

DEVICE FOR MANUFACTURING COATED WIRE

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a device for
5 manufacturing a coated wire such as a resin bond wire
saw (a wire saw formed by fixing abrasive grains to a
wire with a resin adhesive). More particularly, it
relates to a device for manufacturing a fixed abrasive
grain wire saw to be used for slicing materials for a
10 compound semiconductor substrate, such as solar cells,
a substrate for electronics, and gallium arsenide, and
materials for a magnetic and optical substrate, such
as a magnetic body, a crystal, and glass.

15 BACKGROUND OF THE INVENTION

[0002] A resin bond wire saw is produced by heating
and curing a coating material while causing a coated
core wire made by applying a coating material paste
containing abrasive grains to travel. It is disclosed
20 that an enamel wire baking furnace (e.g., Japanese
Patent No. 3078020 B) and an image furnace (e.g.,
Japanese Patent No. 5792208 B) are used for heating.

[0003] The enamel wire baking furnace has an
electrically-heated furnace system and a hot gas
25 circulation furnace system. The electrically-heated
furnace heats inside the furnace by providing an
electric heater in the baking chamber. In the furnace

with hot gas circulation, a baking chamber is partially arranged in a hot gas circulation path. A great amount of hot gas is circulated in the baking device. In either method, there is a limit in the travelling speed of the coated core wire. In either type, there is a limit in a travelling speed of a coated core wire and thus it was difficult to perform heating treatment at high speed, e.g., 100 m/min/unit. [0004] Heating treatment with use of an image furnace is a system to converge heat rays (infrared rays) to a focal point irradiated from a heat source with a curved reflecting plate and cause a coated core wire to travel at the focal point. In this system, heating treatment at high speed, e.g., 100 m/minute/unit or more can be performed. In this system, the coated core wire that is travelling is covered by a transparent cylinder to prevent a reflecting surface from clouding with a volatile component from a coating material paste generated when heating the coated core wire. When the volatile component reaches an inner circumferential surface of the transparent cylinder, however, the volatile component is condensed on the inner circumferential surface, resulting in tarnish due to contamination of the inner circumferential surface. When the inner circumferential surface gets tarnished, heat rays (infrared rays) irradiated from a heating source are blocked from penetrating walls of

the transparent cylinder and thus being difficult to heat the coated core wire. As a result, there was a disadvantage of a decrease in efficiency of heating treatment. In addition, once the inner
5 circumferential surface of the transparent cylinder was contaminated, it was needed to exchange and clean the transparent cylinder. There was a disadvantage of a decrease in production efficiency due to frequent exchanges of the transparent cylinder.

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PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0005] Patent Document 1: Japanese Patent No. 3078020

B

15 Patent Document 2: Japanese Patent No. 5792208

B

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

20 [0006] In a device for manufacturing a coated wire such as a resin bond wire saw by heating a coated core wire while causing the coated core wire to pass through a hollow portion of a transparent cylinder, it is an object of the present invention to provide a
25 device for manufacturing a coated wire having a transparent cylinder which does not easily get tarnished, capable of solving a problem such as a

decrease in production efficiency due to exchanges of the transparent cylinder.

MEANS FOR SOLVING THE PROBLEMS

5 [0007] The inventors of the present invention have found out that a coated wire such as a resin bond wire saw can effectively be manufactured with travelling of the coated core wire by sending out rectified gas to the inner circumferential surface of a lower end of
10 the transparent cylinder. As a result, the inventors have accomplished the present invention as a result of their careful study to solve the aforementioned problems.

[0008] The summary of the present invention is
15 described as below.

In a first preferred aspect, there is provided a device for manufacturing a coated wire according to the present invention which includes: means for applying a coating material paste to a core wire;
20 means for causing a coated core wire applied with the coating material paste to travel upward; heating means for curing the applied coating material paste by irradiating heat rays to the travelling coated core wire; a transparent cylinder for surrounding at least
25 a portion in the coated core wire where the heat rays are irradiated by inserting the coated core wire; and means for forming a gas flow provided at a lower end

of the transparent cylinder, the gas flow forming means for feeding gas having been introduced from a compressed gas source into a hollow portion of the transparent cylinder, in which an opening for going
5 round along an inner circumferential surface is formed between the gas flow forming means and the inner circumferential surface of the transparent cylinder, and gas is fed from the opening into the hollow portion of the transparent cylinder by the gas flow
10 forming means.

[0009] In a second preferred aspect of the device for manufacturing a coated wire according to the present invention, the gas flow forming means includes a baffle plate having a diameter of smaller than an
15 inner diameter of the transparent cylinder, and an outer circumferential surface of the baffle plate is faced to the inner circumferential surface of the transparent cylinder via a gap, which is an opening.

[0010] In a third preferred aspect of the device for
20 manufacturing a coated wire according to the present invention, the gas flow forming means includes: a baffle plate positioned at an upper end of the gas flow forming means; a cylindrical intermediate member having a diameter of smaller than the diameter of the
25 baffle plate; a base part for supporting the intermediate member; and a cylindrical side wall having an inner diameter of greater than a diameter of

an outer circumferential surface of the intermediate member and an outer diameter of not greater than the diameter of the baffle plate. The intermediate member is vertically arranged from a central part of the base part and is arranged coaxially with the baffle plate to be interposed between the base part and the baffle plate. The side wall is vertically arranged coaxially with the outer circumferential surface of the intermediate member on an upper surface of the base part with the intermediate member surrounded. In addition, an upper edge of the side wall is coupled to a lower surface of the baffle plate. The base part has a mounting surface where the transparent cylinder is mounted and is arranged coaxially with the side wall such that a gap is formed between the inner circumferential surface of the transparent cylinder to be mounted and an outer circumferential surface of the side wall. An inlet port for introducing gas from the compression gas source into a space surrounded by the baffle plate, the intermediate member, the base part, and the side wall is provided on the bottom of the base part. A plurality of outlet ports internally and externally penetrating the side wall are circumferentially formed at intervals on the side wall in a circumferential direction. An insertion hole for penetrating central axes of the baffle plate, the

intermediate member, and the base part up and down where the coated core wire is inserted is formed.

