United States Patent	12390881
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Mizushima; Daisuke

Laser welding method

Abstract

A laser welding method according to this disclosure is a laser welding method for welding first and second coils (members) to each other by applying a laser beam to the first and second coils in a state where the first and second coils are brought into contact with each other. The laser welding method includes: a first step of forming a weld pool by applying a laser beam to the first coil; and a second step of continuing the application of the laser beam to the first coil until the width of a bridge formed between the first and second coils becomes wider than the width of the laser beam, the bridge being formed such that the weld pool is attached to the second coil by growing.

Inventors: **Mizushima; Daisuke (Toyota, JP)**

Applicant: **TOYOTA JIDOSHA KABUSHIKI KAISHA** (Toyota, JP)

Family ID: **1000008764203**

Assignee: **TOYOTA JIDOSHA KABUSHIKI KAISHA (Toyota, JP)**

Appl. No.: **17/717699**

Filed: **April 11, 2022**

Prior Publication Data

Document Identifier	Publication Date
US 20220371123 A1	Nov. 24, 2022

Foreign Application Priority Data

JP	2021-084082	May. 18, 2021

Publication Classification

Int. Cl.: **H02K15/00** (20250101); **B23K26/06** (20140101); **B23K26/21** (20140101); **B23K26/322** (20140101); **H02K15/35** (20250101); B23K101/36 (20060101)

U.S. Cl.:

CPC **B23K26/21** (20151001); **B23K26/322** (20130101); **H02K15/35** (20250101); B23K2101/36 (20180801)

Field of Classification Search

CPC: H02K (15/00); B23K (26/06); B23K (26/22)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
10717153	12/2019	Nakamura	N/A	H01R 4/021
2018/0036836	12/2017	Nakamura	N/A	B23K 26/0736
2019/0199153	12/2018	Nishimura	N/A	H02K 15/35
2020/0083787	12/2019	Fujiyoshi	N/A	H02K 15/35
2020/0112236	12/2019	Hirao	N/A	H01R 4/029

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
107671420	12/2017	CN	N/A
2018-20340	12/2017	JP	N/A
2018-30155	12/2017	JP	N/A
2019-140839	12/2018	JP	N/A
2019-181506	12/2018	JP	N/A

Primary Examiner: Abraham; Ibrahime A

Assistant Examiner: Samuels; Lawrence H

Attorney, Agent or Firm: Sughrue Mion, PLLC

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION
(1) This application claims priority to Japanese Patent Application No. 2021-084082 filed on May 18, 2021, incorporated herein by reference in its entirety.
BACKGROUND
1. Technical Field
(2) This disclosure relates to a laser welding method.
2. Description of Related Art
(3) Laser beam welding is known as a welding method for a stator coil. In a case where laser beam welding is used, the dimension of a welded portion can be made compact in comparison with a case where conventional TIG arc welding is used, and this makes it possible to downsize a whole product dimension.

(4) As a related art, Japanese Unexamined Patent Application Publication No. 2019-140839 (JP 2019-140839 A) describes a manufacturing method for a rotary electric machine. The manufacturing method can prevent or restrain an insulating coating from being damaged in a case where a coil wire is welded to a neutral line in the rotary electric machine. The manufacturing method described in JP 2019-140839 A includes: a placing step of placing, in a contacting manner, a connection part set in a coating-peeled part in an end part of a coil wire covered with an insulating coating and a connection part set in a neutral line; and a welding step of performing laser beam welding on a contact portion such that a side closer to the insulating coating is set as a staring point and a side distant from the insulating coating is set as an end point. The starting point of the laser beam welding is an end part of the contact portion that is closer to the insulating coating, and the end point of the laser beam welding is an end part of the contact portion that is distant from the insulating coating. On the side closer to the insulating coating, it is possible to achieve a relatively small amount of heat to be input by the welding in comparison with the side distant from the insulating coating.

SUMMARY

(5) With reference to FIGS. **9**A, **9**B, **9**C, problems of this disclosure will be described. FIG. **9**A is a view illustrating a schematic configuration of a stator **101** according to another related art. The stator **101** includes a stator core **102** and a plurality of coils **110**. The stator core **102** is configured such that annular electromagnetic steel sheets are laminated in the axial direction of the stator **101** (the z-axis direction in FIG. **9**A). The coils **110** are mounted on respective slots provided on an inner peripheral surface of the stator core **102**, and respective end parts (coil ends) of the coils **110** project from an upper end surface of the stator core **102**.

