Method of Connecting Metal Strips

A trailing end of a first metal strip is connected to a leading end of a second metal strip in a strip-treatment plant by first forming at least one of the strips as a cold-rolled, non-annealed metal strip and then superposing the trailing end of the first strip and the leading end of the second strip at an overlap. Then the strips are connected at the overlap at least 20 connection points per meter of the strips by clinching without through cutting.
METHOD OF CONNECTING METAL STRIPS

FIELD OF THE INVENTION

[0001] The present invention relates to method of connecting metal strips. More particularly this invention concerns strip-connecting method of a strip-treatment plant.

BACKGROUND OF THE INVENTION

[0002] In a strip-treatment plant it is frequently necessary to connect a trailing end of a first metal strip to the leading end of a second metal strip. To do this, the trailing and leading ends are positioned one above the other at an overlap and are connected to one another at the overlap at several connection points by clinching without separation and consequently without a cutting component.

[0003] In strip-treatment plants that are also designated as strip-processing lines, strips wound into coils are generally unwound in the upstream intake end, then run through one or more treatment stations and at the outlet end are, if required, wound up again or alternatively are also cut into plates. The leading end of a new coil is connected to the trailing end of the preceding coil so that the strips do not always have to be rethreaded. The strip connection is particularly important, since defective strip connections can have negative effects on further processing.

[0004] Therefore the most varied methods for strip connection, for example by welding, punching and/or gluing are known from the prior art (see for example U.S. Pat. No. 8,109,428 and US 2007/029039).

[0005] In practice it has been shown that, as an alternative to the conventional methods, strip connections can also be produced by punched joining, also called clinching. Clinching is a method of connecting metal strips or metal sheets without the use of an additional material. A clinching tool generally consists of punch(es) and die(s). The strips to be connected are pressed into or against the die by the punch in a similar manner to deep drawing with plastic deformation. In this case the strips are connected to one another in positive engagement (and non-positive engagement) without the use of rivets. Due to the configuration of the die and the punch, the materials flow transversely on or in the die, so that, as in a rivet connection, a positive connection is created, but without the use of separate rivets. Within the context of the invention “clinching” means punch joining without separation and consequently without cutting.

[0006] Such a method of the type described in the introduction is known for example from WO 2014/033037. In this case the connection points are produced during the strip connection by clinching, and a plurality of connection points are made spaced apart transversely with respect to the travel direction of the strip, forming one or more rows of connection points. In this case it is advantageous if the tool or the tools is/are adjusted in a position-controlled manner.

[0007] The known method of connecting strips by clinching without separation has proved successful in practice, but is capable of further development. This is the starting point for the invention.

OBJECTS OF THE INVENTION

[0008] It is therefore an object of the present invention to provide an improved method of connecting metal strips.

[0009] Another object is the provision of such an improved method of connecting metal strips that overcomes the abovementioned disadvantages, in particular that operates with high quality in a simple manner.

SUMMARY OF THE INVENTION

[0010] A trailing end of a first metal strip is connected to a leading end of a second metal strip in a strip-treatment plant by first forming at least one of the strips as a cold-rolled, non-annealed metal strip and then superposing the trailing end of the first strip and the leading end of the second strip at an overlap. Then the strips are connected at the overlap at least 20 connection points per meter of the strips by clinching without through cutting.

[0011] If the clinching it is necessary or advantageous if the components to be joined have good ductility or good forming capacity under compressive and tensile stress. In practice, therefore, it has been assumed hitherto that only metal sheets or strips with high elongation at rupture are suitable. For this reason, in the connection of aluminum strips clinching has been limited hitherto to annealed aluminum strips. Tests have now shown surprisingly that also cold-rolled, unannealed metal strips, for example aluminum strips, can be connected with sufficient quality by clinching. Tests have shown that clinching with good quality can be achieved even when the elongation at rupture A80 is only 6% or less. For the stretch at break the tensile test involves the difference between the measured length after the rupture and the initial measured length, based on the initial measured length, the stretch at break being specified as a percentage. Since the value of the stretch at break is also determined as a ratio of measured length to sample cross-section, the stretch at break is characterized in more detail by a corresponding index, wherein in the present case the stretch at break A80 is based on a tensile test at a measured length of the sample of 80 mm. Metal strips are preferably used, of which the stretch at break A80 is 2% to 5%, preferably approximately 3% to 4%. Consequently according to the invention a satisfactory strip connection is successful even in the case of cold-rolled, unannealed metal strips. The metal strips may for example be strips of aluminum or an aluminum alloy or copper or a copper alloy. In this case the fact that the strip connection is formed by a plurality of connection points is particularly significant. Preferably at least 40 connection points are used for the strip connection, preferably at least 80 connection points, particularly preferably at least 100 connection points. Because of the large number of connection points that produce the strip connection, the tearing of individual clinch points can be accepted. In this regard, the invention is based on the recognition that in the connection of unannealed, cold-rolled metal strips it is possible to operate in a boundary region in which potentially individual clinch points tear. However, because of the large number of clinch points the durability of the strip connection is not critically impaired, so that the method according to the invention can be used in practice even with unannealed, cold-rolled metal strips. In this case the plurality of connection points can be produced in a row of connection points with a plurality of connection points distributed over the strip width or particularly preferably also in a plurality of rows of connection points one behind the other in the strip-travel direction. In this case one or more rows of connection points can be produced simulta-
neously with only one single press stroke. In this respect reference may be made to the knowledge disclosed by WO 2014/033037.

