feeder 40 unwinds and feeds out the strip-shaped steel sheet M from a wound hoop material F. More specifically, the feeder 40 includes a hoop feeding device 42. The strip-shaped steel sheet M is unwound and fed out from the hoop material F by this hoop feeding device 42. The hoop feeding device 42 is provided, for example, with a pair of clamping rolls 44. The strip-shaped steel sheet M is fed out while being gripped from both sides by the pair of clamping rolls 44. Further, the strip-shaped steel sheet M is fed from the feeder 40 to the oil application part 50, the pressing part 60, the adhesive application part 70, and the lamination part 80. The direction in which this strip-shaped steel sheet M is fed out is called the feeding direction, and is indicated by the symbol C in the drawing. Here, in the following, "downstream" and "downstream side" refer to downstream and the downstream side in the feeding direction of the strip-shaped steel sheet M. Further, when reference is made to "upstream" or an "upstream side", this indicates upstream or the upstream side in the feeding direction of the strip-shaped steel sheet M.

[0014] The strip-shaped steel sheet M is, for example, an electromagnetic steel sheet. As the electromagnetic steel sheet, a known electromagnetic steel sheet may be used. For example, a non-oriented electromagnetic steel sheet may be used, or a grain-oriented electromagnetic steel sheet may be used, as the electromagnetic steel sheet. As the non-oriented electromagnetic steel sheet, the non-oriented electrical steel strip of JIS C2552:2014 may be used. As the grain-oriented electromagnetic steel sheet, the grain-oriented electrical steel strip of JIS C2553:2012 may be used. Further, both sides of the strip-shaped steel sheet M may be covered with an insulation coating.

[0015] The oil application part 50 is the portion of the manufacturing apparatus 30 that applies oil to the strip-shaped steel sheet M that will be the material for the core sheets 22. The oil application part 50 is provided, for example, with plural nozzles 52 that apply oil by spraying the oil toward one surface of the strip-shaped steel sheet M. Oil is supplied to each nozzle 52 from an oil supply source (not shown). Here, in the oil application part 50 of the present embodiment, processing oil for pressing is applied to the strip-shaped steel sheet M. Further, in the present embodiment, each nozzle 52 applies the oil in a downward orientation. Therefore, oil is applied to the upper surface of the strip-shaped steel sheet M. Furthermore, the oil is applied across the entire width of the strip-shaped steel sheet M.

[0016] The pressing part 60 is the portion of the manufacturing apparatus 30 that performs punch processing on the strip-shaped steel sheet M. This pressing part 60 is provided with a first-stage punching part 62 and a second-stage punching part 64.

[0017] The first-stage punching part 62 is located downstream of the oil application part 50

the female die 64b, and the strip-shaped steel sheet M is fed downstream.

[0025] Plural stator tooth parts 26 are formed at the strip-shaped steel sheet M by the first-stage punching part 62 and the second-stage punching part 64. Here, the plural tooth parts 26 are portions at which windings configuring the stator are formed as concentrated windings or distributed windings.

[0026] The adhesive application part 70 is a portion of the manufacturing apparatus 30 that has the function of applying an adhesive to one surface of the strip-shaped steel sheet M. The adhesive application part 70 is provided with an adhesive supply device 72, a supply channel 74, an application head 76, and a steel sheet holder 71.

[0027] The adhesive supply device 72 is a device that supplies adhesive from an adhesive container (not shown) that stores adhesive, to the application head 76. For example, an anaerobic adhesive is used as the adhesive that bonds together the core sheets 22. As an anaerobic adhesive, for example, "ARONTITE" (registered trademark) manufactured by Toagosei Co., Ltd. may be used. Further, the adhesive supply device 72 may be attached to the fixed mold 90, or it may be installed in a separate location from the fixed mold 90. Similarly, the adhesive container may be attached to the fixed mold 90, or it may be installed in a separate location from the fixed mold 90.

[0028] The supply channel 74 is a flow path for supplying adhesive from the adhesive container to the application head 76. The supply channel 74 is configured, for example, by a non-metallic material. Specifically, the supply channel 74 is a pipe configured by a resin material; that is, a resin pipe.