(6) FIG. **9**B is a view illustrating, in a magnified manner, the vicinity of an end part of a section A**10** of the coils **110** along the axial direction in FIG. **9**A. As illustrated in FIG. **9**B, the coils **110** are provided such that coils **110** adjacent to each other in the radial direction of the stator **101** (the x-axis direction in FIG. **9**B) are paired. Respective end parts of the paired coils **110** are brought into contact with each other and are subjected to a laser beam from above. Hereby, the coils **110** can be joined to each other.

(7) FIG. **9**C is a view illustrating a partial region A**20** in FIG. **9**B in a further magnified manner. In FIG. **9**C, coils **110***a*, **110***b* are adjacent to each other in the radial direction (the x-axis direction in FIG. **9**C). In a state where respective end parts of the coils **110***a*, **110***b* are brought into contact with each other, the respective end parts are subjected to a laser beam L from above. Hereby, the coils **110***a*, **110***b* can be joined to each other.

(8) Here, like the example illustrated in FIG. **9**C, other members including coils **110***c*, **110***d* may be placed below the coils **110***a*, **110***b*. Here, the coils **110***a*, **110***b* are targeted for welding, but the coils **110***c*, **110***d* and so on placed below the coils **110***a*, **110***b* are not targeted for welding. In order to perform welding, metallic materials are exposed in the respective end parts of the coils **110***a*, **110***b* targeted for welding. In the meantime, the coils **110***c*, **110***d* that are not targeted for welding are covered with insulating coatings, as illustrated in FIG. **9**C.

(9) For example, a single mode laser with a spot diameter of 0.1 mm is used as the laser beam L. The single mode laser has a high energy density and can weld coils to each other while a deep keyhole is formed. Accordingly, the single mode laser is good at efficiently melting, with a little heat, copper or the like that is hard to melt. However, in a case where there is a gap of 0.05 mm or more on a contacting face for welding between the coil **110***a* and the coil **110***b*, the laser beam L might penetrate through the contacting face, and the insulating coatings of the coil **110***c* and the coil **110***d* below the coil **110***a* and the coil **110***b* might be burned out. The burnout of the insulating coatings can cause serious material defects that directly lead to poor insulation.

(10) In order to solve such a problem, it is conceivable to use a jig configured to clamp coils highly accurately so as not to generate a gap of 0.05 mm or more on a contacting face for welding. However, in a case where such a jig is provided, the productivity of products does not improve

because of restrictions on a space for the jig, and the manufacturing cost increases.
(11) This disclosure is accomplished in view of the above problems, and an object of this disclosure is to provide a laser welding method that can reduce such a risk that a laser beam penetrates through between members targeted for welding.
(12) A laser welding method according to this disclosure is a laser welding method for welding a first member and a second member to each other by applying a laser beam to the first member and the second member in a state where the first member and the second member are brought into contact with each other. The laser welding method includes: a first step of forming a weld pool by applying the laser beam to the first member; and a second step of continuing the application of the laser beam to the first member until a width of a bridge formed between the first member and the second member becomes wider than a width of the laser beam, the bridge being formed such that the weld pool is attached to the second member by growing.
(13) With this disclosure, it is possible to provide a laser welding method that can reduce such a risk that a laser beam penetrates through between members targeted for welding.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:
(2) FIG. **1** is a perspective view illustrating a schematic configuration of a stator;
(3) FIG. **2** is a view diagrammatically illustrating end parts of coils;
(4) FIG. **3** is a side view of a joined portion and illustrates a laser welding method according to an embodiment;
(5) FIG. **4** is a side view of the joined portion and illustrates the laser welding method according to the embodiment;
(6) FIG. **5** is a side view of the joined portion and illustrates the laser welding method according to the embodiment;
(7) FIG. **6** is a side view of the joined portion and illustrates the laser welding method according to the embodiment;
(8) FIG. **7** is a plan view of the joined portion and illustrates the laser welding method according to the embodiment;
(9) FIG. **8** illustrates appearance pictures of the joined portion and illustrate the laser welding method according to the embodiment;
(10) FIG. **9**A is an explanatory view illustrating a laser welding method according to a related art;
(11) FIG. **9**B is an explanatory view illustrating the laser welding method according to the related art; and
(12) FIG. **9**C is an explanatory view illustrating the laser welding method according to the related art.
DETAILED DESCRIPTION OF EMBODIMENTS
(13) A concrete embodiment to which this disclosure is applied will be described in detail with reference to the drawings. However, this disclosure is not limited to the following embodiment. Further, the following description and drawings are simplified appropriately to make the description clear.
(14) First, with reference to FIG. **1**, a configuration of a stator **100** including coils **10** to be welded by use of a laser welding method according to the present embodiment will be described. FIG. **1** is a perspective view illustrating a schematic configuration of the stator **100**. As illustrated in FIG. **1**, the stator **100** that is a stator for a motor includes a stator core **15** and a plurality of coils **10**.