[0012] Advantageous modifications of the invention are explained below:

[0013] Optionally the thickness of the trailing end of the first metal strip and/or the thickness of the leading end of the second metal strip are measured before the connection and that the clinching process is controlled or adjusted as a function of the measured thicknesses. The clinching takes place with a clinching tool that has punches and dies. Thus the depth of insertion of the punch or the punches into the material is controlled or adjusted, for example position-controlled, as a function of the measured thickness of the strip or the measured thicknesses of the strips. In this case the invention is based on the recognition that it is particularly important for the quality of the strip connection that a connection be produced without cutting and consequently without cutting edges. This presupposes that the punch does not penetrate excessively deep into the material. On the other hand, for production of a satisfactory and firm connection it is essential that the punch penetrates to a sufficient depth into the material, and as a result the depth of penetration of the punch into the strips is particularly significant. For this reason it is in principle possible to carry out the joining process in a position-controlled manner. According to the invention, however, in addition to a position adjustment or as an alternative to a position adjustment a control or adjustment of the joining process takes place as a function of the actual thicknesses of the metal strips. In practice it has been shown that the thicknesses of the strips to be connected deviate from the specified/assumed values or from the desired values. Since now according to the invention a determination of the actual thickness of the metal strips takes place, ensured during the joining process that the joining process will always carried out with an optimal depth of penetration. Particularly preferably both the thickness of the trailing end of the first strip and also the thickness of the leading end of the second strip are measured. The thickness measurement or the thickness measurements can take place for example by laser thickness measurements.

[0014] Since, according to the invention, a thickness measurement takes place, it is also no longer necessary for trailing ends or leading ends potentially having greater thickness deviations, for example excess thicknesses, to be cut off in advance, but the strip connection can be produced in such regions that are in any case cut off later if need be as scrap.

[0015] The measurement of the strip thickness or strip thickness takes place before the joining, and in fact preferably separately for each of the two strips. Alternatively, it is also within the scope of the invention to measure the overall thickness of the strips positioned one above the other (before the joining process). It is possible to measure the thickness or the thicknesses in the vicinity of or in/on the joining device. Alternatively, however, the measurement can take place at another location, for example immediately downstream of the decoiler.

[0016] According to a further aspect of the invention, it is proposed that the leading end and the trailing end and/or the clinching tool be positioned in such a way that no punch of the joining tool strikes one of the strip edges and/or that before or after connecting the strips one or more edge punches are not done on one or both strip edges. In other words the punched connection points are restricted to an inner region of the strips offset inward from the side edges of the strips.

[0017] In this case the invention is based on the discovery that, in order to prevent problems as the strips run through different components of the apparatus, satisfactory clinch points must be produced and that it must be ensured that a clinch point is not produced or is not present at a strip edge. If for example a clinch point is produced at an existing strip edge, at such an unsound clinch point depending upon the degree of coverage of the strip edge the punch can produce jagged edges on the strip. In this region later, during travel through the strip treatment line, particles break off that for example adhere to rollers and lead to marks on the strip. Consequently according to the invention precautions are taken in order to prevent the production or existence of a clinch point at a strip edge.

[0018] Therefore, optionally, the possibility exists that already during the positioning of the leading end and/or the trailing end and/or the positioning of the tool no punching of the joining tool is effected at a strip edge.

