

Technical Field

[0001]

10 The present invention relates to a guide tube for guiding and inserting a sensor into a heat transfer tube of a boiler, the sensor being configured to measure a wall thickness of the heat transfer tube.

The present application claims priority based on JP 2019-191111 filed in Japan on October 18, 2019, the contents of which are incorporated herein.

15

Background Art

[0002]

20 In a plant provided with a boiler, such as a coal fired boiler in a thermal power plant or a waste heat boiler for power generation provided in a refuse incinerator, wall thickness measurement of a heat transfer tube (boiler tube) of the boiler is periodically performed by using a sensor. In particular, in a case where an ultrasonic probe, which is a type of sensor, is inserted inside of a heat transfer tube filled with water, wall thickness measurement of the heat transfer tube is referred to as “water immersion UT” (“UT” is an abbreviation of Ultrasonic Testing).

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In the plant, a plurality of heat transfer tubes are connected to a header extending linearly in a horizontal direction, and are connected to the header orthogonally to a center axis of the header. In addition, the header includes a tube base for inspection used for checking the inside of the header, and the tube base is disposed at an end portion on the center axis facing a corridor installed in the plant, or is disposed in a side surface facing the corridor. The tube base is formed integrally with the header by welding. Some tube bases include a flange to enable opening and closing of the tube base, and some tube bases are formed by creating an opening by fusion cutting and, after predetermined work, re-welding a lid or the like to hermetically seal the opening.

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[0003]

35 When the wall thickness measurement of the heat transfer tube is performed, a worker needs to form an opening in the tube base and pass the sensor through the inside of the header from the opening to the heat transfer tube that is to be measured.

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However, the header generally has a small inside diameter, and it is difficult for a worker to pass the sensor through the header.

5 Thus, instead of the worker going through the inside of the header to
insert the sensor into the heat transfer tube to be measured, a guide tube is
provided as a device that guides and inserts the sensor into the heat transfer
tube. That is, the guide tube is a device configured to pass the sensor through
the inside of the header from the opening to the heat transfer tube, and guide
10 and insert the sensor to an opening of the heat transfer tube that is open to the
header.

[0004]

 The applicant has already published a guide tube to be inserted from an
opening of a tube base disposed in a side surface of a header (see Patent
15 Document 1), and a guide tube to be inserted from an opening of a tube base
disposed at an end portion on a center axis of a header (see Patent Document
2).

Citation List Patent Literature

[0005]

Patent Document 1: JP 6004989 B

Patent Document 2: JP 6260070 B

Summary of Invention Technical Problem

[0006]

 The guide tube disclosed in Patent Document 1 has a slightly
complicated structure because the guide tube needs to bend at a plurality of
30 positions.

 On the other hand, according to the guide tube disclosed in Patent
Document 2, the guide tube needs to be bent at only one site, specifically, only
a tip of the guide tube needs to be bent at about 90°. Thus, the structure can be
simplified as compared with the guide tube disclosed in Patent Document 1.

35 However, generally, the width of the corridor is narrow, and, in a
direction opposite to the tube base across the corridor, other devices in the
plant are disposed or a wall of the plant is present. Thus, in the corridor in
which a worker works to perform the wall thickness measurement, the length of
a guide tube that is linear and that can be inserted inside the header from an
40 opening of the tube base is restricted to an upper limit.

 Therefore, in a case where the length of a header is sufficiently longer
than the length of the guide tube disclosed in Patent Document 2, the length of

5 the guide tube is insufficient. Thus, for some heat transfer tubes connected to the header, the sensor cannot be guided and inserted into the heat transfer tubes.

When the length of the guide tube is insufficient, another guide tube may be added. However, cable connected to the sensor needs to be reliably
10 collected from the heat transfer tube. Thus, generally, a cable having a length of several tens of meters or more without a break is used, and a plurality of lines of cable divided into short lengths are not used by coupling the plurality of lines of cable to each other. On the other hand, since, on a side opposite to the tip at which the guide tube is bent, a worker operates wire for bending the
15 guide tube, a length of the wire is designed to be a length corresponding to the length of the guide tube, in other words, a length slightly longer than the length of the guide tube.

Therefore, in a case where the length of the guide tube is insufficient, and another guide tube having a cylindrical shape is simply added, it is
20 necessary to insert another such guide tube from an end of the long cable. Thus, there is a concern that it takes time to add another guide tube. In addition, when another line of wire having a length corresponding to a length of other such guide tube is simply connected to the wire for bending the guide tube, the wire deflects at a large distance from these guide tubes, and the wire is caught by a
25 welded site of an inner wall of the header and is cut or the like to cause failure. As a result, there is a concern that the guide tube cannot appropriately guide the sensor to the heat transfer tube.

Thus, development of a guide tube that can appropriately guide the sensor to a heat transfer tube while having a simple structure that enables a
30 worker to quickly and easily perform connection has been eagerly desired.
[0007]

The present invention provides a guide tube that has a simple structure and that can appropriately guide a sensor to a heat transfer tube without being affected by the length of a header.