(15) The stator core **15** is configured such that annular electromagnetic steel sheets are laminated in the axial direction of the stator **100** (the z-axis direction in FIG. **1**). The stator core **15** has a generally cylindrical shape as a whole. On an inner peripheral surface of the stator core **15**, teeth **13** projecting toward the inner peripheral side and extended in the axial direction of the stator **100**, and slots **14** as grooves each formed between adjacent teeth **13** are provided. The coils **10** are mounted in the slots **14**. The coil **10** is formed generally in a U-shape, and both end parts of the coil **10** project from an upper end surface of the stator core **15**.
(16) The coil **10** may be an electric wire having a rectangular section, that is, a flat wire, for example. Further, generally, the coil **10** is made of pure copper, but the coil **10** is not limited to this. The coil **10** may be made of a metallic material having a high conductivity such as aluminum or an alloy mainly containing copper or aluminum.
(17) The xyz right-handed coordinate system illustrated in FIG. **1** is illustrated for convenience of description of a positional relationship between constituents. Generally, a z-axis positive side represents a vertically upper side, and an xy-plane represents a horizontal plane. This is common between the figures. The x-axis represents the radial direction of the stator **100**. Herein, a direction directed outwardly from the center of the stator **100** is defined as an x-axis positive direction. Further, the y-axis represents the circumferential direction of the stator **100**. On a section A**1** of the coil **10** along the axial direction in FIG. **1**, a direction directed from the near side on the plane of paper toward the depth side is defined as a y-axis positive direction. Further, the z-axis represents the axial direction of the stator **100**. A direction directed from bottom up along the vertical direction of the stator **100** is defines as a z-axis positive direction.
(18) In the present embodiment, respective end parts of coils **10** adjacent to each other in the radial direction (the x-axis direction) are welded to each other by a laser beam L, so that a joined portion **20** (described later) is formed. The coils **10** adjacent to each other are paired to form one joined portion **20**, so that a plurality of joined portions **20** is formed in the whole stator **100**. The joined portions **20** may be arranged in a toric shape along the circumferential direction of the stator core **15**. Further, the joined portions **20** thus arranged in a toric shape may be placed in a plurality of rows along the radial direction.
(19) FIG. **2** is a view diagrammatically illustrating ends of the coils **10** by enlarging the vicinity of the section A**1** of the coils **10** in FIG. **1**. Each of the coils **10** is paired with its adjacent coil **10** in the radial direction. In FIG. **2**, for example, four pairs of coils **10** are illustrated. Respective end parts of the adjacent coils **10** are brought into contact with each other, and an abutment part between the end parts is subjected to the laser beam L, so that the joined portion **20** is formed between the coils **10**. Hereby, the adjacent coils **10** can be welded to each other.
(20) The following description deals with, as an example, a case where a coil **10***a* (a first member) and a coil **10***b* (a second member) illustrated in FIG. **2** are welded to each other by applying the laser beam L to the coils **10***a*, **10***b* in a state that the coils **10***a*, **10***b* are brought into contact with each other.
(21) As illustrated in FIG. **2**, the coils **10***a*, **10***b* are covered with insulating coatings **12***a*, **12***b*, respectively. The insulating coatings **12***a*, **12***b* may be insulating coatings formed by baking an enamel material or coating with vinyl-chloride-based resin or the like. Further, in respective end parts **11***a*, **11***b* of the coils **10***a*, **10***b*, the insulating coatings **12***a*, **12***b* are peeled off, so that a metallic material (e.g., copper) is exposed. By applying the laser beam L to the end parts **11***a*, **11***b* to form the joined portion **20**, the coils **10***a*, **10***b* are welded to each other.
(22) A plurality of joined portions **20** is formed by welding respective end parts of coils **10** adjacent to each other in the radial direction such that the joined portions **20** are arranged in a toric shape along the circumferential direction of the stator core **15**. Further, the joined portions **20** arranged in a toric shape are placed in a plurality of rows in the radial direction.
(23) The coils **10***a*, **10***b* may be placed at a position where the laser beam L can be applied to members other than the coils **10***a*, **10***b* in a case where the laser beam L penetrates through the coils