[0019] Alternatively or additionally, the invention proposes that one or more edge punches or stampings are introduced at one or both strip edges. The stamping out of metal strips is known in principle in the art for purposes of trimming the joined strips. Thus, for example, it may be advantageous to make edge punches in the strip connection of strips of unequal width, for example when the new strip wider than the old one, as the wider corners of the new strip could become stuck in the line, for example on squeeze rollers. In order to avoid this, in this case the corners are cut away obliquely by stamping using a trapezoidal or semicircular punching tool. According to the invention the possibility now exists of introducing the edge punches after clinching together the strips, provided that no connection point is cut by the punching.

[0020] Alternatively the possibility exists of making one or more edge punches before connecting the strips. This is, for example, advantageous when there is a risk of a clinching punch striking the strip edge. In this case the edges can be punched off or trimmed before connecting the strips provided that as a function of the tool geometry and the strip width a tool punch is prevented from striking a strip edge.

[0021] Apart from the possibility already mentioned above of centering the trailing end and the leading end at the center of the apparatus, the possibility exists that only one of the strips is centered with respect to the other one. Then both trailing ends or both strips lie outside of the center of the apparatus. The clinching tool is then shifted in the width direction so that the center axis thereof corresponds to the trailing ends. Then again the possibilities explained above are available in order to prevent a clinch point from being located at the strip edge.

[0022] Optionally it is possible for the clinching tool to remain fixed in the center of the apparatus. The position of the two strips relative to center of the apparatus is measured. In this way it is then known where the clinch points are in the two connected trailing ends. The edge punch now takes place for each side so that no clinch point is punched. In the event that trimming is also carried out on the fine, the punching depth on each side is correspondingly greater, but again so that no clinch point is punched.

[0023] According to a further aspect of the invention it is proposed that the strips are oiled before and/or during the clinching. The oiling of the components to be joined during the clinching is known in principle, in order to minimize the tool wear during clinching and to maximize the service life. In practice, however, it has been shown that the oiling is unfa-
vable for the deep-drawing process during clinching. This relates to the fact that the oiling reduces the friction of the components to be joined or the strips and this can have a negative effect on the connection quality or connection strength. With this as the starting point the invention now proposes that only the upper surface of the upper metal strip and the lower surface of the lower metal strip are coated with oil. Consequently according to the invention the oiling takes place exclusively from below onto the lower strip and from above onto the upper strip, so that no oiling takes place between the two strip ends. Thus the problems that are observed in practice can be avoided in a simple and reliable manner, at the same time, tool wear can be minimized and the service life can be maximized.

[0024] In an optional embodiment of the invention the strips are connected to one another by tempered clinching. Then it is provision that the metal strips to be connected are heated before and/or during the connection. To this end the possibility exists of preheating the strips themselves with suitable temperature regulating devices and then clinching them. Alternatively or additionally the temperature regulation can also take place by the clinching tools themselves. To this end the possibility exists of heating the upper tool and/or the lower tool, so that the strip is then heated under contact pressure and is then transformed. To this end it may be advantageous to operate with a non-contoured die or a non-contoured counter-tool, and the counter-tool and/or the punch can be heated. When the strips are heated by one or both tools, it may be advantageous if the strips are pressed together by suitable means, for example a clamping device or the like, before the clinching or pressing. Thus the possibility exists of pressing the strips with a holding-down tool against the (heated) mating surface, so that heating of the connection region takes place. Then the clinching takes place with the aid of the punch. However, contact pressure during the heating can also be effected by the tools or punches themselves. In the (first) heating phase then only a fixing of the strips and the heating take place and in a (second) clinching phase the connection then takes place.

[0025] For the tempered clinching it is advantageous if the movable tool, for example the upper tool, can be adjusted in position, in particular when in a heating phase the punch must be positioned on the strip for the contact preheating. In the case of contact preheating with the aid of the tool it is also advantageous if the contact pressure (during the heating) is adjustable depending upon the strip.

[0026] The tempering (heating) of the metal strips increases the formability or the forming capacity thereof, so that the connection process can be optimized. This is advantageous in particular in the connection of brittle materials, since the formability of brittle materials can be improved by tempering. Overall the tempering may be advantageous in the case of specific materials or combinations of materials. The formation of cracks can be avoided.