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Solution to Problem

[0008]

To solve the above-described problem, a guide tube according to the present invention is a guide tube that contains and guides a sensor and a cable
40 connected to the sensor from an opening of a tube base disposed at one end on a center axis of a header of a boiler to a heat transfer tube connected to the header, the sensor being configured to measure a wall thickness of the heat

5 transfer tube, the guide tube including: a tip guide tube configured to releasably house the sensor; and a first additional guide tube that is connectable to the tip guide tube; the tip guide tube including: a wire including one end at which a connection terminal is disposed; a tip portion to which an other end of the wire is fixed and which is bendable; a main body portion having a rod-like shape
10 and a substantially U-shaped cross section, and including one end to which the tip portion is connected; and a lid portion having a surface to which the wire is fixed in a manner movable forward and backward, and a back surface from which the lid portion is fitted to the main body portion; the first additional guide tube including: an additional wire including one end at which an
15 additional connection terminal is disposed, and an other end at which a slide terminal is disposed; an additional main body portion having a rod-like shape and a substantially U-shaped cross section; an additional lid portion having a surface to which the additional wire is fixed in a manner movable forward and backward, and a back surface from which the additional lid portion is fitted to
20 the additional main body portion; and a slide portion disposed on a surface of the additional lid portion and being configured to restrict movement of the slide terminal in a manner movable forward and backward by a predetermined distance in a length direction of the additional lid portion; in which the connection terminal is connected to the slide terminal; the sensor is housed in
25 the tip portion, the other end of the main body portion and one end of the additional main body portion are connected to each other, the cable is disposed inside the main body portion and inside the additional main body portion, and the lid portion and the additional lid portion are fitted to the main body portion and the additional main body portion, respectively, such that the tip guide tube
30 and the first additional guide tube are integrated into one cylindrical shape; and the additional connection terminal is pulled to bend the tip portion.

Advantageous Effects of Invention

[0009]

35 According to the present invention, an additional guide tube can be connected to a tip guide tube, and the length of a guide tube can be increased. That is, even in a case where a length of a header is sufficient as compared to a length of the tip guide tube, an additional guide tube can be appropriately connected to the tip guide tube, and thus a sensor can be guided to a heat
40 transfer tube to which the sensor cannot be guided only by the tip guide tube.

In addition, when an additional guide tube is connected to the tip guide tube, a cable is housed in an additional main body portion, and subsequently an

5 additional lid portion is fitted to the additional main body portion, and the additional guide tube can be formed into a cylindrical shape. Thus, connection time of the additional guide tube by a worker can be shortened.

Further, a wire of the tip guide tube and an additional wire of the additional guide tube connected to the wire are fixed to surfaces of a lid portion and the additional lid portion, respectively in a manner movable forward and backward. Then, a connection terminal of the wire and a slide terminal of the additional wire are connected to each other. In addition, a slide portion disposed in the surface of the additional lid portion restricts movement of the slide terminal. Thus, there is no concern that these wires deflect at a large distance from the tip guide tube and the additional guide tube to cause failure of the guide tube.

Therefore, a guide tube that has a simple structure and that can appropriately guide the sensor to a heat transfer tube without being affected by the length of a header can be provided.

Brief Description of Drawings

[0010]

FIG. 1 is a schematic diagram of a tube wall thickness measuring system using a guide tube 1 according to an embodiment of the present invention.

FIG. 2 is a schematic view illustrating a configuration of the guide tube 1 including a plurality of additional guide tubes and a wire operating device 11 that are sequentially connected to a tip guide tube 13. FIG. 2(a) is a top view of the guide tube 1, FIG. 2(b) is a side view of the guide tube 1, and FIG. 2(c) is a top view of the guide tube 1 with a lid portion 19 and an additional lid portion 24 being detached.

FIG. 3 is a schematic view illustrating a configuration of a slide portion 25. FIG. 3(a) is a top perspective view of the slide portion 25, and FIG. 3(b) is a schematic view illustrating a configuration of a slide terminal 21.

FIG. 4 is a cross-sectional view in an xz plane for explaining movement of the slide terminal 21 in the slide portion 25, and movement of a connection terminal 15 or an additional connection terminal 20 contained in the slide terminal 21. FIG. 4(a) illustrates a state immediately after the connection terminal 15 or the additional connection terminal 20 is inserted into the slide terminal 21. FIG. 4(b) illustrates a state where the connection terminal 15 or the additional connection terminal 20 moves inside the slide terminal 21, and wire of the tip guide tube 13 and wire of an additional guide tube 14 connected to the tip guide tube 13 are firmly coupled to each other, or two lines of wire of

5 the two additional guide tubes 14 connected to each other are firmly coupled to each other.

FIG. 5 is a schematic view illustrating a configuration of a locking portion 28.

10 FIG. 6 is a schematic view for explaining, in the xz plane, connection between the tip guide tube 13 and the additional guide tube 14. FIG. 6(a) is a schematic view of the tip guide tube 13, FIG. 6(b) is a schematic view of the additional guide tube 14, and FIG. 6(c) is a schematic view illustrating a state where the tip guide tube 13 and the additional guide tube 14 are connected to each other.

15 FIG. 7 is a schematic view illustrating a cross-sectional configuration in a yz plane of the tip guide tube 13 and the additional guide tube 14. FIG. 7(a) is a I-I arrow view of FIG. 6(a) as viewed from a +x-axial direction. FIG. 7(b) is a II-II arrow view of FIG. 6(a) as viewed from the +x-axial direction. FIG. 7(c) is a III-III arrow view of FIG. 6(b) as viewed from the +x-axial direction.

