AMENDED CLAIMS
[Received by the International Bureau on 27 July 2010 (27.07.10)]

1. Method of monitoring a crimping process, comprising the steps of:

- determination whether an actual force stroke progression (Fa) / force time progression occurring during crimping is within a tolerance band in at least one point, the tolerance band having an upper border (Bu) above and a lower border (Bl) below an ideal force stroke progression (Fi) / force time progression and
- qualifying a crimp as passed, for which said condition is true,

characterized in the additional steps of:

- determination whether said actual force stroke progression (Fa) / force time progression is a) above or b) below said ideal force stroke progression (Fi) / force time progression in at least one point and
- shifting the upper border (Bu) and/or the lower border (Bl) upwards in case a) and downwards in case b), wherein there are a presettable absolute upper limit (Lu), at which an upward shifting of the upper border (Bu) is inhibited, and a presettable absolute lower limit (Ll), at which a downward shifting of the lower border (Bl) is inhibited.

2. Method as claimed in claim 1, **characterized in** that there are a first zone (Z1) above and a second zone (Z2) below said ideal progression (Fi) and that

- the upper border (Bu) and/or the lower border (Bl) is shifted upwards if the actual progression (Fa) is within said first zone (Z1), and
- the upper border (Bu) and/or the lower border (Bl) is shifted downwards if the actual progression (Fa) is within said second zone (Z2).

3. Method as claimed in any one of the claims 1 to 2, **characterized in** that there are a first zone (Z1) near above, a second zone (Z2) near below, a third zone (Z3) far above, and a fourth zone (Z4) far below said ideal progression (Fi) and that

- the lower border (Bl) is shifted upwards if the actual progression (Fa) is within said first zone (Z1),
- the upper border (Bu) is shifted downwards if the actual progression (Fa) is within said second zone (Z2),
- the upper border (Bu) is shifted upwards if the actual progression (Fa) is within said third zone (Z3), and
- the lower border (Bl) is shifted downwards if the actual progression is within said fourth zone (Z4).

4. Method as claimed in claim 3, **characterized in** that the first zone (Z1) is adjacent to said ideal progression (Fi), the third zone (Z3) is spaced from the first zone (Z1), the second zone (Z2) is adjacent to said ideal progression (Fi), and the fourth zone (Z4) is spaced from the second zone (Z2).

5. Method as claimed in any one of the claims 3 to 4, **characterized in** that the upper border (Bu) is spaced from the third zone (Z3) and the lower border (Bl) is spaced from the fourth zone (Z4).

6. Method as claimed in any one of the claims 1 to 5, **characterized in** that instead of or in addition to the force (F) a physical variable derived from the force (F) is used.

7. Method as claimed in any one of the claims 1 to 6, **characterized in** that the mean value of the tolerance band

gets the ideal force progression (Fi) after a predetermined number of cycles of the method as claimed in any one of the claims 1 to 7.

8. Crimping press for manufacturing crimp connections, comprising:

- means for determination whether an actual force stroke progression (Fa) / force time progression occurring during crimping is within a tolerance band in at least one point, the tolerance band having an upper border (Bu) above and a lower border (Bl) below an ideal force stroke progression (Fi) / force time progression and
- means for qualifying a crimp as passed, for which said condition is true,

characterized in

- means for determination whether said actual force stroke progression (Fa) / force time progression is a) above or b) below said ideal force stroke progression (Fi) / force time progression in at least one point and
- means for shifting the upper border (Bu) and/or the lower border (Bl) upwards in case a) and downwards in case b), wherein there are a presettable absolute upper limit (Lu), at which an upward shifting of the upper border (Bu) is inhibited, and a presettable absolute lower limit (Ll), at which a downward shifting of the lower border (Bl) is inhibited.

9. Computer program product, which when loaded into the memory of a control for a crimping press performs the function of the method as claimed in any one of the claims 1 to 7.