[0027] The method according to the invention can be carried out with an apparatus for connecting metal strips. Such an apparatus is generally characterized by a connection press with a press frame, an upper press part and a lower press part, and an upper tool with at least one punch (or die) for the clinching is carried by the upper press part and a lower tool with at least one die (or punch) for the clinching is carried by the lower press part, the upper press part and/or the lower press part being movable (with respect to one another) by one or more drives for application of a pressing force. Thus the possibility exists of moving the upper press part with the upper tool with the aid of drives against the fixed lower tool or vice versa. The drives may for example be hydraulic pressing cylinders. In this case in particular existing designs of punched connection presses can also be used. High pressing forces can be applied, so that not only individual connection points but also at the same time a plurality of connection points can be set, in particular one or more complete rows of connection points.

[0028] Thus the invention proposes that the upper tool is a multiple tool with a plurality of punches (or dies) distributed over the strip width and the lower tool is a multiple tool with a plurality of dies (or punches) distributed over the strip width.

[0029] Taking into account the fact that the method should be adaptable in a simple manner to different strips and in particular strip thickness, it is particularly preferable to provide a tool changer with a plurality of upper tools and a plurality of lower tools (and consequently a plurality of tool sets) that can be moved selectively out of a working position inside the press to a working position outside the press, and vice versa.

[0030] With the aid of the tool changer it is possible to provide a plurality of clinching tools or tool sets, so that a simple adaptation of the machine to the particular situation, in particular to different strip thicknesses, can take place. In addition, it is possible to equip the tool changer with an additional (conventional) punching tool, so that if required the machine can also be converted into a punching device.

[0031] As already explained, the tools for the clinching generally have a punch on the one hand and a die on the other hand. The die may for example be a contoured or profiled die that can be adapted to the shape of the punch. Within the context of the invention, however, “die” may also mean a non-contoured, flat die and consequently a flat counter-tool, so that also so-called “dieless” clinching methods are covered.

[0032] The apparatus can be equipped with one or more thickness sensors that can measure the thickness of the trailing end of the first metal strip and/or the thickness of the leading end of the second metal strip. Moreover, a control and/or adjustment device may be provided by which the clinching process can be controlled or adjusted as a function of the measured thickness or the measured thicknesses. Furthermore one or more punching devices can be provided that can do one or more edge punches before and/or during the connecting the strips. Finally the apparatus may be equipped with one or more oils, by which the metal strip or the metal strips and/or the tools can be oiled.

BRIEF DESCRIPTION OF THE DRAWING

[0033] The above and other objects, features, and advantages will become more readily apparent from the following description, reference being made to the accompanying drawings in which:

[0034] FIG. 1 is a vertical section through a first embodiment;
[0035] FIG. 2 is a simplified view in direction x of FIG. 1;
[0036] FIG. 3 is a vertical section through a second embodiment;
[0037] FIG. 4 is a side view of the second embodiment of FIG. 3;
[0038] FIG. 5 is a simplified view in direction y of FIG. 3; and
FIG. 6 is a simplified view of the clinch connection with strip-thickness measurement.

SPECIFIC DESCRIPTION OF THE INVENTION

[0040] The drawings show an apparatus for connecting metal strips, specifically for connecting a trailing end of a first metal strip to the leading end of a second metal strip. Such an apparatus is preferably integrated into a strip-processing plant (strip-processing line), for example in the upstream intake end of such a strip-processing line. Coiled metal strips are unwound at the intake, then run through various treatment stations and are coiled up again at the downstream outlet end or further processed in some other manner. The leading end of a new coil is connected to the trailing end of the preceding coil so that the metal strips do not always have to be rethreaded. For this purpose the leading end and the trailing end are positioned one above the other at an overlap and are connected to one another at a plurality of connection points at the overlap. Such connection process is known in principle. The metal strips are not shown in FIGS. 1 to 5, only the strip plane E is indicated.

[0041] According to the invention, the connection points are produced by clinching without cutting. To this end, the apparatus has a connection press 2 with a press frame 3 in turn having an upper part 4 and a lower part 5. A strip-travel direction B is indicated in FIG. 4, in FIGS. 1 and 3 it is perpendicular to the drawing plane. An upper tool 6 with a plurality of punches 8 for the clinching is carried by the upper press part 4. A lower tool 7 with a plurality of dies 9 for the clinching is carried by the lower press part 5. The upper tool 6 with the punches 8 and the lower tool 7 with the dies 9 form a tool set 10a, 10b, 10c. The upper tool 6 and the lower tool 7 each have multiple tools each with a plurality of punches 8 and dies 9 distributed over the strip width. In the illustrated embodiments the upper press part 4 is movable against the stationary lower press part 5 by drives 11 for application of the pressing force. Here, the drives 11 are hydraulic pressing cylinders 11 whose pistons are connected to the movable upper press part 4 and are supported on the stationary upper beam of the press frame 3. FIGS. 1 and 3 each show the press 2 in a divided view closed in one half and opened in the other half. The upper press part 4 is guided on the press frame 3 on guides 15.