[0011] In a fourth preferred aspect of the device for manufacturing a coated wire according to the present invention, an axial direction of each of the plurality of outlet ports is obliquely faced to a radial direction of the transparent cylinder.

[0012] In a fifth preferred aspect of the device for manufacturing a coated wire according to the present invention, the plurality of outlet ports are continuously opened in a circumferential direction.

[0013] In a sixth preferred aspect of the device for manufacturing a coated wire according to the present invention, a guide cylinder vertically and coaxially arranged with a central axis of the intermediate member is provided on the base part and is vertically arranged in a detachable manner by guiding an outer circumferential surface of the transparent cylinder to an inner circumferential surface of the guide cylinder.

[0014] In a seventh preferred aspect of the device for manufacturing a coated wire according to the present invention, a heating source for irradiating infrared rays is used for the heating means arranged near the outer circumferential surface of the transparent cylinder.

[0015] In an eighth preferred aspect of the device for manufacturing a coated wire according to the present

invention, the heating means includes a plurality of image furnaces vertically arranged.

ADVANTAGES OF THE INVENTION

5 [0016] According to the present invention, it is possible to prevent an inner circumferential surface of a transparent cylinder surrounding a coated core wire from getting dirty due to a volatile component generated when heating the coated core wire to be
10 cured. Stable production can continuously be performed without a decrease in heating efficiency at the time when heating the coated core wire by a heating means to be cured. In addition, production can be performed without a decrease in production
15 efficiency by reducing the frequency of exchanges and cleaning of the transparent cylinder.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

20 FIG. 1 (a) is a front viewed cross-section schematic view showing an aspect of a device for manufacturing a coated wire of the present invention;

FIG. 1 (b) is a cross-section schematic view showing an aspect of a gas flow forming means of the
25 present invention;

FIG. 2 is a schematic view showing an inside of the gas flow forming means of the device for manufacturing a coated wire shown in FIG. 1 (b);

FIG. 3 is a schematic view showing an inside of
5 the gas flow forming means of the device for manufacturing a coated wire in another aspect shown in FIG. 1 (b).

FIG. 4 is a cross-sectional end view of the gas
10 flow forming means shown in FIG. 2;

FIG. 5 is a cross-sectional end view, in which the gas flow forming means shown in FIG. 4 is viewed from line A-A;

FIG. 6 is a cross-sectional end view, in which
15 the gas flow forming means shown in FIG. 4 is viewed from line B-B;

FIG. 7 is a cross-sectional end view, in which the gas flow forming means shown in FIG. 4 is viewed from line C-C;

FIG. 8 is a cross-sectional end view showing
20 still another aspect of the gas flow forming means of the device for manufacturing a coated wire shown in FIG. 1 (b);

FIG. 9 is a cross-sectional end view showing a
25 further aspect of the gas flow forming means shown in FIG. 1 (b);

FIG. 10 is a cross-sectional end view, in which the gas flow forming means shown in FIG. 9 is viewed from line D-D;

FIG. 11 is a cross-section view, in which the gas
5 flow forming means shown in FIG. 9 is viewed from line E-E; and

FIG. 12 is a cross-sectional end view showing a still further aspect of the gas flow forming means shown in FIG. 1 (b).

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Embodiments of a device for manufacturing a coated wire of the present invention will now be described below.

15 [0019] A device for manufacturing a coated wire of the present invention is a device for manufacturing a resin bond wire saw by fixing abrasive grains to a core wire surface via a resin.

[0020] FIGS. 1 (a) and 1 (b) each show one example of
20 an aspect of a device for manufacturing a coated wire of the present invention. Similar reference numerals shown in each figure are identical or similar.

[0021] As shown in FIGS. 1 (a) and 1 (b), a device 2
for manufacturing a coated wire of this embodiment
25 includes: an application means 6 for applying a coating material paste to a core wire 4; a travelling means for causing a coated core wire 8 (not shown)

formed by applying the coating material paste to travel from downward to upward (arrow 3); a heating means 10 for heating the travelling coated core wire 8 to cure the coating material paste; and a transparent cylinder 16 for surrounding a heated part of the coated core wire 8 to be heated by the heating means 10. The transparent cylinder 16 is arranged in a standing position, making a travelling axis of the coated core wire 8 as a central axis. A gas flow forming means 18 for introducing compressed gas from outside to be rectified and sending out gas into the inside of the transparent cylinder 16 is provided at a lower end of the transparent cylinder 16. An insertion hole 26 where the coated core wire 8 is inserted and travels is provided in a central portion of the gas flow forming means 18. Reference numeral 12 shows a guide roll for guiding the travelling of the core wire 4 and the coated core wire 8.