10. A method of monitoring a crimping process, comprising:

generating an ideal crimping force progression level;

setting a tolerance band of actual force progression level surrounding the ideal force progression level;

providing the tolerance band with an upper border of actual force progression level above the ideal force progression level;

setting a first zone of actual crimping force progression level above the ideal force progression;

setting a first lower bound of actual force progression level as a lower bound for the first zone;

setting the level of the first lower bound of actual force progression level higher than the ideal force progression;

setting a first upper bound of actual force progression as an upper bound for the first zone;

setting the level of the first upper bound of actual force progression level higher than the first lower bound;

defining a fixed upper limit of actual crimping force progression level above the upper border;

providing the tolerance band with a lower border of actual force progression level below the ideal force progression level;

setting a second zone of actual crimping force progression level below the ideal force progression;

setting a second upper bound of actual force progression level as an upper bound for the second zone;

setting the level of the second upper bound of actual force progression level lower than the ideal force progression;

setting a second lower bound of actual force progression as a lower bound for the second zone;

setting the level of the second lower bound of actual force progression level lower than the second upper bound;

defining a fixed lower limit of actual crimping force progression level below the lower border;

measuring the actual force progression of a crimping operation;

making a determination of whether the measured actual force progression lies within the first zone or the second zone;

dynamically shifting the tolerance band defined by the upper tolerance border and lower tolerance border based on the determination; and,

limiting the dynamic shifting of the tolerance band to within the fixed upper limit and the fixed lower limit.

11. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the upper border to a higher level of force progression when the determination indicates the first zone.

12. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the lower border to a higher level of force progression when the determination indicates the first zone.

13. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the upper border to a lower level of force progression when the determination indicates the second zone.

14. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the lower border to a lower level of force progression when the determination indicates the second zone.

15. A method of monitoring a crimping process as claimed in claim 10, further comprising:

setting the upper border force progression level coincident with the first upper bound for the first zone; and,

setting the lower border force progression level coincident with the second lower bound for the second zone.

16. A method of monitoring a crimping process as claimed in claim 10, further comprising:

setting the upper border force progression level above the first upper bound for the first zone; and,

setting the lower border force progression level below the second lower bound for the second zone.

17. A method of monitoring a crimping process as claimed in claim 10, further comprising:

indicating crimps as passable when they result from a force progression within the tolerance band.

18. A method of monitoring a crimping process as claimed in claim 10, further comprising:

making the determination only when the actual force is above a threshold force.

19. A method of monitoring a crimping process, comprising:

generating an ideal crimping force progression level;

setting a tolerance band of actual force progression level surrounding the ideal force progression level;

providing the tolerance band with an upper border of actual force progression level above the ideal force progression level;

setting a first zone of actual crimping force progression level above the ideal force progression;

setting a first lower bound of actual force progression level as a lower bound for the first zone;

setting a first upper bound of actual force progression as an upper bound for the first zone;

setting the level of the first upper bound of actual force progression level higher than the first lower bound;

setting a third zone of actual crimping force progression level above the first zone and below the upper border;

setting a third lower bound of actual force progression level as a lower bound for the third zone;

setting a third upper bound of actual force progression level as an upper bound for the third zone;

defining a fixed upper limit of actual crimping force progression level above the upper border;

providing the tolerance band with a lower border of actual force progression level below the ideal force progression level;

setting a second zone of actual crimping force progression level below the ideal force progression;

setting a second upper bound of actual force progression level as an upper bound for the second zone;

setting a second lower bound of actual force progression as a lower bound for the second zone;

setting the level of the second lower bound of actual force progression level lower than the second upper bound;

setting a fourth zone of actual crimping force progression level below the second zone and above the lower border;

setting a fourth upper bound of actual force progression level as an upper bound for the fourth zone;

setting a fourth lower bound of actual force progression level as a lower bound for the fourth zone;

defining a fixed lower limit of actual crimping force progression level below the lower border;

measuring the actual force progression of a crimping operation;

making a determination of whether the measured actual force progression lies within the first zone or the second zone, or the third zone, or the fourth zone;

dynamically shifting the tolerance band defined by the upper tolerance border and lower tolerance border based on the determination; and,

limiting the dynamic shifting of the tolerance band to within the fixed upper limit and the fixed lower limit.