[0029] The application head 76 is attached to the leading end of the supply channel 74 and is the portion that applies the adhesive to one surface of the strip-shaped steel sheet M. The application head 76 is housed in a recessed housing part 91 provided on the upper surface of the fixed mold 90. Here, the application head 76 of the present embodiment is an example of an application part in the present disclosure. Further, in Figs. 5 to 6A and 6B, the arrow A indicates the flow of the adhesive.

[0030] As shown in Fig. 3, the application head 76 has plural discharge ports 77 for discharging adhesive. The adhesive supply device 72 is configured to be able to continuously discharge adhesive from the plural discharge ports 77. Therefore, adhesive is continuously discharged from the plural discharge ports 77. Furthermore, as used herein, "adhesive is continuously discharged from the discharge ports 77" includes continuously discharging adhesive from the discharge ports 77 onto the strip-shaped steel sheet M from an adhesive application position to at least a next adhesive application position by means of the adhesive

supply device 72.

[0031] Further, as shown in Fig. 4, each discharge port 77 faces upward. That is, each discharge port 77 faces the lower surface of the strip-shaped steel sheet M at a time of manufacturing the laminated core 20. In the present embodiment, in a state in which adhesive is protruding from the discharge port 77 (in other words, a state in which the adhesive is exiting from the discharge port 77 upwards) as shown in Fig. 6B, the discharge port 77 and the strip-shaped steel sheet M are brought close to each other such that a gap remains between the discharge port 77 and the strip-shaped steel sheet M, and adhesive is applied to the lower surface of the strip-shaped steel sheet M.

[0032] In the application head 76, portions configuring the respective discharge ports 77 are configured by non-metallic material. Further, portions configuring the discharge ports 77 of the application head 76 include an inner wall surface 77b configuring the discharge port 77 and a peripheral part 77a of the discharge port 77.

[0033] Further, as shown in Fig. 4, the application head 76 has a storage part 78 for storing adhesive supplied from an external source. Specifically, the resin pipe configuring the supply channel 74 is connected to a connection port of the application head 76, and the supply channel 74 is communicated with the storage part 78. The storage part 78 is communicated with each discharge port 77. Therefore, the adhesive sent through the supply channel 74 is discharged from each discharge port 77 via the storage part 78. Further, in the application head 76, portions configuring the storage part 78 are configured by non-metallic material.

Here, the portions configuring the storage part 78 in the application head 76 include an inner wall surface 78a configuring the storage part 78 and an inner wall surface 78b of a flow path portion connecting the storage part 78 and the discharge port 77.

[0034] Further, since the storage part 78 is a portion that stores the adhesive, a portion that is narrower in diameter than the discharge port 77 is not formed in the storage part.

[0035] The application head 76 of the present embodiment has an annular protrusion 79 on its surface (the top surface in Fig. 4) that protrudes from the surface. This protrusion 79 has, for example, an annular shape. The top part of this protrusion 79 is a flat surface that is flat in the circumferential direction (hereinafter, referred to as "top surface 79a" as appropriate). The plural discharge ports 77 are formed on the top surface 79a of the protrusion 79, spaced apart in the circumferential direction of the protrusion 79. Here, in the present embodiment, since the top part of the protrusion 79 is a flat surface, plural discharge ports 77 are formed on the flat surface; however, in a case in which the top part of the protrusion 79 is a curved surface that curves in an arc shape as viewed in cross-section, the discharge port 77 is formed at the

periphery punching male die 82 is able to move vertically together with the spring 86 in a state in which it is supported by the spring 86. The outer periphery punching male die 82 has an outer diameter that is substantially the same as the outer diameter of the laminated core 20.

[0042] The outer periphery punching female die 84 is a die having a cylindrical internal space, and has an internal diameter that is substantially the same as the outer diameter of the laminated core 20.