[0022] The heating means 10 is preferably a heat source that radiates heat rays. Halogen lamps and infrared lamps are exemplified as the heating means 10. More particularly, a heating source with use of infrared rays is preferable as a heat source of the heating means 10. Irradiation of infrared rays effectively facilitates a chemical reaction of curing an adhesive composition contained in the coating material paste. This enables a curing reaction at

high speed, compared to the case in which a resin is cured by heating with use of hot gas. As a result, a uniform higher-order structure of the molecules can be obtained. An image furnace can concentrate beams at a position of the coated core wire 8 by the reflection of hot rays with a reflecting curved plate, resulting in superior heating efficiency. A plurality of image furnaces are preferably disposed along a direction where the core wire 4 travels. Infrared gold image furnaces (Trademark registration "Gold Image") produced by ADVANCE RIKO, Inc. are used as image furnaces.

[0023] The heating means 10 has three stages in this embodiment. In the lowest stage-heating means 10, the coated core wire 8 is heated to evaporate a volatile component such as an organic solvent. As well as evaporating the remaining volatile component, the middle stage-heating means 10 sinters the coated core wire 8. The upper stage-heating means 10 sufficiently adds the heat to the coated core wire 8 to bake a resin containing abrasive grains at the core wire 4. While the temperature of the heating means 10 from the lower stage to the upper stage may be set constant, the temperature may be set at higher or lower from the lower stage to the higher stage according to physical properties of the coated core wire 8. The number of stages of the heating means 10 is not limited to three

but may be one stage, two stages or four stages or more.

[0024] The transparent cylinder 16 is arranged, surrounding the coated core wire 8 in such a manner to divide between the heating means 10 and the coated core wire 8. A quartz glass cylinder is used for the transparent cylinder 16 due to the request for heating the coated core wire 8 by passing through hot rays irradiated from the heating means 10. The transparent cylinder 16 is not limited to the quartz glass cylinder but preferably has thermal resistance and has a high transmittance of hot rays. The transparent cylinder 16 has an inner diameter d of e.g., 20 mm to 50 mm.

[0025] The gas flow forming means 18 includes a base part 32 situated at a lower end, an intermediate member 36 situated at the midpoint, a side wall 38, and a baffle plate 28 situated at an upper end in a travelling direction order of the coated core wire 8. Broken lines drawn in the gas flow forming means 18 in FIGS. 1 (a) and 1 (b) each show a boundary of each part. Central axes of the base part 32, the intermediate member 36, the side wall 38, and the baffle plate 28 are arranged coaxially with the travelling axis of the coated core wire 8. A space surrounded by the baffle plate 28, the intermediate member 36, the side wall 38, and the base part 32 is

formed as an annular gas chamber 48. An insertion hole 26 where the coated core wire 8 is inserted is formed, vertically penetrating through the central axes of the baffle plate 28, the intermediate member 36, and the base part 32. The gas flow forming means 18 takes gas from a compressed gas source into the annular gas chamber 48 to rectify gas and feeds the rectified gas to a hollow portion of the transparent cylinder 16 ("a hollow portion of the transparent cylinder" is hereafter referred to as "a hollow portion"). As a compressed gas source, an air compressor or an air pump is used when gas is air and a gas cylinder is used when gas is nitrogen gas and the like.

[0026] The base part 32 is arranged at a lower end of the gas flow forming means 18. A mounting surface 42 where the transparent cylinder 16 is mounted and a guide cylinder 44 for guiding the transparent cylinder 16 to the mounting surface are provided on the base part 32. The guide cylinder 44 is vertically arranged relative to the mounting surface 42 in the base part 32, making the travelling axis of the coated core wire 8 as a central axis. An outer circumferential surface of the lower end of the transparent cylinder 16 is guided into an inner circumferential surface of the guide cylinder 44 to be provided up and down in a detachable manner.

[0027] The baffle plate 28 is placed at the upper end of the gas flow forming means 18 and its diameter is smaller than the inner diameter of the transparent cylinder 16. An upper surface of the baffle plate 28 is horizontally provided in the same manner as the diameter direction of the transparent cylinder 16. An annular opening 20 having a gap g is formed between an outer circumferential surface of the baffle plate 28 and an inner circumferential surface of the mounted transparent cylinder 16. Rectified gas is fed from this opening 20 to the hollow portion of the transparent cylinder 16. The gap g is, for example, 0.5 mm to 2 mm. While the shape of the outer edge of the baffle plate 28 may be selected according to the shape of the inner circumferential surface of the corresponding transparent cylinder 16, the shape may also be annular and polygonal. The upper surface of the baffle plate 28 may both face obliquely instead of being horizontal and may be a convex.

[0028] The intermediate member 36 is cylindrical having a diameter smaller than the diameter of the baffle plate 28 and is arranged in a standing manner from the center of the base part 32, which is connected to the lower surface of the baffle plate 28. The side wall 38 has an inner diameter of greater than the diameter of the outer circumferential surface of the intermediate member 36 and has an outer diameter

equal to or smaller than the outer diameter of the
baffle plate 28. The upper end of the side wall 38 is
connected to the lower surface of the baffle plate 28.
The lower end of the side wall 38 is connected to the
5 upper surface of the base part 32. A predetermined
gap 22 is also formed between the inner
circumferential surface of the transparent cylinder 16
and the outer circumferential surface of the side wall
38. The gap width of the predetermined gap 22 may be
10 equal to or smaller or greater than that of the gap g
of the annular opening 20.