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Description of Embodiments

[0011]

Hereinafter, embodiments of the present invention will be described with reference to the drawings. Here, first, with reference to FIG. 1, an outline
25 of a tube wall thickness measuring system using a guide tube of the present invention will be described, and subsequently, with reference to FIGS. 2 to 7, a guide tube 1 of an embodiment will be described in detail.

Note that an orthogonal coordinate system including an x-axis, a y-axis, and a z-axis is illustrated as appropriate. A plane including the x-axis and the y-axis (xy plane) is a horizontal plane, and a direction in which an arrow of the z-axis is directed is a vertical direction and an upward direction.
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In addition, a “+x-axial direction (plus x-axial direction)” means a direction in which an arrow of the x-axis is directed, and a “-x-axial direction (minus x-axial direction)” means a direction opposite to the direction in which the arrow of the x-axis is directed. The same applies to a “+y-axial direction (plus y-axial direction)” and a “-y-axial direction (minus y-axial direction)”,
35 and a “+z-axial direction (plus z-axial direction)” and a “-z-axial direction (minus z-axial direction)”.

[0012]

40 First, with reference to FIG. 1, a tube wall thickness measuring system using a guide tube 1 will be described.

5 In a plant provided with a boiler such as a coal fired boiler of a thermal power plant or a waste heat boiler for power generation provided in a refuse incinerator, a plurality of heat transfer tubes 2 provided in the boiler are connected orthogonally to and in communication with a header 3 that extends in a horizontal direction.

10 The header 3 includes an end portion facing a corridor 4 that is a passage in which a worker can work, and the header 3 includes, at the end portion, a tube base 5 protruding in the horizontal direction. The tube base 5 has a cylindrical shape having an outside diameter smaller than an outside diameter of the header 3. The tube base 5 is disposed such that a center axis of the header 3 and a center axis of the tube base 5 correspond to each other. One
15 end of the tube base 5 is connected to and in communication with the header 3. The other end of the tube base 5 is welded to a metal plate or closed by a flange not to form an opening. When the guide tube 1 is inserted into the inside of the header 3, the other end of the tube base 5 is opened.

20 Wall thickness measurement of the heat transfer tubes 2 connected to the header 3 is performed by a tube wall thickness measuring system including at least a sensor 6 configured to measure a wall thickness of a heat transfer tube with use of an ultrasonic wave or the like, cable 7 including one end connected to the sensor 6, an analysis device 8 connected to the other end of the cable 7,
25 and a display device 9 configured to display results of calculation performed by the analysis device 8.

 The analysis device 8 performs calculation related to wall thicknesses of the heat transfer tubes 2, based on information of measurement performed using an ultrasonic wave or the like by the sensor 6. The analysis device 8
30 causes the display device 9 to display the results of the calculation (information related to the wall thicknesses of the heat transfer tubes 2). The analysis device 8 is an arithmetic device such as a computer. Although the analysis device 8 and the display device 9 such as a monitor are described separately here, the analysis device 8 and the display device 9 do not need to be separated. For
35 example, a notebook personal computer including the analysis device 8 and the display device 9 integrated with each other may be used.

 The cable 7 is a cable that is bendable and that is used to transmit an electrical signal (in particular, information of measurement performed by the sensor 6) from the sensor 6 to the analysis device 8. The cable 7 includes no
40 break and has a length of several tens of meters or more. Thus, the tube wall thickness measuring system includes a cable winding device 10. The cable

5 winding device 10 can perform automatic or manual winding of the cable 7 and automatic or manual unwinding of the cable 7.

The guide tube 1 described in detail below is a portion of the tube wall thickness measuring system. The guide tube 1 is a device that is inserted into the inside of the header 3 and that guides the sensor 6 to an opening of a
10 predetermined heat transfer tube 2 connected to the header 3. A tip of the guide tube 1 and a wire operating device 11 disposed in the corridor 4 are connected to each other by wire. Then, a worker operates the wire operating device 11, and thus the tip of the guide tube 1 can be bent in a direction substantially perpendicular to the center axis of the header 3, that is, in a direction of about
15 90°. Since the center axis of the header 3 and a center axis of the heat transfer tube 2 are orthogonal to each other, the sensor 6 can be inserted easily to the predetermined heat transfer tube 2. Note that the wire operating device 11 may be disposed in a work stand 12 having an appropriate height.

[0013]

20 Next, with reference to FIGS. 2 to 7, the guide tube 1 will be described. After an outline of a main configuration of the guide tube 1 is described, other configurations including the main configuration will be described in detail.

Note that here, the wire operating device 11 pulls a bending wire 16a via an additional wire 22a. Specifically, the wire operating device 11 includes a
25 bending reel 11a and a stretching reel 11b, and the additional wire 22a is wound by the bending reel 11a while the stretching reel 11b is loosened. Accordingly, the bending wire 16a connected to the additional wire 22a is pulled, and a tip portion 17 of a tip guide tube 13 of the guide tube 1 is bent. In addition, the wire operating device 11 pulls stretching wire 16b via additional
30 wire 22b. Specifically, the additional wire 22b is wound by the stretching reel 11b while the bending reel 11a is loosened. Accordingly, a configuration is achieved in which the stretching wire 16b connected to the additional wire 22b is pulled, and the tip portion 17 of the tip guide tube 13 of the guide tube 1 is stretched. Thus, in FIGS. 2 to 7, two rows of wire corresponding to the bending
35 reel 11a and the stretching reel 11b, respectively, are illustrated.

