Amendment of Claims under Article 19

1. (Amended) A wire bonding apparatus for connecting a plurality of first bonding points and a plurality of second bonding points with a wire, the apparatus comprising:

a bar-shaped bonding tool having a through hole in which the wire is inserted, and a pressing surface provided at a periphery of the through hole at a tip of the bonding tool and configured to press the wire against a bonding target, the through hole extending along a longitudinal direction of the bonding tool;

a clamper configured to hold the wire;

a folding station having a stepped portion for catching the wire tail extending from the tip of the bonding tool; and

a control unit configured to specify movement of the bonding tool, and to open and close the clamper, wherein

the control unit comprises:

wire tail extension means configured to move the bonding tool, after bonding the wire to a previous one of the second bonding points, upward while the clamper is opened, and then along a straight line directed from a succeeding one of the first bonding points to a succeeding one of the second bonding points by a predetermined distance, and cause the wire to extend from the through hole of the bonding tool in a direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point;

tail cut means configured to, after causing the wire tail to extend, cut the wire tail by moving the bonding tool in the direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point while the clamper is closed; and

wire tail folding means configured to, after moving the bonding tool to the folding station and positioning the wire tail along the stepped portion, move the bonding tool toward the succeeding second bonding point along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, thereby causing the wire tail to be flexed toward the succeeding first bonding point.

2. (Canceled)

3. (Amended) The wire bonding apparatus according to claim 1, wherein

the control unit forms the wire tail using:

the wire tail extension means and the tail cut means, when an angle between a first straight line and a second straight line is smaller than a predetermined angle, the first straight line connecting a previous one of the first bonding points and the previous second bonding point, the second straight line connecting the succeeding first bonding point and the succeeding second bonding point; and

the wire tail folding means, when the angle between the first straight line and the second straight line is equal to or greater than the predetermined angle.

4. The wire bonding apparatus according to claim 3, wherein

an end portion of the through hole on a side of the pressing surface is a straight hole, and an angle between an inner surface of the straight hole and the pressing surface is substantially at a right angle.

5. (Amended) The wire bonding apparatus according to claim 1, wherein

the pressing surface is an annular flat surface, and

the wire tail extension means moves the bonding tool such that the wire tail is slightly longer than an outside radius of the pressing surface.

6. The wire bonding apparatus according to claim 5, wherein

the wire tail extension means moves the bonding tool horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance.

7. The wire bonding apparatus according to claim 5, wherein

the wire tail extension means moves the bonding tool obliquely upward by a predetermined oblique distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point.

8. The wire bonding apparatus according to claim 5, wherein

the plurality of first bonding points are leads on a substrate, and

the plurality of second bonding points are pads on a chip.

9. The wire bonding apparatus according to claim 5, wherein

the stepped portion of the folding station comprises a wall surface for catching the wire tail, and a flat upper surface that continues to the wall surface, and

the wire tail folding means moves the bonding tool at a height at which the pressing surface of the bonding tool is higher than the flat upper surface of the stepped portion of the folding station by a height slightly higher than a diameter of the wire.

10. (Amended) A wire bonding method of connecting a plurality of first bonding points and a plurality of second bonding points with a wire, the method comprising:

a step of preparing a wire bonding apparatus comprising: a bar-shaped bonding tool having a through hole in which the

wire is inserted, and a pressing surface provided at a periphery of the through hole at a tip of the bonding tool and configured to press the wire against a bonding target, the through hole extending along a longitudinal direction of the bonding tool; a clamper configured to hold the wire; and a folding station having a stepped portion for catching the wire tail extending from the tip of the bonding tool, and

a wire tail extension step of, after bonding the wire to a previous one of the second bonding points, moving the bonding tool upward while the clamper is opened, moving the bonding tool along a straight line directed from a succeeding one of the first bonding points to a succeeding one of the second bonding points by a predetermined distance, and causing the wire to extend from the through hole of the bonding tool in the direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point;

a tail cut step of, after causing the wire tail to extend, cutting the wire tail by moving the bonding tool in the direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point while the clamper is closed; and

a wire tail folding step of, after moving the bonding tool to the folding station and positioning the wire tail along the stepped portion, moving the bonding tool toward the succeeding second bonding point along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, thereby causing the wire tail to be flexed toward the succeeding first bonding point.

11. (Canceled)

12. (Amended) The wire bonding method according to claim 10, wherein

the wire tail is formed in the wire tail extension step and the tail cut step, when an angle between a first straight line and a second straight line is smaller than a predetermined angle, the first straight line connecting a previous one of the first bonding points and the previous second bonding point, the second straight line connecting the succeeding first bonding point and the succeeding second bonding point; and

the wire tail is formed in the wire tail folding step, when the angle between the first straight line and the second straight line is equal to or greater than the predetermined angle.