[0029] An inlet port 58 leading to the annular gas
chamber 48 from outside is provided on the bottom of
the gas flow forming means 18. Gas is introduced from
15 the compressed gas source into the annular gas chamber
48 via a pipe joint (not shown) connected to the inlet
port 58. A plurality of outlet ports 50 penetrating
inside and outside are arranged in a circle with a
predetermined interval in the circumference direction
20 on the side wall 38 (FIG. 2). Gas brought into the
annular gas chamber 48 passes through the plurality of
outlet ports 50 and is derived to the gap 22 formed
between the inner circumferential surface of the
transparent cylinder 16 and the outer circumferential
25 surface of the side wall 38. Gas derived to the gap
22 moves upward from the gap 22 and is fed into a
hollow portion of the transparent cylinder 16 from the

annular opening 20. Gas fed from the entire circumference of the annular opening 20 into the hollow portion goes up along the inner circumferential surface of the transparent cylinder 16. That is, gas
5 fed from the annular opening 20 into the hollow portion of the transparent cylinder 16 forms a gas flow layer in parallel with the inner circumferential surface of the transparent cylinder 16, i.e., a gas curtain. A plurality of inlet ports 58 instead of an
10 inlet port may be disposed on the bottom of the gas flow forming means 18. The plurality of outlet ports 50 provided on the side wall 38 may be not only arranged at intervals but may also be continuously opened in a circumference direction (FIG. 3).

15 [0030] Compressed gas derived from the inlet port 58 to the gas chamber 48 is once blocked at the side wall 38 and spreads all over the gas chamber 48. As a result, the gas pressure inside the gas chamber is equalized all around the gas chamber 48 and gas
20 derived from the outlet ports 50 on the side wall 38 has a flow velocity that is substantially the same. Consequently, the gas curtain that moves upward along the inner circumferential surface of the transparent cylinder 16 from the opening 20 has also substantially
25 the same flow velocity and the same flow rate over the entire circumference. While the flow rate of the gas fed from the entire circumference of the opening 20

into the hollow portion of the transparent cylinder 16 depends on the diameter of the transparent cylinder 16, the flow rate is preferably 15 liter/minute to 30 liter/minute.

5 [0031] An accompanying gas flow is brought into the hollow portion of the transparent cylinder 16 from the insertion hole 26 by the travelling of the coated core wire 8. When the coated core wire 8 is heated, a volatile component generated from the coating material
10 paste peripherally diffuses. The volatile component that peripherally diffuses goes up along with the surrounding accompanying gas flow of the coated core wire 8. The accompanying gas flow containing a volatile component is further strengthened by a rise
15 of ambient temperatures when heating the coated core wire 8, resulting in moving upward while spreading in a diameter direction of the transparent cylinder 16.
[0032] Typical gas fed into the hollow portion of the transparent cylinder 16 via the gas flow forming means
20 18 includes air, nitrogen, and inert gas. Air is preferable from a point of costs. The gas is supplied after being pressurized at atmospheric pressure or higher.

[0033] A metal wire or a resin wire is used as the
25 core wire 4 of the coated wire to be used in the present invention. A steel wire is preferably used for a resin bond wire saw. While the wire diameter of

the core wire 4 is not particularly limited, the wire diameter is typically 0.05 mm to 0.3 mm.

[0034] The coating material paste to be applied to the core wire 4 is mainly composed of a resin before
5 curing, abrasive grains, and a solvent. Examples of the resin to be used for a resin bond wire saw include a phenol resin and an epoxy resin. The abrasive grains may be any abrasive grains for a fixed abrasive grain wire saw. Examples of the abrasive grains
10 include diamond abrasive grains, cubic system boron nitride (CBN) abrasive grains, alumina abrasive grains, and silicon carbide abrasive grains. Additionally, a filler made from inorganic particles may be added to the coating material paste. The coating material
15 paste is applied in a substantially uniform thickness by the application means 6. As an example, the core wire 4 is immersed in the coating material paste and then is caused to pass through dies (not shown), resulting in uniform application.

20 [0035] Next, operations and effects of the device 2 for manufacturing a coated wire of the present invention will now be described.

[0036] One of objectives for installing the gas flow forming means 18 is to form a gas curtain for moving
25 upward along the inner circumferential surface of the transparent cylinder 16. The gas curtain has a role to block a radial course of the accompanying gas flow

containing a volatile component generated at the time of heating the coated core wire 8 from the coating material paste, diluting the concentration of the volatile component by mixing gas flow of the gas curtain and the accompanying gas flow to immediately exhaust mixed gas flow so that the mixed gas flow may not remain on the inner circumferential surface of the transparent cylinder 16.

[0037] The other objective for installing the gas flow forming means 18 is to catch the volatile component generated at the time of heating the coated core wire 8 with use of the accompanying gas flow brought from the insertion hole 26 by the travelling of the coated core wire 8 to exhaust the volatile component outside the transparent cylinder 16. The flow rate of the accompanying gas flow depends on the diameter of the insertion hole 26 shown in FIG. 1 (b). When the diameter of the insertion hole 26 is too great, the accompanying gas flow becomes excessive, resulting in a reduction of the heating efficiency of the coated core wire 8. Consequently, the diameter d_h of the insertion hole 26 is preferably 8 mm to 15 mm. In the gas brought into the transparent cylinder 16 as the accompanying gas flow, the coated core wire 8 is heated and its surrounding gas is also heated, which becomes an upward gas flow by an increase in flow velocity. The upward gas flow whose flow velocity is

increased catches the volatile component generated from the coating material paste and moves further upward while spreading in a radial direction of the transparent cylinder 16.