[0043] The heater 88 is integrally incorporated into the outer periphery punching female die 84. The heater 88 heats the core sheets 22, which are stacked inside the outer periphery punching male die 84, from the surroundings thereof. In a case of using a heat-curing type adhesive, the adhesive hardens upon receipt of heat from the heater 88. Further, in a case of using a room-temperature curing adhesive, the adhesive hardens at room temperature without requiring heating. Further, in a case of using a room-temperature curing type adhesive, the heater 88 may be omitted.

[0044] According to the lamination part 80, in a state in which the feeding of the strip-shaped steel sheet M is paused, the outer periphery punching male die 82 is lowered to sandwich the strip-shaped steel sheet M between itself and the outer periphery punching female die 84. Further, by pushing the outer periphery punching male die 82 into the outer periphery punching female die 84, core sheets 22 with their outer periphery punched out are obtained from the strip-shaped steel sheet M.

[0045] The core sheets 22 punched out from the strip-shaped steel sheet M are laminated onto the upper surface of other core sheets 22 that have been punched out previously and laminated and bonded inside the outer periphery punching female die 84. Further, pressure from the outer periphery punching male die 82 and heat from the heater 88 are applied. At this time, the pressure applied to the core sheet 22 from the outer periphery punching male die 82 is maintained at a constant level by the biasing force of the spring 86. Furthermore, the spring 86 may be omitted by appropriately setting the height position of the male die 82.

[0046] As a result, the core sheet 22 currently punched out is bonded to the upper surface of the core sheet 22 previously punched out. By repeating these respective processes of periphery punching, pressurizing, and heating a number of times equal to the number of layers of the respective core sheets 22, a laminated core 20 is formed inside the outer periphery punching female die 84. A fixed laminated core 20 is transferred to the lower side of the mold through a through-hole (not shown in Fig. 2) formed in the fixed mold 90 and ejected from the mold.

[0047] As shown in Fig. 2, the female die 62b, the female die 64b, the application head 76,

the outer periphery punching female die 84, and the heater 88 are fixed on the fixed mold 90.

[0048] The male die 62a, the male die 64a, the steel sheet holder 71, and the outer periphery punching male die 82 are fixed to the lower surface of the movable mold 92.

[0049] When the strip-shaped steel sheet M is fed toward the downstream side and paused, the movable mold 92 is brought closer to the fixed mold 90—that is, lowered—whereby punching out of the outer periphery of the core sheet 22, lamination and bonding, applying adhesive to the position of the core sheet 22 that will next have its outer periphery punched out at the strip-shaped steel sheet M, the second punching process at the position at which the adhesive will be applied next at the strip-shaped steel sheet M, and the first punching process at the position at which the second punching operation will be performed next at the strip-shaped steel sheet M, are performed simultaneously.

[0050] Next, the movable mold 92 is raised and stowed above the strip-shaped steel sheet M, after which the strip-shaped steel sheet M is fed only a predetermined distance toward the downstream side again and then paused again. In this state, the movable mold 92 is lowered, and processing continues at each position. In this way, the laminated core 20 is manufactured by repeatedly feeding the strip-shaped steel sheet M intermittently and moving the movable mold 92 up and down during pauses.

[0051] Explanation follows regarding the mechanism and effects of the present exemplary embodiment.

In cases in which members that configure a channel for anaerobic adhesive to flow in (for example, pipes, mold channels, and the like) are formed from metal materials, the anaerobic adhesive reacts with the metal, and a curing reaction progresses steadily even in a state in which curing accelerators or the like are not added. As the curing reaction of an anaerobic adhesive progresses, its fluidity decreases. In particular, in narrow channels, pipes, and bends in channels, even a slight decrease in fluidity can cause clogging. For example, in a case of applying an anaerobic adhesive to a strip-shaped steel sheet M using a needle-shaped metal nozzle, the anaerobic adhesive is susceptible to solidifying within the metal nozzle. In this way, the curing reaction of the anaerobic adhesive can proceed easily inside the metal nozzle, causing a change in viscosity, as a result of which it becomes difficult to apply the correct amount of adhesive to the strip-shaped steel sheet M as time passes. In cases of punching out core sheets 22 at punching speeds of 100 spm or more in particular, since the anaerobic adhesive, having undergone a curing reaction, has reduced fluidity, it becomes more difficult to apply the appropriate amount of adhesive to the strip-shaped steel sheet M. In contrast, in the manufacturing apparatus 30 of the present embodiment, the portion