However, the configuration is not limited to this, and a mechanism configured to stretch the tip portion 17 that is bent may be achieved without using the wire 16b. For example, the mechanism can be achieved by connecting a biasing member such as a spring or rubber to the tip portion 17 and a main
40 body portion 18. That is, the bending wire 16a is pulled by the wire operating device 11 via the additional wire 22a, and thus the tip portion 17 of the tip guide tube 13 of the guide tube 1 is bent. In addition, a configuration is

5 possible in which tensile force of the bending wire 16a is loosened by the wire operating device 11 via the additional wire 22a, and thus the tip portion 17 is automatically stretched by force of the biasing member.

In the following description, each component will be described, in particular with respect to one of the two rows of wire illustrated, and the one
10 row of wire is formed from the bending wire 16a and a single line of or a plurality of lines of the additional wire 22a connected to the bending wire 16a. Description corresponding to one row of wire corresponding to the stretching wire 16b is similar to description corresponding to the bending wire 16a, and thus will be omitted. In each component, a configuration identical to the
15 configuration provided in the one row of wire corresponding to the bending wire 16a may be provided separately in the one row of wire corresponding to the stretching wire 16b.

[0014]

First, an outline of a main configuration of the guide tube 1 will be
20 described.

The guide tube 1 is a guide tube that contains and guides, from the opening of the tube base 5 disposed at one end on the center axis of the header 3 of the boiler to the heat transfer tube 2 connected to the header 3, the sensor 6 configured to measure the wall thickness of the heat transfer tube 2, and the
25 cable 7 connected to the sensor 6. The guide tube 1 includes at least the tip guide tube 13 releasably housing the sensor 6, and an additional guide tube 14 connectable to the tip guide tube 13. As described below, another additional guide tube 14 (for example, a second additional guide tube 14b) having the same structure can be connected to the additional guide tube 14 (for example, a
30 first additional guide tube 14a). Therefore, a plurality of the additional guide tubes 14 including an identical structure are prepared, and thus the guide tube 1 can guide the sensor 6 to the predetermined heat transfer tube 2 without being affected by the length of the header 3.

The tip guide tube 13 includes at least a wire 16, the tip portion 17, the
35 main body portion 18, and a lid portion 19. The wire 16 includes one end at which a connection terminal 15 is disposed. The tip portion 17 is fixed to the other end of the wire 16 and is bendable. The main body portion 18 includes one end to which the tip portion 17 is connected, and has a rod-like shape and a substantially U-shaped (corresponding to the English word “U”) cross section.
40 The lid portion 19 has a surface to which the wire 16 is fixed in a manner movable forward and backward, and includes a back surface from which the lid portion 19 is fitted to the main body portion 18.

5 The additional guide tube 14 includes at least additional wire 22, an
additional main body portion 23, an additional lid portion 24, and a slide
portion 25. The additional wire 22 includes one end at which an additional
connection terminal 20 is disposed, and includes another end at which the slide
10 terminal 21 is disposed. The additional main body portion 23 has a rod-like
shape and a substantially U-shaped (corresponding to the English word “U”)
cross section. The additional lid portion 24 has a surface to which the
additional wire 22 is fixed in a manner movable forward and backward, and has
a back surface from which the additional lid portion 24 is fitted to the
15 additional main body portion 23. The slide portion 25 is disposed on the
surface of the additional lid portion 24, and restricts movement of the slide
terminal 21 in a manner movable forward and backward by a predetermined
distance in a length direction (x-axial direction) of the additional lid portion 24.

 Then, for example, in a case where the guide tube 1 is formed from the
tip guide tube 13 and one additional guide tube 14 (first additional guide tube
20 14a), the sensor 6 is housed in the tip portion 17, and the other end of the main
body portion 18 and one end of the additional main body portion 23 are
connected to each other. Further, the cable 7 is disposed inside the main body
portion 18 and inside the additional main body portion 23, and the lid portion
19 and the additional lid portion 24 are fitted to the main body portion 18 and
25 the additional main body portion 23, respectively. Accordingly, the tip guide
tube 13 and the additional guide tube 14 (first additional guide tube 14a) are
integrated into one cylindrical shape. In addition, at this time, the connection
terminal 15 is connected to the slide terminal 21, and the additional connection
terminal 20 is pulled. Accordingly, the slide terminal 21 at the other end of the
30 additional wire 22 (the additional wire 22a connected to the bending wire 16a)
is pulled. As a result, the connection terminal 15 connected to the slide terminal
21 is pulled, and the tip portion 17 fixed to the other end of the wire 16
(bending wire 16a) is bent.

[0015]

35 Next, in addition to at least the configuration of the guide tube 1, other
configurations will be described in detail.

 First, a configuration related to the lid portion 19 and the additional lid
portion 24 will be described, and subsequently, a configuration related to the
main body portion 18 and the additional main body portion 23, and a
40 configuration related to the tip portion 17 connected to the main body portion
18 will be described.