[0042] The illustrated embodiments are each equipped with a tool changer 12 that has a plurality of tool sets 10a, 10b, 10c each consisting of an upper tool 6 and a lower tool 7. With the aid of this tool changer 12 the individual tool sets 10a, 10b, 10c can be selectively moved from a working position inside the press into a waiting position outside the press and vice versa. This way it is possible to replace the tools and to adapt the apparatus to requirements, for example to the respective strip thickness. Different tools are preferably used for the connection of specific strip thicknesses. Different tools are preferably used for the connection of specific strip thicknesses.

[0043] FIGS. 1 and 2 on the one hand and FIGS. 3 to 5 on the other hand show two embodiments with differently configured tool changers 12.

[0044] In FIGS. 1 and 2 a first embodiment is illustrated in which the tools 6, 7 are moved by the tool changer 12 transversely with respect to the strip-travel direction B out of the working position and into the waiting position. In this embodiment the tool changer 12 is laterally adjacent to the press 2 for this purpose. It has a change table 14 with a plurality of tool sets 10a, 10b, 10c, one behind the other in the strip-travel direction B. If the tool located in the connection press 2 is to be replaced, it is pulled (or pushed) transversely with respect to the strip-travel direction B out of the press and onto the change table 14. The change table 14 then moves parallel to the strip-travel direction, for example by one position, so that then another tool can be pushed (or pulled) transversely with respect to the strip-travel direction B into the press 2. In the simplified plan view in FIG. 2 it can be seen that in the illustrated embodiment four different tools or tool sets 10a, 10b, 10c, 10d are in the tool changer 12. Three tool sets 10a, 10b, 10c where one, two or three rows of connection points can be set are provided for the clinching. Consequently the first tool set 10a has a single row of punches and dies, whereas the second tool set 10b has two rows of punches and dies one behind the other in the strip-travel direction B and the third tool set 10c has three rows of punches and dies one behind the other in the strip-travel direction B, so that selectively with one single press stroke one, two or three rows of connection points can be set, depending upon which tool set 10a, 10b, 10c is in the press 2. An additional tool set 10d is also provided that is a punching tool 10f, so that the press can also be simply converted for a punched connection. It is clear that different tool sets can be used for example for different strip thicknesses or strip thickness regions, and the individual tool sets 10a, 10b, 10c generally have different point diameters or punch diameters. For thin strips small point diameters are generally used, and then a relatively large number of connection points are set. For thick strips large point diameters are used, and fewer points are then generally set.

[0045] In this case it can be seen that the upper tool 6 and the lower tool 7 are connected to one another by guides 13 while forming the tool set 10a, 10b, 10c. Here, there are guide posts 13 that ensure that the upper tool 6 and the lower tool 7 with punches and dies are satisfactorily brought together in the desired position. In this case each tool set has a total of four guide posts 13 at the corners. This also applies to the embodiment according to FIGS. 1 and 2 as well as to the embodiment according to FIGS. 3 and 4.

[0046] While the tool sets 10a, 10b, and 10c or 10d are changed transversely with respect to the strip-travel direction B in the embodiment according to FIGS. 1 and 2, FIGS. 3 to 5 show a second embodiment in which the tool sets 10a, 10b, 10c or 10d are moved along the strip-travel direction B for changing purposes. The individual tool sets are in turn one behind the other in the strip-travel direction B; however, this time they are not laterally offset relative to the connection press 2, but are offset relative to the connection press 2 in the strip-travel direction. Nevertheless, travel of the metal strip is not disrupted, since the upper tools 6 are always above the metal strip or the strip plane E and the lower tools 7 are always below the metal strip, and since the guide posts 13 are always outside the strip region. In this embodiment the tool set can then also be changed when the strip is in the machine. FIG. 4 shows a view in which, for example, the punch tool 10f is in the machine.

[0047] In order to be able to change the tool sets 10a, 10b, 10c, 10d, change drives are generally provided, for example hydraulic drives that are not shown in detail in the drawings.