5 [0038] As the accompanying gas flow goes up, the accompanying gas flow containing the volatile component spreads in the radial direction of the transparent cylinder 16. The radial course is, however, blocked by the gas curtain moving upward
10 along the inner circumferential surface of the transparent cylinder 16 and thus going up while mixing with a gas flow for forming the gas curtain. The mixed gas flow between the gas flow of the gas curtain and the accompanying gas flow moves upward up to an
15 upper end of the transparent cylinder 16. The mixed gas flow that has reached the upper end of the transparent cylinder 16 is absorbed along with the volatile component from an opening of the upper end of the transparent cylinder 16 by an exhaust duct (not
20 shown) provided near the opening to be exhausted. The exhaust duct may directly be connected to the upper end of the transparent cylinder 16. As mentioned above, the accompanying gas flow containing the volatile component is mixed with the gas flow of the
25 gas curtain. This prevents the volatile component from accessing the inner circumferential surface of the transparent cylinder 16 while maintaining a high

concentration of the volatile component and remaining
in the accompanying gas flow. The mixed gas flow
between the gas flow of the gas curtain and the
accompanying gas flow is quickly exhausted from the
5 opening of the upper end of the transparent cylinder
16. This minimizes adhesion of the volatile component
to the entire inner circumferential surface of the
transparent cylinder 16. Consequently, the
transmission of hot rays irradiated from the heating
10 means 10 relative to the transparent cylinder 16 does
not become deteriorated, resulting in production
without a decrease in heating efficiency of the coated
core wire 8.

[0039] In general, when gas is excessively fed into a
15 heating chamber to prevent wall surfaces in the
heating chamber from being contaminated, heat of work
is removed by gas, resulting in a reduction in heating
efficiency of the work. As a result, like the present
invention, it is preferable to prevent the inner
20 circumferential surface of the transparent cylinder 16
from being contaminated by an interaction between the
gas curtain flowing along the inner circumferential
surface of the transparent cylinder 16 by feeding
compressed gas with a minimum flow rate to the gas
25 flow forming means 18 provided at the lower end of the
transparent cylinder 16 and the accompanying gas flow
brought from the insertion hole 26 where the coated

core wire 8 travels.

[0040] Adhesion prevention effects of the volatile component to the inner circumferential surface of the transparent cylinder 16 can be obtained by directly
5 spraying gas all over the inner circumferential surface up and down or flowing a great amount of gas to all over the inner circumferential surface of the transparent cylinder 16 up and down. However, a great amount of gas is introduced into the hollow portion of
10 the transparent cylinder 16 and this gas prevents a temperature rise in the coated core wire 8 while heating. As a result, it is impossible to conduct heating treatment at high speed and the coated core wire 8 deviates from a convergent beam portion of
15 infrared rays due to a large shake of the coated core wire 8. This makes it impossible to effectively heat the coated core wire 8. In addition, such an aspect poses an impediment barrier of travelling of the coated core wire 8 due to the installation of a lot of
20 complicated shaped instruments in the hollow portion.

[0041] In this embodiment, gas fed into the hollow portion consists of gas fed from the opening 20 to upward in the lower end of the transparent cylinder 16 along the inner circumferential surface of the
25 transparent cylinder 16 and the accompanying gas flow brought from the insertion hole 26 by the travelling of the coated core wire 8. As the gas is not directly

sprayed to the coated core wire 8, impact to be exerted on heating of the coated core wire 8 and physical effects such as vibrations can be minimized. The flow rate of gas to be fed to the transparent
5 cylinder 16 can also be minimized, resulting in a reduction in the extent of blocking the temperature rise of the coated core wire 8 being heated.

Additionally, the diameter of the insertion hole 26 in which the accompanying gas flow is brought is set as
10 small as 8 mm to 15 mm. This makes it possible to perform a heating process for curing the coating material paste of the coated core wire 8 at high speed such as 100 m/min or faster.

[0042] The device 2 for manufacturing a coated wire of
15 the present invention is not equipped with a gas spray device or a spray member above the plane baffle plate 28 having no projections on its upper surface.

Consequently, there is no need to install a gas spray member and a gas spray device or a member and a device
20 for controlling a gas flow that could block the travelling and operations of the coated core wire 8 in the hollow portion on the device 2 for manufacturing a coated wire.

[0043] A further preferable embodiment of a gas flow
25 forming means 18 to be used in the present invention will now be described according to FIG. 4.

[0044] As shown in FIG. 4, a gas flow forming means

18a includes a baffle plate 28a situated at its upper end, an intermediate member 36a, a side wall 38a, and a base part 32a situated at its lower end. Each of the components is arranged, making a travelling axis of a coated core wire 8 as a central axis. A space surrounded by the baffle plate 28a, the intermediate member 36a, the side wall 38a, and the base part 32a is formed as an annular gas chamber 48a. An insertion hole 26a, in which the central axes of the baffle plate 28a, the intermediate member 36a, and the base part 32a are vertically penetrated and the coated core wire 8 is inserted, is formed. An upper surface of the baffle plate 28a extends in a direction perpendicular to the travelling axis of the coated core wire 8, that is, horizontally extends in a radial direction of a transparent cylinder 16a. The baffle plate 28a and an inner circumferential surface of the transparent cylinder 16a are arranged coaxially, making the travelling axis of the coated core wire 8 as a central axis. As shown in FIGS. 4 and 5, an annular opening 20a is formed at a predetermined gap g between an outer circumferential surface of the baffle plate 28a and the inner circumferential surface of the transparent cylinder 16a.