configuring the discharge port 77 of the application head 76 is configured by a non-metallic material. In the present embodiment, the discharge port 77, which discharges the adhesive, is the portion having the narrowest diameter in the flow path of the adhesive. By configuring the portion configuring these discharge ports 77 from a non-metallic material, it becomes possible to suppress the progression of a curing reaction of the adhesive inside the discharge port 77. Further, in the application head 76, the storage part 78 that delivers adhesive to the discharge port 77 also has the parts that configure the storage part 78 configured by non-metallic material. Therefore, it is possible to suppress the progress of a curing reaction of the adhesive inside the storage part 78. Furthermore, since the components configuring the supply channel 74 are also configured by non-metallic materials, it is possible to suppress the progress of the curing reaction of the adhesive within the supply channel 74. By configuring the portions that configure the flow path of the adhesive with non-metallic materials in this way, the progression of a curing reaction of the adhesive can be suppressed, and it becomes possible to apply the appropriate amount of adhesive to the strip-shaped steel sheet M. Further, since the progression of a curing reaction of the adhesive can be suppressed, even in cases of punching out core sheets 22 at punching speeds of 100 spm or more, it becomes possible to apply the appropriate amount of adhesive to the strip-shaped steel sheet M. Furthermore, since the progression of a curing reaction of the adhesive can be suppressed, maintenance of the application head 76 in response to clogging will not be required for a long period of time. Therefore, maintainability is improved.

[0052] Further, in the manufacturing apparatus 30, in a state in which the adhesive is protruding from the discharge port 77 as shown in Fig. 6B, the discharge port 77 and the strip-shaped steel sheet M are brought close to each other such that a gap remains between the discharge port 77 and the strip-shaped steel sheet M, and adhesive is applied to the lower surface of the strip steel plate. Here, in a case in which the discharge port 77 is contacted against the strip-shaped steel sheet M and the adhesive is applied, there is a risk that the curing reaction of the anaerobic adhesive contacting the strip-shaped steel sheet M will be accelerated. In contrast, in the manufacturing apparatus 30, since a gap remains between the discharge port 77 and the strip-shaped steel sheet M when the adhesive is applied, the curing reaction of the anaerobic adhesive is less likely to be accelerated, and clogging of the discharge port 77 can be suppressed.

[0053] Further, in the manufacturing apparatus 30, the entire application head 76 is configured by a non-metallic material. For this reason, compared to a case in which a part of the application head 76 is made of a metal material, it becomes possible to reliably suppress

the strip-shaped steel sheet and punch out a core sheet;

continuously discharging an adhesive from a plurality of discharge ports that are configured by a non-metallic material and that are included in an application part provided at the lower mold or the upper mold, and applying the adhesive to one surface of the strip-shaped steel sheet; and

laminating the core sheet, which has been punched out from the strip-shaped steel sheet by pressing by the upper mold and the lower mold, while bonding the core sheet with the adhesive.

[0080] Further, the disclosure of Japanese Patent Application No. 2023-195401 filed on November 16, 2023, is incorporated herein by reference in its entirety.

[0081] All publications, patent applications and technical standards mentioned herein are incorporated herein by reference to the same extent as if each individual publication, patent application and technical standard were specifically and individually indicated to be incorporated by reference.

Description of Reference Numerals

[0082]

20 LAMINATED CORE
22 CORE SHEET
30 MANUFACTURING APPARATUS
40 FEEDER
50 OIL APPLICATION PART
60 PRESSING PART
62 FIRST-STAGE PUNCHING PART
64 SECOND-STAGE PUNCHING PART
70 ADHESIVE APPLICATION PART
72 ADHESIVE SUPPLY DEVICE
74 SUPPLY CHANNEL
76 APPLICATION HEAD
80 LAMINATION PART
90 FIXED MOLD
92 MOVABLE MOLD
100 APPLICATION HEAD
102 PAD
110 APPLICATION HEAD