[0048] The tools indicated in FIGS. 2 and 5 show that with the apparatus according to the invention, a plurality of connection points spaced apart transversely with respect to the strip-travel direction B can be simultaneously produced, forming at least one row of connection points extending over the strip width or almost the full strip width. Depending on which of the tools is used, a plurality of rows of connection
points one behind the other in the strip-travel direction can also be produced simultaneously. Thus the possibility exists of making the entire strip connection with one single press stroke, even when there are several rows of connection points. The connection press provides sufficient pressing forces with the hydraulic cylinders 11.

[0049] The principle of the clinch connection according to the invention is illustrated by way of example and in a simplified manner in FIG. 6. In this case the trailing end of the first metal strip B1 and the leading end of the second metal strip B2 and their overlap are shown, and the connection points are set by clinching there with the clinching tool 6, 7. In this case a clinch connection without cutting is shown. FIG. 6 shows that the thickness D1 of the trailing end of the first metal strip B1 is measured by a first thickness sensor 16 and the thickness D2 of the leading end of the second metal strip B2 is measured by a second thickness sensor 17, before connecting the strips. These thickness sensors 16, 17 can be designed for example as optical thickness sensors, for example using laser radiation. These thickness sensors 16, 17 make it possible to control the joining process with or without feedback as a function of the measured thickness or the measured thicknesses D1, D2, using a controller. In the illustrated embodiment the thickness sensors are in the immediate vicinity of the joining tools, and can be integrated into it. However, the invention also comprises embodiments in which the thickness sensors are at another position inside the strip-treatment plant, so for example a thickness sensor can be immediately downstream of a decoiler in order to measure the thickness of the leading end there, and its corresponding output signal or the corresponding value can then be processed during the strip connection.

[0050] Moreover as shown in FIG. 6, the possibility exists of oiling the strips with oils 18, 19. In this in the illustrated embodiment at the overlap only the upper surface of the upper metal strip B2 and the lower surface of the lower metal strip B1 are oiled. Optionally and additionally the possibility exists of oiling the corresponding tool surfaces.

[0051] An edge trimmer 20 for squaring the edges of the strips after they have been clinched together is shown in FIG. 4.

[0052] The options illustrated in FIG. 6 can be used individually or in combination, for example in an apparatus according to FIGS. 1 to 5, but also alternatively in the differently configured apparatuses.

We claim:
1. A method of connecting a trailing end of a first metal strip to the leading end of a second metal strip in a strip-treatment plant, the method comprising the steps of:
   forming at least one of the strips as a cold-rolled, non-annealed metal strip; superposing the trailing end of the first strip and the leading end of the second strip at an overlap; and connecting the strips at the overlap at least 20 connection points per meter of the strips by clinching without through cutting.
2. The strip-connecting method defined in claim 1, wherein the first strip and/or the second strip is/are formed of aluminum, an aluminum alloy, copper, or a copper alloy.
3. The strip-connecting method defined in claim 1, wherein the material of the metal strips has a stretch at break A50 of a maximum of 8%.
4. The strip-connecting method defined in claim 3, wherein the stretch at break is 2% to 5%.
5. The strip-connecting method defined in claim 3, wherein the stretch at break is 3% to 4%.
6. The strip-connecting method defined in claim 1 wherein at least 30 connection points per meter are set by clinching.
7. The strip-connecting method defined in claim 1, wherein at least 50 connection points per meter are set by clinching.
8. The strip-connecting method defined in claim 1, further comprising the step of:
   measuring the thickness of the trailing end of the first and/or of the second metal strip before connection; and
   controlling the clinching process as a function of the measured thickness or thicknesses.
9. The strip-connecting method defined in claim 8, wherein the clinching process is controlled by controlling a depth of insertion of a clinching tool as a function of the measured thickness or thicknesses.
10. The strip-connecting method defined in claim 9, wherein the depth is increased as the measured thickness or thickness increases.
11. The strip-connecting method defined in claim 1, further comprising the step of:
   restricting the connections points to an inner region of the strips inwardly offset from side edges of the strips.
12. The strip-connecting method defined in claim 11, further comprising the step of:
   trimming the side edges of the strips after setting the connection points.
13. The strip-connecting method defined in claim 1, further comprising, when one of the strips is above the other of the strips at the overlap, the steps of:
   lubricating only an upper face of the one strip and a lower face of the other strip prior to clinching together while excluding lubrication of a lower face of the one strip and an upper face of the other strip such that there is no lubrication between the strips at the overlap.

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