[0045] A mounting surface 42a for mounting the transparent cylinder 16a is disposed on an upper surface of the horizontally provided base part 32a. A

guide cylinder 44a for guiding a lower end of the transparent cylinder 16 to be fitted and inserted is also vertically arranged on the upper surface of the base part 32a, making the travelling axis of the coated core wire 8 as the central axis. The transparent cylinder 16a is loosely fitted to and inserted into the inner side of the guide cylinder 44a and is placed on the mounting surface 42a. The baffle plate 28a, the intermediate member 36a, and the side wall 38a are integrally formed to be fixed to the base part 32a by screws. While the outer peripheral shape of the baffle plate 28a may be selected in conformity with the shape of the inner circumferential surface of the transparent cylinder 16a that is oppositely faced, the outer peripheral shape may be not a circle shown in FIG. 5 but may be a polygon.

[0046] As shown in FIG. 6, a plurality of outlet ports 50a that are radially penetrated and go round at intervals in a circumferential direction are provided on the side wall 38a. FIG. 6 shows an embodiment substantially the same as the embodiment shown in FIG. 2. To make the flow velocity and the flow rate of gas exhausted from each outlet port 50a, the shape of the plurality of outlet ports 50a is preferably the same shape and size. In addition, an inlet port 58a for introducing gas from a compressed gas source such as an air pump or an air compressor into an annular gas

chamber 48a is provided on the base part 32a (See FIG. 7).

[0047] As shown in FIG. 4, an introduction path of gas is a path to pass through the inlet port 58a, the gas chamber 48a, the plurality of outlet ports 50a, and the gap 22a to reach the inner circumferential surface of the transparent cylinder 16a. An arrow 56a shows a gas flow. Compressed gas introduced into the gas chamber 48a from the inlet port 58a spreads all over the gas chamber 48a. The pressure applied on the entire circumference of the gas chamber 48a becomes substantially the same. Gas that is equalized in pressure is derived from the plurality of outlet ports 50a penetrating the side wall 38a to the gap 22a between the transparent cylinder 16a and the side wall 38a. Gas derived to the gap 22a is fed from the annular opening 20a into the hollow portion of the transparent cylinder 16a to form a gas curtain moving upward along the inner circumferential surface of the transparent cylinder 16a.

[0048] As the coated core wire 8 travels, the accompanying gas flow that is introduced moves upward while catching a volatile component generated from a coating paste by heating the coated core wire 8. The accompanying gas flow is warmed by the coated core wire 8 being heated to become an upward current, resulting in moving upward while spreading in the

radial direction of the transparent cylinder 16a.

While the accompanying gas flow spreads in the radial direction of the transparent cylinder 16a, the route of the accompanying gas flow is blocked by the gas
5 curtain flowing upward along the inner circumferential surface of the transparent cylinder 16a to move upward while mixing with the gas flow for forming the gas curtain. A mixed gas flow between the gas flow of the gas curtain and the accompanying gas flow is exhausted
10 from the upper end of the opening of the transparent cylinder 16a. This prevents the accompanying gas flow from accessing the inner circumferential surface of the transparent cylinder 16a while containing the highly concentrated volatile component and thus
15 minimizing the attachment of the volatile component to the inner circumferential surface of the transparent cylinder 16a.

[0049] FIG. 8 illustrates another embodiment of the gas flow forming means 18a. The gas flow forming
20 means 18a may be an aspect in which a penetrating direction (axis direction) of each outlet port 50b may be obliquely positioned to a radial direction of the side wall 38b.

[0050] As shown in FIG. 8, a plurality of outlet ports
25 50b for horizontally penetrating the side wall 38b from outside to inside go round at certain intervals in a circumferential direction. The penetrating

direction (axis direction) of each outlet port 50b is diagonally opposite to the radial direction of the side wall 38b. As a result, the penetrating direction of the outlet ports 50b is diagonally opposite to the radial direction of the transparent cylinder 16a. In the aspect shown in FIG. 8, a positional relation between each of the outlet ports 50b and the central axis of the transparent cylinder 16a is arranged to be similar to an arrangement of a rotation axis and blades for a steam turbine.

[0051] Such an arrangement of the plurality of outlet ports 50b causes gas derived from the outlet ports 50b to be fed from the annular opening 20a after having diagonally been sprayed on the inner circumferential surface of the transparent cylinder 16a seen from the radial direction of the transparent cylinder 16a. Gas fed from the opening 20a flows along the inner circumferential surface of the transparent cylinder 16a by a centrifugal force to form a gas curtain. A gas flow to form the gas curtain spirally moves upward along the inner circumferential surface of the transparent cylinder 16a. In this aspect, compared to the case where gas fed from the opening 20a forms a gas curtain straightly moving upward in parallel to the central axis of the transparent cylinder 16a, the length of time that gas remains inside the transparent cylinder 16a becomes longer and thus increasing time

to catch the accompanying gas flow containing a volatile component. As a result, this aspect has greater prevention effects against attachment of the volatile component to the inner circumferential surface when gas having the same flow rate is flown. [0052] Consequently, in this aspect, certain prevention effects of the attachment of the volatile component can be obtained by gas with less flow rate, resulting in a small extent that gas blocks an increase in temperature of the coated core wire 8 being heated. Heating processing at higher speed than the case such as FIG. 4 where the penetrating direction of each of the outlet ports 50a is the radial direction of the transparent cylinder 16a can be performed.

[0053] Another preferable embodiments of the device 2 for manufacturing a coated wire will now be described according to FIG. 9. A plurality of annular outlet ports 50c continuously opening in a circumferential direction may be provided on a side wall 38b of a gas flow forming means 18b. FIG. 9 shows substantially the same embodiment as the embodiment illustrated in FIG. 3.