20. A method of monitoring a crimping process as claimed in claim 19, further comprising:

shifting the upper border to a lower level of force progression when the determination indicates the second zone.

21. A method of monitoring a crimping process as claimed in claim 19, further comprising:

shifting the upper border to a higher level of force progression when the determination indicates the third zone.

22. A method of monitoring a crimping process as claimed in claim 19, further comprising:

shifting the lower border to a higher level of force progression when the determination indicates the first zone.

23. A method of monitoring a crimping process as claimed in claim 19, further comprising:

shifting the lower border to a lower level of force progression when the determination indicates the fourth zone.

24. A method of monitoring a crimping process as claimed in claim 19, further comprising:

setting the level of the first lower bound of actual force progression level coincident with the ideal force progression; and,

setting the level of the second upper bound of actual force progression level coincident to the ideal force progression.

25. A method of monitoring a crimping process as claimed in claim 19, further comprising:

setting the upper border force progression level above the third upper bound for the third zone; and,

setting the lower border force progression level below the fourth lower bound for the fourth zone.

26. A method of monitoring a crimping process as claimed in claim 19, further comprising:

setting the level of the first lower bound of actual force progression level higher than the ideal force progression; and,

setting the level of the second upper bound of actual force progression level lower than the ideal force progression.

27. A method of monitoring a crimping process as claimed in claim 19, further comprising:

indicating crimps as passable when they result from a force progression within the tolerance band.

28. A method of monitoring a crimping process as claimed in claim 19, further comprising:

setting the upper border force progression level coincident with the third upper bound for the third zone; and,

setting the lower border force progression level coincident with the fourth lower bound for the fourth zone.

29. A method of monitoring a crimping process as claimed in claim 19, further comprising:

setting a force progression level distance between said third lower bound and said third upper bound to be one-eighteenth of the distance between the ideal force progression level and the levels of the upper and lower borders of force progression level.

30. A method of monitoring a crimping process, comprising:

generating an ideal crimping force progression level;

setting a tolerance band of actual force progression level surrounding the ideal force progression level;

providing the tolerance band with an upper border of actual force progression level above the ideal force progression level;

setting a first zone of actual crimping force progression level above the ideal force progression;

setting a first lower bound of actual force progression level as a lower bound for the first zone;

setting the first lower bound of actual force progression level coincident with the ideal force progression;

setting a first upper bound of actual force progression as an upper bound for the first zone;

setting the level of the first upper bound of actual force progression level higher than the first lower bound;

defining a fixed upper limit of actual crimping force progression level above the upper border;

providing the tolerance band with a lower border of actual force progression level below the ideal force progression level;

setting a second zone of actual crimping force progression level below the ideal force progression;

setting a second upper bound of actual force progression level as an upper bound for the second zone;

setting the second upper bound of actual force progression level coincident with the ideal force progression;

setting a second lower bound of actual force progression as a lower bound for the second zone;

setting the level of the second lower bound of actual force progression level lower than the second upper bound;

generating a fixed lower limit of actual crimping force progression level below the lower border;

measuring the actual force progression of a crimping operation;

making a determination of whether the measured actual force progression lies within the first zone or the second zone;

dynamically shifting the tolerance band defined by the upper tolerance border and lower tolerance border based on the determination; and,

limiting the dynamic shifting of the tolerance band to within the fixed upper limit and the fixed lower limit.