13. (Amended) The wire bonding method according to claim 10, wherein

the pressing surface is an annular flat surface, and

in the wire tail extension step, the bonding tool is moved such that the wire tail is slightly longer than an outside radius of the pressing surface.

14. The wire bonding method according to claim 13, wherein

in the wire tail extension step, the bonding tool is moved horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance.

15. The wire bonding method according to claim 13, wherein

in the wire tail extension step, the bonding tool is moved obliquely upward by a predetermined oblique distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point.

16. The wire bonding method according to claim 13, wherein

the plurality of first bonding points are leads on a substrate, and

the plurality of second bonding points are pads on a chip.

17. The wire bonding apparatus according to claim 5, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire, the control unit starts bonding,

after a last one of the pads on a previous one of the chips and a lead on the substrate corresponding to this pad are connected with a wire, from a set of pads and leads of a subsequent one of the chips on which a pad and a lead corresponding to this pad are disposed along a direction directed from the last pad on the previous chip to the lead corresponding to this last pad.

18. The wire bonding apparatus according to claim 5, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire,

the control unit sequentially performs bonding to each of sets of pads and leads respectively corresponding to the pads, the pads and the leads in each set being connected by lines in a similar direction.

19. The wire bonding apparatus according to claim 5, wherein

the wire tail extension step moves the bonding tool horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance, and

horizontally from the second bonding point to the first bonding by a predetermined XY-direction distance.

20. The wire bonding method according to claim 13, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire, bonding is started after a last one of the pads on a previous one of the chips and a lead on the substrate corresponding to this pad are connected with a wire, from a set of pads and leads of a subsequent one of the chips on which a pad and a lead corresponding to this pad are disposed along a direction directed from the last pad on the previous chip to the lead corresponding to this last pad.

21. The wire bonding apparatus according to claim 13, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire, bonding is sequentially performed to each of sets of pads and leads respectively corresponding to the pads, the pads and the leads in each set being connected by lines in a similar direction.

22. The wire bonding method according to claim 13, wherein

the wire tail extension step moves the bonding tool horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance, and horizontally from the second bonding point to the first bonding by a predetermined XY-direction distance.

CLAIMS

1. A wire bonding apparatus for connecting a plurality of first bonding points and a plurality of second bonding points with a wire, the apparatus comprising:

a bar-shaped bonding tool having a through hole in which the wire is inserted, and a pressing surface provided at a periphery of the through hole at a tip of the bonding tool and configured to press the wire against a bonding target, the through hole extending along a longitudinal direction of the bonding tool;

a clamper configured to hold the wire;

a folding station having a stepped portion for catching the wire tail extending from the tip of the bonding tool; and

a control unit configured to specify movement of the bonding tool, and to open and close the clamper, wherein

the control unit comprises:

wire tail extension means configured to move the bonding tool, after bonding the wire to a previous one of the second bonding points, upward while the clamper is opened, and then along a straight line directed from a succeeding one of the first bonding points to a succeeding one of the second bonding points by a predetermined distance, and cause the wire to extend from the through hole of the bonding tool in a direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point;

tail cut means configured to, after causing the wire tail to extend, cut the wire tail by moving the bonding tool in the direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point while the clamper is closed; and

wire tail folding means configured to, after moving the bonding tool to the folding station and positioning the wire tail along the stepped portion, move the bonding tool toward the succeeding second bonding point along the straight line

directed from the succeeding first bonding point to the succeeding second bonding point, thereby causing the wire tail to be flexed toward the succeeding first bonding point.

2. The wire bonding apparatus according to claim 1, wherein

the control unit forms the wire tail using:

the wire tail extension means and the tail cut means, when an angle between a first straight line and a second straight line is smaller than a predetermined angle, the first straight line connecting a previous one of the first bonding points and the previous second bonding point, the second straight line connecting the succeeding first bonding point and the succeeding second bonding point; and

the wire tail folding means, when the angle between the first straight line and the second straight line is equal to or greater than the predetermined angle.

3. The wire bonding apparatus according to claim 2, wherein

an end portion of the through hole on a side of the pressing surface is a straight hole, and an angle between an inner surface of the straight hole and the pressing surface is substantially at a right angle.

4. The wire bonding apparatus according to claim 1, wherein

the pressing surface is an annular flat surface, and

the wire tail extension means moves the bonding tool such that the wire tail is slightly longer than an outside radius of the pressing surface.

5. The wire bonding apparatus according to claim 4, wherein

the wire tail extension means moves the bonding tool horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance.

6. The wire bonding apparatus according to claim 4, wherein

the wire tail extension means moves the bonding tool obliquely upward by a predetermined oblique distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point.