10*a*, **10***b*. Here, a plurality of other coils **10** not targeted for welding is placed below the coils **10***a*, **10***b* (in a z-axis negative direction). The coils **10** not targeted for welding are fully covered with insulating coatings **12**, including their end parts. Accordingly, in a case where the laser beam L penetrates through a gap between the coils **10***a*, **10***b* at the time when the laser beam L is applied to the coil **10***a*, **10***b* placed above the coils **10** not targeted for welding, the coils **10** not targeted for welding might be burned out.

(24) Next will be described a laser welding method according to the present embodiment with reference to FIGS. **3** to **6**. FIGS. **3** to **6** are side views each illustrating the vicinity of the joined portion **20** between the coils **10***a*, **10***b*. As the laser beam L, a wide laser beam to be emitted from a laser light source of around 1.0 mm may be selected, for example. The laser beam L may be ring mode laser or the like, for example.

(25) FIG. **3** is a view to describe a first step. As illustrated in FIG. **3**, first, the laser beam L is applied to the end part **11***a* of the coil **10***a* so as to form a weld pool **30** in the end part **11***a* (the first step).

(26) FIG. **4** is a view to describe a second step. The application of the laser beam L is continued at a fixed point in the end part **11***a* so as to grow the weld pool **30**. Due to the growth and vibration of the weld pool **30**, the weld pool **30** is attached to the end part **11***b*. Hereby, a bridge (coating) by the weld pool **30** is formed between the end parts **11***a*, **11***b*. After the bridge is formed, the application of the laser beam L to the end part **11***a* is continued until the width of the bridge formed between the end parts **11***a*, **11***b* becomes wider than a width W (not illustrated) of the laser beam L (the second step).

(27) Here, the width W of the laser beam L represents the spot diameter of the laser beam L applied to the end parts **11***a*, **11***b*. In a case where the laser beam L has a circular shape, for example, the width W of the laser beam L may be the diameter of the laser beam L at an application position where the laser beam L is applied to the end parts **11***a*, **11***b*. Further, in a case where the laser beam L has an elliptical shape, the width W of the laser beam L may be the long diameter or the short diameter of the laser beam L at the application position. The bridge is formed by continuing the application of the laser beam L to the end part **11***a* in consideration of the width W of the laser beam L or the shape of the laser beam L so that the laser beam L does not penetrate through a gap between the end parts **11***a*, **11***b*. Thus, the bridge of the weld pool **30** is formed between the end parts **11***a*, **11***b* such that the bridge has a width wider than the width W of the laser beam L.

(28) Note that, in the second step, a time during which the application of the laser beam L to the end part **11***a* is continued may be set in advance. For example, an appropriate application time can be set in advance such that an image of a welding state is captured by use of a high-speed camera, and the depth of the welding or the like on a sectional view of the joined portion **20** in the middle of the welding or after the welding is observed. By setting the application time in advance, it is possible to perform the welding efficiently. In addition, it is possible to restrain occurrence of defects.

(29) Subsequently, as illustrated in FIG. **5**, the laser beam L is moved from the end part **11***a* to the end part **11***b* such that the laser beam L moves over the bridge. Since the bridge is formed to be wider than the width W of the laser beam L, the laser beam L can be moved without causing the laser beam L to penetrate through between the end parts **11***a*, **11***b*.

(30) Subsequently, as illustrated in FIG. **6**, the application of the laser beam L to the end part **11***b* is continued until weld-penetration of the coil is deepened sufficiently in the end part **11***b*. Hereby, the joined portion **20** by the weld pool **30** is formed between the end parts **11***a*, **11***b*. Note that the application time of the laser beam L to the end part **11***b* may be set in advance by use of a high-speed camera or the like, similarly to the application time to the end part **11***a*.

(31) By performing the above process repeatedly in accordance with the length (in the y-axis direction) of the gap to be filled between the end parts **11***a*, **11***b*, the welding between the coils **10***a*, **10***b* can be completed.

