visual field of the frame-side imaging apparatus; and

the control part

adjusts the horizontal position of the collet based on the first deviation and the second deviation by the collet drive part.

6. The electronic component mounting apparatus according to claim 5, comprising a back-surface camera which is arranged between a pickup part which picks up the

electronic component from the wafer and a mounting part which mounts the picked up electronic component on the mounting object, and captures an image of the front end of the collet and an image of a back surface of the electronic component sucked on the front end of the collet,

wherein the image processing part detects position deviation amounts of the electronic component with respect to the collet based on the image of the front end of the collet and the image of the back surface of the electronic component captured by the back-surface camera, and

the control part

adjusts the horizontal position of the collet by the collet drive part based on the first deviation, the second deviation, and the position deviation amounts of the electronic component with respect to the collet.

7. The electronic component mounting apparatus according to any one of claims 1 to 3, comprising:

a mounting collet which has center holes and mounts the electronic component sucked on a front end of the mounting collet on a mounting object;

a mounting collet drive part which drives the mounting collet in the horizontal direction;

a frame-side illumination part which makes light incident from a root side of the mounting collet to the center holes of the mounting collet; and

a frame-side imaging apparatus which captures an image of the mounting collet from the root side of the mounting collet,

wherein the image processing part processes the image captured by the frame-side imaging apparatus;

the control part adjusts a position of the mounting collet;

the frame-side imaging apparatus captures, in a state that the electronic component is sucked on the front end of the mounting collet, an image of reflected light which is the light

incident to the center holes of the mounting collet and reflected on a surface of the electronic component sucked on the front end of the mounting collet;

the image processing part detects a center position of the center holes of the mounting collet as a mounting collet center position based on the image of the reflected light captured by the frame-side imaging apparatus, and detects a first deviation between the detected mounting collet center position and a reference position in a visual field of the frame-side imaging apparatus, wherein the reflected light is reflected on the surface of the electronic component sucked on the front end of the mounting collet; and

the control part adjusts a horizontal position of the mounting collet by the mounting collet drive part based on the first deviation.

8. The electronic component mounting apparatus according to claim 7, wherein the frame-side imaging apparatus captures an image of the mounting object;

the image processing part detects a mounting position for mounting the electronic component based on the image of the mounting object captured by the frame-side imaging apparatus, and detects a second deviation between the detected mounting position and the reference position in the visual field of the frame-side imaging apparatus; and

the control part

adjusts the horizontal position of the mounting collet by the mounting collet drive part based on the first deviation and the second deviation.

9. The electronic component mounting apparatus according to claim 8, comprising

a back-surface camera which is arranged between a pickup part which picks up the electronic component from the wafer and a mounting part which mounts the picked up electronic component on the mounting object, and captures an image of the front end of the mounting collet and an image of a back surface of the electronic component sucked on the front end of the mounting collet, wherein

the image processing part detects position deviation amounts of the electronic component with respect to the mounting collet based on the image of the front end of the mounting collet and the image of the back surface of the electronic component captured by the back-surface camera, and

5 the control part

adjusts the horizontal position of the mounting collet by the mounting collet drive part based on the first deviation, the second deviation, and the position deviation amounts of the electronic component with respect to the mounting collet.

10. An electronic component mounting apparatus, comprising:

10 a mounting collet which has center holes and mounts an electronic component sucked on a front end of the mounting collet on a mounting object;

a mounting collet drive part which drives the mounting collet in a horizontal direction;

a frame-side illumination part which makes light incident from a root side of the mounting collet to the center holes of the mounting collet;

15 a frame-side imaging apparatus which captures an image of the mounting collet from the root side of the mounting collet;

an image processing part which processes the image captured by the frame-side imaging apparatus; and

a control part which adjusts a position of the mounting collet, wherein

20 the frame-side imaging apparatus captures, in a state that the electronic component is sucked on the front end of the mounting collet, an image of reflected light which is the light incident to the center holes of the mounting collet and reflected on a surface of the electronic component sucked on the front end of the mounting collet;

the image processing part detects a center position of the center holes of the mounting
25 collet as a mounting collet center position based on the image of the reflected light captured by

the frame-side imaging apparatus, and detects a first deviation between the detected mounting collet center position and a reference position in a visual field of the frame-side imaging apparatus, wherein the reflected light is reflected on the surface of the electronic component sucked on the front end of the mounting collet; and

5 the control part adjusts a horizontal position of the mounting collet by the mounting collet drive part based on the first deviation.

11. The electronic component mounting apparatus according to claim 10, wherein the frame-side imaging apparatus captures an image of the mounting object;

the image processing part detects the mounting position for mounting the electronic
10 component based on the image of the mounting object captured by the frame-side imaging apparatus, and detects a second deviation between the detected mounting position and the reference position in the visual field of the frame-side imaging apparatus; and

the control part

adjusts the horizontal position of the mounting collet by the mounting collet drive part
15 based on the first deviation and the second deviation.