7. The wire bonding apparatus according to claim 4, wherein

the plurality of first bonding points are leads on a substrate, and

the plurality of second bonding points are pads on a chip.

8. The wire bonding apparatus according to claim 4, wherein

the stepped portion of the folding station comprises a wall surface for catching the wire tail, and a flat upper surface that continues to the wall surface, and

the wire tail folding means moves the bonding tool at a height at which the pressing surface of the bonding tool is higher than the flat upper surface of the stepped portion of the folding station by a height slightly higher than a diameter of the wire.

9. A wire bonding method of connecting a plurality of first bonding points and a plurality of second bonding points with a wire, the method comprising:

a step of preparing a wire bonding apparatus comprising: a bar-shaped bonding tool having a through hole in which the

wire is inserted, and a pressing surface provided at a periphery of the through hole at a tip of the bonding tool and configured to press the wire against a bonding target, the through hole extending along a longitudinal direction of the bonding tool; a clamper configured to hold the wire; and a folding station having a stepped portion for catching the wire tail extending from the tip of the bonding tool, and

a wire tail extension step of, after bonding the wire to a previous one of the second bonding points, moving the bonding tool upward while the clamper is opened, moving the bonding tool along a straight line directed from a succeeding one of the first bonding points to a succeeding one of the second bonding points by a predetermined distance, and causing the wire to extend from the through hole of the bonding tool in the direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point;

a tail cut step of, after causing the wire tail to extend, cutting the wire tail by moving the bonding tool in the direction along the straight line directed from the succeeding first bonding point to the succeeding second bonding point while the clamper is closed; and

a wire tail folding step of, after moving the bonding tool to the folding station and positioning the wire tail along the stepped portion, moving the bonding tool toward the succeeding second bonding point along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, thereby causing the wire tail to be flexed toward the succeeding first bonding point.

10. The wire bonding method according to claim 9, wherein

the wire tail is formed in the wire tail extension step and the tail cut step, when an angle between a first straight line and a second straight line is smaller than a predetermined angle, the first straight line connecting a previous one of the first bonding points and the previous second bonding point, the

second straight line connecting the succeeding first bonding point and the succeeding second bonding point; and

the wire tail is formed in the wire tail folding step, when the angle between the first straight line and the second straight line is equal to or greater than the predetermined angle.

11. The wire bonding method according to claim 9, wherein

the pressing surface is an annular flat surface, and

in the wire tail extension step, the bonding tool is moved such that the wire tail is slightly longer than an outside radius of the pressing surface.

12. The wire bonding method according to claim 11, wherein

in the wire tail extension step, the bonding tool is moved horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance.

13. The wire bonding method according to claim 11, wherein

in the wire tail extension step, the bonding tool is moved obliquely upward by a predetermined oblique distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point.

14. The wire bonding method according to claim 11, wherein

the plurality of first bonding points are leads on a substrate, and

the plurality of second bonding points are pads on a chip.

15. The wire bonding apparatus according to claim 4, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire, the control unit starts bonding,

after a last one of the pads on a previous one of the chips and a lead on the substrate corresponding to this pad are connected with a wire, from a set of pads and leads of a subsequent one of the chips on which a pad and a lead corresponding to this pad are disposed along a direction directed from the last pad on the previous chip to the lead corresponding to this last pad.

16. The wire bonding apparatus according to claim 4, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire,

the control unit sequentially performs bonding to each of sets of pads and leads respectively corresponding to the pads, the pads and the leads in each set being connected by lines in a similar direction.

17. The wire bonding apparatus according to claim 4, wherein

the wire tail extension step moves the bonding tool horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance, and horizontally from the second bonding point to the first bonding by a predetermined XY-direction distance.

18. The wire bonding method according to claim 11, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire, bonding is started after a last one of the pads on a previous one of the chips and a lead on the substrate corresponding to this pad are connected with a wire, from a set of pads and leads of a subsequent one of the chips on which a pad and a lead corresponding to this pad are disposed along a direction directed from the last pad on the previous chip to the lead corresponding to this last pad.

19. The wire bonding apparatus according to claim 11, wherein

when a plurality of chips are disposed on a common substrate, and a plurality of pads of each chip and leads on the substrate corresponding to the pads are connected with a wire, bonding is sequentially performed to each of sets of pads and leads respectively corresponding to the pads, the pads and the leads in each set being connected by lines in a similar direction.

20. The wire bonding method according to claim 11, wherein

the wire tail extension step moves the bonding tool horizontally by a predetermined XY-direction distance along the straight line directed from the succeeding first bonding point to the succeeding second bonding point, after moving the bonding tool upward by a predetermined Z-direction distance, and horizontally from the second bonding point to the first bonding by a predetermined XY-direction distance.