5 A wire guide portion 26 fixes the wire 16 to the surface of the lid
portion 19 in a manner movable forward and backward (see FIGS. 2(a) and
2(b)). The wire guide portion 26 is disposed on the surface of the lid portion
19. The wire guide portion 26 includes a through-hole having an inside
10 diameter slightly larger than a diameter of the wire 16 in the length direction
(x-axial direction) of the lid portion 19 having a rectangular plate-like shape.
The wire 16 is disposed through the through-hole, and thus the wire 16 is fixed
in a manner movable forward and backward in the length direction (x-axial
direction) of the lid portion 19. In FIGS. 2(a) and 2(b), three wire guide
portions 26 are disposed at equal intervals on the surface of the lid portion 19.
15 From the viewpoint of reducing deflection of the wire 16, desirably, a plurality
of the wire guide portions 26 are disposed, but according to design, only two
wire guide portions 26 may be disposed or four or more wire guide portions 26
may be disposed.

In addition, an additional wire guide portion 27 fixes the additional wire
20 22 to the surface of the additional lid portion 24 in a manner movable forward
and backward (see FIGS. 2(a) and 2(b)). The additional wire guide portion 27
is disposed in the surface of the additional lid portion 24. The additional wire
guide portion 27 includes a through-hole having an inside diameter slightly
larger than a diameter of the additional wire 22 in the length direction (x-axial
25 direction) of the additional lid portion 24 having a rectangular plate-like shape.
The additional wire 22 is disposed through the through-hole, and thus the
additional wire 22 is fixed in a manner movable forward and backward in the
length direction (x-axial direction) of the additional lid portion 24. In FIG. 2,
two additional wire guide portions 27 are disposed in the surface of the
30 additional lid portion 24. From the viewpoint of reducing deflection of the
additional wire 22, desirably, a plurality of the additional wire guide portions
27 are disposed. However, since the slide portion 25 described below is
disposed in the additional lid portion 24, only one additional wire guide portion
27 may be disposed according to design. Alternatively, three or more additional
35 wire guide portions 27 may be disposed according to design.

According to the guide tube 1 including the wire guide portion 26 and
the additional wire guide portion 27 and including the slide portion 25
described below, the wire 16 or the additional wire 22 do not deflect at a large
distance from the tip guide tube 13 and the additional guide tube 14. Thus,
40 failure of the guide tube due to deflection of the wire can be prevented.

[0016]

5 The slide portion 25 is disposed in the surface of the additional lid
portion 24. The slide portion 25 is a quadrangular pillar-shaped hollow
component configured to restrict movement of the slide terminal 21 in a
manner movable forward and backward by a predetermined distance in the
length direction (x-axial direction) of the additional lid portion 24 (see FIGS.
10 2(a) and 2(b)).

 As illustrated in FIGS. 3(a) and 4, the slide portion 25 is constituted by
an exterior portion 25a having a box shape and including an opening formed in
one surface (a lower surface of two surfaces in the z-axial direction) of the
quadrangular pillar, and by the surface of the additional lid portion 24 to which
15 the opening of the exterior portion 25a is connected. In the surface of the
additional lid portion 24 that is covered with the exterior portion 25a, a groove
25b extending in the x-axial direction is formed to regulate movement of the
slide terminal 21 in the y-axial direction and to make the slide terminal 21
movable in the x-axial direction. Note that here, the groove 25b is formed in
20 the surface of the additional lid portion 24, but instead of forming the groove
25b in the surface of the additional lid portion 24, a rectangular plate may be
connected to an opening portion of the exterior portion 25a, and a groove
corresponding to the groove 25b may be formed in the plate.

 A length in the x-axial direction of the groove 25b has the same
25 dimension as the predetermined distance by which the slide terminal 21 is
movable forward and backward. In addition, a dimension in the y-axial
direction of the groove 25b (a dimension of a width of the groove) is
substantially identical to and is slightly larger than a dimension “W” of a width
of the slide terminal 21 described below. A dimension in the z-axial direction of
30 the groove 25b (a dimension of a depth of the groove) is about one third of a
dimension “H” of a height of the slide terminal 21 described below.

 Two side surfaces of the exterior portion 25a that are disposed in the y-
axial direction are both rectangular plates.

 In addition, one side surface (a side surface in the -x-axial direction) of
35 two side surfaces disposed in the x-axial direction (a side surface in the -x-
axial direction and a side surface in the +x-axial direction) is a rectangular
plate connected to the two side surfaces disposed in the y-axial direction. The
one side surface of the two side surfaces disposed in the x-axial direction
includes a through-hole having a dimension that is larger than the diameter of
40 the additional wire 22 and that does not enable the slide terminal 21 to pass
through the through-hole. Then, the additional wire 22 is inserted into the
through-hole.

5 The other side surface (the side surface in the +x-axial direction) of the two side surfaces disposed in the x-axial direction (the side surface in the -x-axial direction and the side surface in the +x-axial direction) and a top surface connected to the above-described four side surfaces include openings, respectively, and the openings are rectangular and in communication with each other along the groove 25b. These openings are each formed with a dimension that is slightly smaller than a dimension “D” in the -x-axial direction from the other side surface and slightly smaller than the dimension “W” in the y-axial direction, and that is sufficiently larger than each of the diameters of the wire 16 and the additional wire 22.

15 A dimension in the z-axial direction from a bottom surface of the groove 25b to the top surface of the exterior portion 25a is a dimension that is substantially the same as and slightly larger than the dimension “H”. Thus, the slide terminal 21 can move only inside the slide portion 25 in the x-axial direction without being detached from the groove 25b.