[0054] The gas flow forming means 18b is provided so as to surround the travelling coated core wire 8. The gas flow forming means 18b includes a base part 32b, an intermediate member 36b, a side wall 38b, and a

baffle plate 28b. Broken lines drawn in the gas flow forming means 18b in FIG. 9 each indicate a boundary of each part. An insertion hole 26b for penetrating the baffle plate 28b, the intermediate member 36b, and the base part 32b up and down where the coated core wire 8 is inserted is formed. A space surrounded by the base part 32b, the intermediate member 36b, the side wall 38b, and the baffle plate 28b is formed as an annular gas chamber 48b.

10 [0055] An annular outlet port 50c with a gap m continuously opening in a circumferential direction is provided between a lower end of the side wall 38b and an upper surface of the base part 32b. An inlet port 58b for introducing gas introduced from a compressed gas source into the gas chamber 48b is provided on the base part 32b. A guide cylinder 44b for guiding a lower end of the transparent cylinder 16b to be placed on a mounting surface 42b is provided on the upper surface of the base part 32b. The guide cylinder 44b is disposed coaxially with the coated core wire 8. An annular opening 20b having a predetermined gap g is formed between the outer circumferential surface of the baffle plate 28b and the inner circumferential surface of the transparent cylinder 16b (See FIG. 10).

25 [0056] While the cross-sectional shape of the side wall 38b is not limited to a particular shape, for example, the shape may be a triangle as shown in FIG.

9. A hypotenuse of the inlet port 58b and a hypotenuse of the side wall 38b face each other. As shown in FIG. 11, the intermediate member 36b, the side wall 38b, the baffle plate 28b, the transparent cylinder 16b, and the guide cylinder 44b are arranged as the central axis of the travelling axis of the coated core wire 8. While the shape of the outer edge of the baffle plate 28b may be selected in conformity with the shape of the inner circumferential surface of the transparent cylinder 16b oppositely facing, the shape may be not a circle but a polygon.

[0057] An introduction path for gas goes through the inlet port 58b, the gas chamber 48b, the outlet ports 50c, and a gap 22b to reach the inner circumferential surface of the transparent cylinder 16b from the opening 20b. Gas having introduced from the compressed gas source is introduced into the gas chamber 48b from the inlet port 58b. Introduced gas collides with a slope of the triangle-shape side wall 38b, thus changing the flow direction of the gas substantially in a radial direction of the gas chamber 48b. Gas spreads all over an inner circumferential surface of the side wall 38b, that is, an inside of the gas chamber 48b. Gas spreads all over the gas chamber 48b and pressure in the gas chamber 48b is almost uniform at the whole circumference.

Subsequently, rectified gas substantially having the

same flow velocity is derived from the annular outlet port 50c under the side wall 38b to the gap 22b. Gas derived to the gap 22b is further fed from the annular opening 20b into the hollow portion of the transparent cylinder 16b (arrow 56b). Thus fed gas forms a gas curtain that moves upward along the inner circumferential surface of the transparent cylinder 16b.

[0058] The accompanying gas flow generated by the travelling of the coated core wire 8 is brought into the hollow portion of the transparent cylinder 16b from the insertion hole 26b. The accompanying gas flow containing a volatile component generated from a coating material paste of the coated core wire 8 heated by a heating means 10 is further heated to move upward at an increased speed. As the accompanying gas flow moves upward, the accompanying gas flow spreads in the radial direction of the transparent cylinder 16b. While the accompanying gas flow spreads in the radial direction of the transparent cylinder 16b, the course of the accompanying gas flow is blocked by the gas curtain flowing upward along the inner circumferential surface of the transparent cylinder 16b. This makes the accompanying gas flow move upward while mixing with a gas flow that forms the gas curtain. The mixed gas flow composed of the gas flow of the gas curtain and the accompanying gas flow is

exhausted from the opening at the upper end of the transparent cylinder 16b. This minimizes the attachment of the volatile component to the inner circumferential surface of the transparent cylinder 16b without access of the accompanying gas flow to the inner circumferential surface of the transparent cylinder 16b while containing a highly concentrated volatile component.

[0059] As shown in FIG. 12, as the other embodiment, an inlet port 58c for horizontally penetrating a side wall 38c from a side surface of a guide cylinder 44c may be provided in a gas flow forming means 18c. Such a configuration enables gas to be introduced into the bottom of a gas chamber 48c.

[0060] An introduction path of gas passes through the inlet port 58c, the gas chamber 48c, an outlet port 50d, and a gap 22c and reaches the inner circumferential surface of the transparent cylinder 16c from the opening 20c. Arrows 56c each indicate a gas flow. Gas introduced from the inlet port 58c spreads all over the whole circumference, resulting in uniform pressure. Consequently, gas fed from the opening 20c after passing through the gas chamber 48c and the outlet port 50d has substantially the same speed at the entire circumference of the inner periphery of the transparent cylinder 16c. As a result, it is possible to effectively eliminate the

attachment of the volatile component to the whole circumference of the transparent cylinder 16c at a minimum flow rate. In addition, production can be performed without any decrease in heating efficiency of the coated core wire 8 by preventing the inner circumferential surface of the transparent cylinder 16c from being dirty.

[0061] As mentioned above, while embodiments of the present invention have been described so far, the device 2 for manufacturing a coated wire can control loss of transparency of the transparent cylinder 16 caused by a volatile component generated from a coating material paste at the time of production. This increases the production efficiency with minor cleaning and exchanging of the transparent cylinder 16.