Claims

What is claimed is:

1. A method of monitoring a crimping process, comprising:

generating an ideal crimping force progression level;

setting a tolerance band of actual force progression level surrounding the ideal force progression level;

providing the tolerance band with an upper border of actual force progression level above the ideal force progression level;

setting a first zone of actual crimping force progression level above the ideal force progression;

setting a first lower bound of actual force progression level as a lower bound for the first zone;

setting the level of the first lower bound of actual force progression level higher than the ideal force progression;

setting a first upper bound of actual force progression as an upper bound for the first zone;

setting the level of the first upper bound of actual force progression level higher than the first lower bound;

defining a fixed upper limit of actual crimping force progression level above the upper border;

providing the tolerance band with a lower border of actual force progression level below the ideal force progression level;

setting a second zone of actual crimping force progression level below the ideal force progression;

setting a second upper bound of actual force progression level as an upper bound for the second zone;

setting the level of the second upper bound of actual force progression level lower than the ideal force progression;

setting a second lower bound of actual force progression as a lower bound for the second zone;

setting the level of the second lower bound of actual force progression level lower than the second upper bound;

defining a fixed lower limit of actual crimping force progression level below the lower border;

measuring the actual force progression of a crimping operation;

making a determination of whether the measured actual force progression lies within the first zone or the second zone;

dynamically shifting the tolerance band defined by the upper tolerance border and lower tolerance border based on the determination; and,

limiting the dynamic shifting of the tolerance band to within the fixed upper limit and the fixed lower limit.

2. A method of monitoring a crimping process as claimed in claim 1, further comprising:

shifting the upper border to a higher level of force progression when the determination indicates the first zone.

3. A method of monitoring a crimping process as claimed in claim 1, further comprising:

shifting the lower border to a higher level of force progression when the determination indicates the first zone.

4. A method of monitoring a crimping process as claimed in claim 1, further comprising:

shifting the upper border to a lower level of force progression when the determination indicates the second zone.

5. A method of monitoring a crimping process as claimed in claim 1, further comprising:

shifting the lower border to a lower level of force progression when the determination indicates the second zone.

6. A method of monitoring a crimping process as claimed in claim 1, further comprising:

setting the upper border force progression level coincident with the first upper bound for the first zone; and,
setting the lower border force progression level coincident with the second lower bound for the second zone.

7. A method of monitoring a crimping process as claimed in claim 1, further comprising:

setting the upper border force progression level above the first upper bound for the first zone; and,

setting the lower border force progression level below the second lower bound for the second zone.

8. A method of monitoring a crimping process as claimed in claim 1, further comprising:

indicating crimps as passable when they result from a force progression within the tolerance band.

9. A method of monitoring a crimping process as claimed in claim 1, further comprising:

making the determination only when the actual force is above a threshold force.

10. A method of monitoring a crimping process, comprising:

generating an ideal crimping force progression level;

setting a tolerance band of actual force progression level surrounding the ideal force progression level;

providing the tolerance band with an upper border of actual force progression level above the ideal force progression level;

setting a first zone of actual crimping force progression level above the ideal force progression;

setting a first lower bound of actual force progression level as a lower bound for the first zone;

setting a first upper bound of actual force progression as an upper bound for the first zone;

setting the level of the first upper bound of actual force progression level higher than the first lower bound;

setting a third zone of actual crimping force progression level above the first zone and below the upper border;

setting a third lower bound of actual force progression level as a lower bound for the third zone;

setting a third upper bound of actual force progression level as an upper bound for the third zone;

defining a fixed upper limit of actual crimping force progression level above the upper border;

providing the tolerance band with a lower border of actual force progression level below the ideal force progression level;

setting a second zone of actual crimping force progression level below the ideal force progression;

setting a second upper bound of actual force progression level as an upper bound for the second zone;

setting a second lower bound of actual force progression as a lower bound for the second zone;

setting the level of the second lower bound of actual force progression level lower than the second upper bound;

setting a fourth zone of actual crimping force progression level below the second zone and above the lower border;

setting a fourth upper bound of actual force progression level as an upper bound for the fourth zone;

setting a fourth lower bound of actual force progression level as a lower bound for the fourth zone;

defining a fixed lower limit of actual crimping force progression level below the lower border;

measuring the actual force progression of a crimping operation;

making a determination of whether the measured actual force progression lies within the first zone or the second zone, or the third zone, or the fourth zone;

dynamically shifting the tolerance band defined by the upper tolerance border and lower tolerance border based on the determination; and,

limiting the dynamic shifting of the tolerance band to within the fixed upper limit and the fixed lower limit.

11. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the upper border to a lower level of force progression when the determination indicates the second zone.

12. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the upper border to a higher level of force progression when the determination indicates the third zone.

13. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the lower border to a higher level of force progression when the determination indicates the first zone.

14. A method of monitoring a crimping process as claimed in claim 10, further comprising:

shifting the lower border to a lower level of force progression when the determination indicates the fourth zone.

15. A method of monitoring a crimping process as claimed in claim 10, further comprising:

setting the level of the first lower bound of actual force progression level coincident with the ideal force progression; and,

setting the level of the second upper bound of actual force progression level coincident to the ideal force progression.

16. A method of monitoring a crimping process as claimed in claim 10, further comprising:

setting the upper border force progression level above the third upper bound for the third zone; and,

setting the lower border force progression level below the fourth lower bound for the fourth zone.

17. A method of monitoring a crimping process as claimed in claim 10, further comprising:

indicating crimps as passable when they result from a force progression within the tolerance band.

18. A method of monitoring a crimping process as claimed in claim 10, further comprising:

setting the upper border force progression level coincident with the third upper bound for the third zone; and,

setting the lower border force progression level coincident with the fourth lower bound for the fourth zone.

19. A method of monitoring a crimping process as claimed in claim 10, further comprising:

setting a force progression level distance between said third lower bound and said third upper bound to be one-eighteenth of the distance between the ideal force progression level and the levels of the upper and lower borders of force progression level.

20. A method of monitoring a crimping process, comprising:

generating an ideal crimping force progression level;

setting a tolerance band of actual force progression level surrounding the ideal force progression level;

providing the tolerance band with an upper border of actual force progression level above the ideal force progression level;

setting a first zone of actual crimping force progression level above the ideal force progression;

setting a first lower bound of actual force progression level as a lower bound for the first zone;

setting the first lower bound of actual force progression level coincident with the ideal force progression;

setting a first upper bound of actual force progression as an upper bound for the first zone;

setting the level of the first upper bound of actual force progression level higher than the first lower bound;

defining a fixed upper limit of actual crimping force progression level above the upper border;

providing the tolerance band with a lower border of actual force progression level below the ideal force progression level;

setting a second zone of actual crimping force progression level below the ideal force progression;

setting a second upper bound of actual force progression level as an upper bound for the second zone;

setting the second upper bound of actual force progression level coincident with the ideal force progression;

setting a second lower bound of actual force progression as a lower bound for the second zone;

setting the level of the second lower bound of actual force progression level lower than the second upper bound;

generating a fixed lower limit of actual crimping force progression level below the lower border;

measuring the actual force progression of a crimping operation;

making a determination of whether the measured actual force progression lies within the first zone or the second zone;

dynamically shifting the tolerance band defined by the upper tolerance border and lower tolerance border based on the determination; and,

limiting the dynamic shifting of the tolerance band to within the fixed upper limit and the fixed lower limit.

21. A method of monitoring a crimping process as claimed in claim 20, further comprising:

one of the steps of, setting the upper border of force progression level higher than the first upper bound for the first zone, or alternatively, setting the upper border of force progression level coincident with the first upper bound for the first zone; and,

one of the steps of, setting the lower border of force progression level lower than the second lower bound for the second zone, or alternatively, setting the lower border of force progression level coincident with the second lower bound for the second zone.