20 [0017]

 As illustrated in FIG. 3(b), the slide terminal 21 is a quadrangular pillar-shaped hollow component having the dimension “D” of a length in the x-axial direction, the dimension “W” of a length in the y-axial direction (width), and the dimension “H” of a length in the z-axial direction (height). A bottom surface of the slide terminal 21 (a lower surface, in the vertical direction, of two surfaces disposed in parallel to the z-axial direction) is a rectangular plate having the dimension “D” × the dimension “W”. The bottom surface of the slide terminal 21 is disposed within the groove 25b. Among four side surfaces of the slide terminal 21, two side surfaces disposed in parallel to the y-axial direction are each a rectangular plate having the dimension “D” × the dimension “H”. Note that in the following description, the dimension “W” (capital letter) and a dimension “w” (small letter) that are different dimensions from each other are used as appropriate.

 Among the side surfaces of the slide terminal 21, one side surface (a side surface in the -x-axial direction) of two side surfaces disposed in the x-axial direction (a side surface in the -x-axial direction and a side surface in the +x-axial direction) is a rectangular plate having the dimension “W” × the dimension “H”, and the additional wire 22 is connected to the center of the one side surface. The other side surface (the side surface in the +x-axial direction) has a shape in which an opening is formed in a portion of a rectangular plate having the dimension “W” × the dimension “H”. Specifically, an opening that is rectangular and that has the dimension “w” slightly larger than each of the

5 diameters of the wire 16 and the additional wire 22 in the y-axial direction, and a dimension “h” shorter than the dimension “H” in the z-axial direction by the dimension of the bottom surface of the slide terminal 21 is formed at the center of the other side surface.

10 A top surface of the slide terminal 21 (an upper surface of two surfaces disposed in the z-axial direction) has a shape in which an opening is formed in a portion of a rectangular plate having the dimension “D” × the dimension “W”. Specifically, an opening (hereinafter, referred to as a “large opening”) is formed by removing a portion corresponding to a dimension “d” in the +x-axial direction from the above-described side surface in the -x-axial direction.

15 Further, an opening (hereinafter, referred to as a “small opening”) that is rectangular and has the dimension “w” and that is in communication with both of the “large opening” and the above-described opening having the dimension “w” × the dimension “h” of the side surface in the +x-axial direction is formed at the center of the top surface of the slide terminal 21.

20 The connection terminal 15 disposed in the wire 16 and the additional connection terminal 20 disposed in the additional wire 22 are cylindrical members having diameters larger than the diameters of these wires, respectively. Specifically, the connection terminal 15 and the additional connection terminal 20 are cylindrical members that each have a bottom

25 surface and a top surface each having a diameter greater than the dimension “w” and smaller than the dimension “W” and the dimension “h” (in other words, smaller than an inner dimension of the side surface disposed in the x-axial direction of the slide terminal 21), and that each have a height having a dimension slightly smaller than the dimension “d”. Then, the corresponding

30 one end of the wire 16 or the additional wire 22 is connected to the bottom surface. In addition, similarly, a square pillar that includes a bottom surface and a top surface each including each side larger than the dimension “w” and smaller than an inner dimension of the side surface disposed in the x-axial direction of the slide terminal 21, and that has a height smaller than the

35 dimension “d” may be used as the connection terminal 15.

Therefore, via the opening of the exterior portion 25a, the connection terminal 15 or the additional connection terminal 20 can be housed inside the slide terminal 21 from the above-described openings of the slide terminal 21 that are in communication with each other, in a state where the wire connected

40 to the connection terminal 15 or the additional connection terminal 20 is linearly tensed.

[0018]

5 With reference to FIG. 4, the state of the connection terminal 15 or the additional connection terminal 20 housed in the slide portion 25 will be described.

As illustrated in FIG. 4(a), the slide terminal 21 is moved to the opening of the exterior portion 25a. At this time, immediately after the connection
10 terminal 15 or the additional connection terminal 20 is inserted into the inside of the slide terminal 21 from the “large opening” of the slide terminal 21, the connection terminal 15 or the additional connection terminal 20 is present directly below the “large opening”.

Subsequently, as illustrated in FIG. 4(b), when the additional wire 22
15 connected to the slide terminal 21 is pulled in the -x-axial direction by the wire operating device 11, the connection terminal 15 or the additional connection terminal 20 housed in the slide terminal 21 moves inside the slide terminal 21 to directly below the “small opening”.

Once the connection terminal 15 or the additional connection terminal
20 20 has moved to directly below the “small opening” of the slide terminal 21, the connection terminal 15 or the additional connection terminal 20 is housed in a small room covered with upper, lower, left, and right wall surfaces of the slide terminal 21. An outlet of the small room is only in the -x-axial direction. Thus, even when the tip portion 17 of the guide tube 1 is bent, the connection
25 terminal 15 or the additional connection terminal 20 that are housed in the small room cannot be detached easily from the slide terminal 21. Note that when the tip portion 17 of the guide tube 1 is bent (or stretched), the wire operating device 11 pulls or loosens the one row of wire formed from the wire 16 and the single line of or the plurality of lines of additional wire 22a
30 connected to the wire 16, such that the one row of wire keeps constant tensile force. Thus, it becomes more difficult for the connection terminal 15 or the additional connection terminal 20 to exit the small room and to be detached from the slide terminal 21.