[0062] Further, in the device 2 for manufacturing a coated wire of the present invention, the transparent cylinder 16 can be inserted in the guide cylinder 44 arranged in a standing manner on the base part 32 to be placed on the mounting surface 42 (FIG. 1). This makes the transparent cylinder 16 easier to be inserted in and detached from the gas flow forming means 18, which leads to easily attach the coated core wire 8 when starting an operation. As a result, it becomes further easier to exchange and clean the transparent cylinder 16.

[0063] It is believed obvious that a person skilled in

the art may make various changes and modifications in the present invention in a scope described in the scope of claims thereof. It is to be understood that the present invention is not limited to the

5 aforementioned embodiments illustrated in the drawings but changes are possible within the scope of claims where necessary. Additionally, it is to be understood that unless the present invention is limited to an essentially specific shape, in the aforementioned

10 embodiments, when referring to a shape and a positional relation of each component, the present invention is not limited to the referred shape and the positional relation.

15 INDUSTRIAL APPLICABILITY

[0064] The device for manufacturing a coated wire is applicable to a heating treatment device for travelling linear workpiece, such as a heating furnace for baking a coating material of an insulated resin

20 coating material to a core wire, such as a conductive wire. This enables to perform heating treatment at high speed with high efficiency.

DESCRIPTION OF REFERENCE NUMERALS

25 [0065] 2: device for manufacturing a coated wire; 4: core wire; 6: application means; 8: coated core wire; 10: heating means; 16, 16a, 16b, 16c: transparent

cylinder; 18, 18a, 18b, 18c: gas flow forming means;
20, 20a, 20b, 20c: annular opening; 22, 22a, 22b, 22c:
gap; 26, 26a, 26b, 26c: insertion hole; 28, 28a, 28b,
28c: baffle plate; 32, 32a, 32b, 32c: base part; 36,
5 36a, 36b, 36c: intermediate member; 38, 38a, 38b, 38c:
side wall; 42, 42a,
42b, 42c: mounting surface; 44, 44a, 44b, 44c: guide
cylinder; 50, 50a, 50b, 50c, 50d: outlet port, 58, 58a,
58b, 58c: inlet port

CLAIMS

1. A device for manufacturing a coated wire,
comprising:

5 means for applying a coating material paste to a
core wire;

 means for causing a coated core wire applied with
the coating material paste to travel upward;

 heating means for curing the applied coating
10 material paste by irradiating heat rays to the
travelling coated core wire;

 a transparent cylinder for surrounding at least a
portion in the coated core wire where the heat rays
are irradiated by inserting the coated core wire; and

15 means for forming a gas flow provided at a lower
end of the transparent cylinder, the gas flow forming
means for feeding gas having been introduced from a
compressed gas source into a hollow portion of the
transparent cylinder,

20 wherein an opening for going round along an inner
circumferential surface is formed between the gas flow
forming means and the inner circumferential surface of
the transparent cylinder, and

 gas is fed from the opening into the hollow
25 portion of the transparent cylinder by the gas flow
forming means.

2.The device according to claim 1, wherein the
gas

flow forming means comprises a baffle plate having a
diameter of smaller than an inner diameter of the
5 transparent cylinder, and an outer circumferential
surface of the baffle plate is faced to the inner
circumferential surface of the transparent cylinder
via a gap, which is an opening.

10 3.The device according to claim 2, wherein the
gas

flow forming means comprises:

a baffle plate positioned at an upper end of the
gas flow forming means;

15 a cylindrical intermediate member having a
diameter of smaller than the diameter of the baffle
plate;

a base part for supporting the intermediate
member; and

20 a cylindrical side wall having an inner diameter
of greater than a diameter of an outer circumferential
surface of the intermediate member and an outer
diameter of not greater than the diameter of the
baffle plate,

25 wherein the intermediate member is vertically
arranged from a central part of the base part and is

arranged coaxially with the baffle plate to be
interposed between the base part and the baffle plate,

the side wall is vertically arranged coaxially
with the outer circumferential surface of the

5 intermediate member on an upper surface of the base
part with the intermediate member surrounded,

an upper edge of the side wall is coupled to a
lower surface of the baffle plate,

the base part has a mounting surface where the
10 transparent cylinder is mounted and is arranged
coaxially with the side wall such that a gap is formed
between the inner circumferential surface of the
transparent cylinder to be mounted and an outer
circumferential surface of the side wall,

15 an inlet port for introducing gas from the
compression gas source into a space surrounded by the
baffle plate, the intermediate member, the base part,
and the side wall is provided on the bottom of the
base part,

20 a plurality of outlet ports internally and
externally penetrating the side wall are
circumferentially formed at intervals on the side wall
in a circumferential direction, and,

an insertion hole for penetrating central axes of
25 the baffle plate, the intermediate member, and the
base part up and down where the coated core wire is
inserted is formed.

4. The device according to claim 3, wherein an axial direction of each of the plurality of outlet ports is obliquely faced to a radial direction of the transparent cylinder.

5. The device according to claim 3, wherein the plurality of outlet ports are continuously opened in a circumferential direction.

10

6. The device according to any one of claims 3 to 5, wherein a guide cylinder vertically and coaxially arranged with a central axis of the intermediate member is provided on the base part and is vertically arranged in a detachable manner by guiding an outer circumferential surface of the transparent cylinder to an inner circumferential surface of the guide cylinder.

7. The device according to any one of claims 1 to 6, wherein a heating source for irradiating infrared rays is used for the heating means.

8. The device according to any one of claims 1 to 7, wherein the heating means comprises a plurality of image furnaces vertically arranged.