(32) Next will be described the abovementioned process viewed from a different direction with reference to FIGS. **7**, **8**. Further, the following description deals with a case where the abovementioned process is performed repeatedly. In the above example, the weld pool **30** and the bridge are formed from the end part **11***a* to the end part **11***b* in the first and second steps. Herein, a similar process is also performed from the end part **11***b* to the end part **11***a*. Accordingly, the following description further includes third and fourth steps corresponding to the first and second steps.
(33) FIG. **7** is a plan view of the joined portion **20** and illustrates the laser welding method according to the embodiment. The laser beam L is applied in order of application positions (**1**) to (**8**) in FIG. **7** so as to weld the coils **10***a*, **10***b* to each other. FIG. **8** illustrates appearance pictures of the joined portion **20** that correspond to the application positions (**1**) to (**8**) of the laser beam L illustrated in FIG. **7**.
(34) An application path of the laser beam L will be described with reference to FIG. **7**. First, the laser beam L is applied to the end part **11***a* of the coil **10***a* at the application position (**1**) so as to form the weld pool **30** in the end part **11***a* (the first step).
(35) Then, the application of the laser beam L is continued at the fixed point in the end part **11***a* so as to grow the weld pool **30**. Due to the growth and vibration of the weld pool **30**, the weld pool **30** is attached to the end part **11***b*. Hereby, the bridge by the weld pool **30** is formed between the end parts **11***a*, **11***b*. After the bridge is formed, the application of the laser beam L to the end part **11***a* is continued until the width of the bridge formed between the end parts **11***a*, **11***b* becomes wider than the width W of the laser beam L (the second step).
(36) Hereby, the bridge of the weld pool **30** is formed between the end parts **11***a*, **11***b* such that the bridge is wider than the width W (see (**1**) in FIG. **8**) of the laser beam L. A time during which the application of the laser beam L to the end part **11***a* is continued may be set in advance by use of a high-speed camera or the like.
(37) After the second step, the laser beam L is moved to the end part **11***b* as indicated by the application position (**2**) in FIG. **7**. Since the laser beam L moves over the bridge formed in the first and second steps, the laser beam L can move from the end part **11***a* to the end part **11***b* without penetrating through between the end parts **11***a*, **11***b*.
(38) After the laser beam L is moved to the end part **11***b*, the application of the laser beam L to the end part **11***b* is continued until weld-penetration of the coil is deepened sufficiently in the end part **11***b*. Thus, the joined portion **20** is formed between the end parts **11***a*, **11***b*. Note that the application time of the laser beam L to the end part **11***b* may be set in advance by use of a high-speed camera or the like, similarly to the application time to the end part **11***a*.
(39) Subsequently, as indicated by the application position (**3**), the laser beam L is moved to the insulating coating **12***b* side (a y-axis negative direction). At the application position (**4**), the laser beam L is continuously applied to the end part **11***b* so as to form a weld pool **30** (the third step).
(40) Subsequently, the application of the laser beam L is continued at the application position (**4**) so as to grow the weld pool **30**. Due to the growth and vibration of the weld pool **30**, the weld pool **30** is attached to the end part **11***a*. Hereby, a second bridge by the weld pool **30** is formed between the end parts **11***a*, **11***b*. After the second bridge is formed, the application of the laser beam L to the end part **11***b* is continued until the width of the bridge formed between the end parts **11***a*, **11***b* becomes wider than the width W of the laser beam L (the fourth step).
(41) Hereby, the second bridge of the weld pool **30** is formed between the end parts **11***a*, **11***b* such that the second bridge has a width wider than the width W of the laser beam L. A time during which the application of the laser beam L to the end part **11***b* is continued may be set in advance by use of a high-speed camera or the like. Further, since the end part **11***b* has been already heated by the laser beam L, an application time shorter than the application time to the end part **11***a* to form a first bridge may be set.
(42) After the fourth step, the laser beam L is moved to the end part **11***a* as indicated by the