Therefore, according to the guide tube 1, the connection terminal 15 or
35 the additional connection terminal 20 can be connected very easily and firmly to the slide terminal 2 by merely inserting the connection terminal 15 or the additional connection terminal 20 into the slide terminal 21, in a single operation without the need for screwing or the like. As a result, the wire 16 and the additional wire 22 can be connected to each other, or the plurality lines of
40 additional wire 22 can be connected to each other.

That is, the guide tube 1 includes a simple structure that enables a worker to quickly and easily perform connection.

5 [0019]

A hook 28a is disposed at each of both ends in the y-axial direction of the back surface of the lid portion 19 and at each of both ends in the y-axial direction of the back surface of the additional lid portion 24 (see FIG. 5). The hook 28a is formed in an L-shape (shape of the English letter "L") protruding in the -z-axial direction and extending in the +x-axial direction from a tip of the protruding site. The hook 28a is a part that forms a set with a hook receiver 28b disposed in the main body portion 18 and in the additional main body portion 23 described below. The one set of the hook 28a and the hook receiver 28b constitutes a locking portion 28.

15 A length in the x-axial direction of the hook 28a is a dimension " β ". In addition, a distance in the z-axial direction between the site extending in the +x-axial direction of the hook 28a and the back surface of the lid portion 19 or the back surface of the additional lid portion 24 is a dimension " α ". In addition, a thickness in the z-axial direction of the site extending in the +x-axial direction is a dimension " γ ".

Fitting between the hook 28a and the hook receiver 28b will be described below.

[0020]

Next, the main body portion 18 and the additional main body portion 23 will be described in detail.

The main body portion 18 has a rod-like or linear shape, and includes the one end to which the tip portion 17 is connected (see FIG. 2(c)). In addition, a cross-sectional shape in the yz plane of the main body portion 18 is a substantially U-shape (corresponding to the English word "U") opened in the +z-axial direction. The additional main body portion 23 has a rod-like or linear shape. In addition, a cross-sectional shape in the yz plane of the additional main body portion 23 is a substantially U-shape (corresponding to the English letter "U") opened in the +z-axial direction.

As illustrated in FIGS. 7(b) and 7(c), as viewed in the yz plane, the hook receiver 28b is disposed in each of both inner walls on the y-axis of the main body portion 18 and in each of both inner walls on the y-axis of the additional main body portion 23. As illustrated in FIG. 5, the hook receiver 28b includes a vertical hole having a quadrangular pillar shape, and a horizontal hole extending in the +x-axial direction from a bottom of the vertical hole. The vertical hole is formed in a quadrangular pillar shape, and has a dimension " β " slightly larger than the dimension " β " in the x-axial direction, a dimension slightly larger than a dimension in the y-axial direction of the hook 28a in the

5 y-axis direction, and a depth (“ α ” + “ γ ”). A dimension in the y-axis direction of the horizontal hole is slightly larger than the dimension in the y-axis direction of the hook 28a, and a dimension in the z-axis direction of the horizontal hole is the dimension “ γ ”. Here, the dimension “ α ” is a dimension slightly smaller than the above-described dimension “ α ”, and the dimension
10 “ γ ” is a dimension slightly larger than the above-described dimension “ γ ”. That is, the relationship “ α ” > “ α ”, “ β ” < “ β ”, and “ γ ” < “ γ ” is satisfied.

Thus, the hook 28a disposed in the back surface of the lid portion 19 or in the back surface of the additional lid portion 24 is inserted into the vertical hole in the -z-axis direction. Subsequently, the hook 28a is moved in the +x-axis direction, and thus a portion of the hook 28a can be fitted to the
15 horizontal hole in a single operation. Due to the fitting, the lid portion 19 or the additional lid portion 24 becomes substantially immovable in the y-axis direction and the z-axis direction from the corresponding one of the main body portion 18 or the additional main body portion 23. Then, due to the fitting, the lid portion 19 is fixed to the main body portion 18 to form the tip guide tube 13 having a cylindrical shape. In addition, the additional lid portion 24 is fixed to the additional main body portion 23 to form the additional guide tube 14 having a cylindrical shape.

[0021]

25 Note that as illustrated in FIGS. 2(a) and 2(b), the plurality of additional guide tubes 14 (the first additional guide tube 14a, the second additional guide tube 14b, and a third additional guide tube 14c) are sequentially connected to each other from the tip guide tube 13, and the guide tube 1 is integrated into one cylindrical shape. At this time, the lid portion 19 and a plurality of the additional lid portions 24 are designed such that the lid portion 19 and the additional lid portion 24 adjacent to the lid portion 19, or the additional lid portions 24 adjacent to each other come into contact with each other to achieve the above-described fitting. Further, when the guide tube 1 is connected to the wire operating device 11, the wire operating device 11 is brought into contact
30 with or is pressed against the additional lid portion 24 of the additional guide tube 14 (third additional guide tube 14c) disposed closest to the wire operating device 11 in the -x-axis direction, such that after the fitting, the additional lid portion 24 of the additional guide tube 14 (third additional guide tube 14c) cannot move in the -x-axis direction. Accordingly, the additional guide tube 14 disposed closest to the wire operating device 11 in the -x-axis direction and
40 the wire operating device 11 are connected to each other.

5 Therefore, all the lid portion 19 or the plurality of additional lid portions 24 of the guide tube 1 become immovable substantially in the x-axial direction.