application position (**5**). Since the laser beam L moves over the second bridge formed in the third and fourth steps, the laser beam L can move from the end part **11***b* to the end part **11***a* without penetrating through between the end parts **11***a*, **11***b*.
(43) After the laser beam L is moved to the end part **11***a*, the application of the laser beam L to the end part **11***a* is continued until weld-penetration of the coil is deepened sufficiently in the end part **11***a*. Thus, a second joined portion **20** is formed between the end parts **11***a*, **11***b*. Note that the application time of the laser beam L to the end part **11***a* may be set in advance by use of a high-speed camera or the like, similarly to the application time to the end part **11***b*. Further, since the end part **11***a* has been already heated by the laser beam L, an application time shorter than the application time to the end part **11***b* to form the first joined portion **20** may be set.
(44) Subsequently, as indicated by the application position (**6**), the laser beam L is moved to the insulating coating **12***a* side (the y-axis positive direction). Then, as indicated by the application positions (**7**), (**8**), the laser beam L is moved to the x-axis positive direction and the y-axis negative direction so as to fill the gap between the end parts **11***a*, **11***b*. Thus, the joined portions **20** between the end parts **11***a*, **11***b* are integrated, so that the welding between the coils **10***a*, **10***b* is completed.
(45) Note that, in FIG. **7**, respective arrows indicative of the application positions (**1**) to (**8**) are illustrated so as not to overlap with each other, but the application positions (**1**) to (**8**) are not limited to this. For example, the end point of the arrow indicative of the application position (**6**) may overlap with the application position (**1**). Further, the end point of the arrow indicative of the application position (**8**) may be on the line of the arrow indicative of the application position (**5**), for example. Further, in a case where the bridge is formed such that the laser beam L does not penetrate through between the end parts **11***a*, **11***b*, the application positions may be set such that the arrows do not overlap with each other as illustrated in FIG. **7**.
(46) Further, the application positions of the laser beam L are not limited to those illustrated in FIG. **7**. For example, the laser beam L may be applied in a zigzag manner along the y-axis direction.
(47) As described above, with the laser welding method according to the present embodiment, a bridge by the weld pool **30** can be formed so as to cover the gap between the end parts **11***a*, **11***b*. Further, since the application of the laser beam L to the end part **11***a* or **11***b* is continued until the width of the bridge becomes wider than the width W of the laser beam L, it is possible to restrain the laser beam L from penetrating through the gap between the end parts **11***a*, **11***b*.
(48) Accordingly, even in a case where there is a gap between the end parts **11***a*, **11***b*, it is possible to restrain the laser beam L from being applied to other members placed below the end parts **11***a*, **11***b*. Accordingly, even in a case where other coils **10** or members that are not targeted for welding are placed below the coils **10***a*, **10***b* targeted for welding, it is possible to perform welding appropriately while a risk that those members are burned out is reduced. This makes it possible to simplify a clamp jig and to reduce the cost.
(49) Further, with the laser welding method according to the present embodiment, it is possible to form a plurality of bridges between the end parts **11***a*, **11***b* by the laser beam L and to apply the laser beam L continuously by causing the laser beam L to reciprocate between the end parts **11***a*, **11***b*. Accordingly, it is possible to efficiently perform welding between the coils **10**.
(50) Note that the disclosure is not limited to the above embodiment, and various modifications can be made within a range that does not deviate from the gist of the disclosure. For example, only one laser beam L is used in the abovementioned description, but this disclosure is not limited to this, and a plurality of laser beams L may be used. For example, in a case where two laser beams L are used, applications of the two laser beams L may be started at the same time from the application positions (**1**), (**4**) illustrated in FIG. **7** as respective application start positions for the two laser beams L.

Claims

1. A laser welding method for welding a first member and a second member to each other by applying a laser beam to the first member and the second member in a state where the first member and the second member are brought into contact with each other, the laser welding method comprising: forming a first weld pool by applying the laser beam to the first member; continuing the application of the laser beam to the first member until a width of a first bridge formed between the first member and the second member becomes wider than a width of the laser beam, the first bridge being formed such that the first weld pool is attached to the second member by growing; moving, after the continuing the application of the laser beam to the first member until a width of a first bridge formed between the first member and the second member becomes wider than a width of the laser beam, the laser beam to the second member and continuously applying the laser beam to the second member to form a second weld pool; and continuing the application of the laser beam to the second member until a width of a second bridge formed between the first member and the second member becomes wider than the width of the laser beam, the second bridge being formed such that the second weld pool formed in the second member is attached to the first member by growing, wherein a time during which the laser beam is applied to the first member is a first predetermined time set after starting the forming the first weld pool, based on an image of a welding state captured by use of a camera, and wherein a time during which the laser beam is applied to the second member is a second predetermined time set after starting the forming the second weld pool, based on an image of a welding state captured by use of the camera, the second predetermined time being shorter than the first predetermined time.
2. The laser welding method according to claim 1, wherein the first member and the second member are coils each including an insulating coating.
3. The laser welding method according to claim 1, wherein the first member and the second member are placed at a position where, in a case where the laser beam penetrates through between the first member and the second member, the laser beam is to be applied to a member other than the first member and the second member.