In other words, the tip guide tube 13 and the additional guide tubes 14 directly or indirectly connected to the tip guide tube 13 constitute the guide tube 1, and the lid portion 19 of the tip guide tube 13 or the additional lid portions 24 of the additional guide tubes 14 do not need to be screwed or the like. Therefore, the lid portion 19 or the additional lid portion 24 are fixed substantially inseparably to the corresponding one of the main body portion 18 or the additional main body portion 23, and there is no concern that the lid portion 19 or the additional lid portion 24 are detached from the corresponding one of the main body portion 18 or the additional main body portion 23 unless the guide tube 1 is disassembled by a worker.

That is, the guide tube 1 includes a simple structure that enables a worker to quickly and easily perform connection, and includes a structure in which the lid portion 19 or the additional lid portion 24 firmly keeps integrity without being unintentionally detached.

Here, FIG. 2 illustrates the configuration where the three additional guide tubes 14 are connected to the tip guide tube 13, and the wire operating device 11 is connected to the additional guide tube 14 (here, the third additional guide tube 14c) located at a distal end with respect to the tip guide tube 13. However, according to the length of the header 3, only one additional guide tube such as the first additional guide tube 14a may be provided, or two additional guide tubes such as the first additional guide tube 14a and the second additional guide tube 14b may be provided, or four or more additional guide tubes may be provided. The tip guide tube 13 and the single additional guide tube 14 or the plurality of additional guide tubes 14 are sequentially connected to each other, and the guide tube 1 is integrally formed. At this time, the additional connection terminal 20 of each of the additional guide tubes 14 is directly or indirectly pulled by the wire operating device 11 connected to the additional guide tube 14 located at the distal end with respect to the tip guide tube 13. Accordingly, the additional wire 22 connected directly or indirectly to the wire 16 fixed to the tip portion 17 is pulled, and the tip portion 17 is bent. [0022]

As illustrated in FIG. 2(c), as viewed in the xy plane from above, a shape of the main body portion 18 is a substantially rectangular shape elongated in the x-axial direction. However, a shape of an end portion in the -x-axial direction of the main body portion 18 is a convex shape protruding in the -x-axial direction from the center in the y-axial direction by a predetermined

5 width in the y-axial direction. Note that the tip portion 17 described below is connected to an end portion in the +x-axial direction of the main body portion 18.

10 In addition, as viewed in the xy plane from above, a shape of the additional main body portion 23 is a substantially rectangular shape elongated in the x-axial direction. However, a shape of each of two end portions in the x-axial direction of the additional main body portion 23 is a convex shape protruding in the x-axial direction from the center in the y-axial direction by a predetermined width in the y-axial direction.

15 Hereinafter, the end portion having a convex shape of the main body portion 18 and the end portions each having a convex shape of the additional main body portion 23 are each referred to as a convex end portion 30.

20 As illustrated in FIGS. 7(b) and 7(c), inside each of the main body portion 18 and the additional main body portions 23, a cable mounting base 31 is disposed from the one end to the other end on the x-axis, and a recess having a dimension that is substantially the same as and slightly larger than a diameter of the cable 7 is formed in the cable mounting base 31. The recess is disposed at the center in the y-axial direction of each of the main body portion 18 and the additional main body portion 23. In addition, since the recess is opened in the +z-axial direction, the cable 7 can be mounted from above and mounted 25 down onto the cable mounting base 31. Note that the cable mounting base 31 is designed not to inhibit the fitting between the L-shaped hook 28a and the hook receiver 28b of the locking portion 28.

30 The cable mounting base 31 is disposed from the one end to the other end on the x-axis of each of the main body portion 18 and the additional main body portion 23. Thus, as illustrated in FIG. 7(a), the convex end portion 30 also includes a recess corresponding to the cable mounting base 31.

35 The main body portion 18 and the additional main body portion 23 each include the cable mounting base 31, and thus the plurality of additional guide tubes 14 are sequentially connected to each other from the tip guide tube 13, and the guide tube 1 is integrated into one cylindrical shape. At this time, as illustrated in FIG. 2(c), one line of the cable 7 including no seam can be disposed linearly without deflection along a center axis of the guide tube 1.

40 The sensor 6 housed in the tip portion 17 of the guide tube 1 is guided to the predetermined heat transfer tube 2, and subsequently, when the sensor 6 is inserted into the inside of the heat transfer tube 2, a worker in the corridor 4 pushes the cable 7 out to the inside of the guide tube 1. The cable 7 is pushed out to the inside of the guide tube 1, and thus the sensor 6 connected to the

5 cable 7 is released from the tip portion 17 and enters the inside of the heat transfer tube 2. At this time, the cable 7 is disposed in the recess of the cable mounting base 31. Thus, bending of the cable 7 that is bendable is prevented, and the cable 7 can be pushed out appropriately to the inside of the guide tube 1.

10 That is, according to the guide tube 1, the sensor 7 can be inserted appropriately to the predetermined heat transfer tube 2.
[0023]

From the tip guide tube 13, the plurality of additional guide tubes 14 are sequentially connected to each other, and the guide tube 1 integrated into one
15 cylindrical shape is formed. At this time, as illustrated in FIGS. 2, 6, and 7, the respective convex end portions 30 of the main body portion 18 and the additional main body portion 23 or the respective convex end portions 30 of the two additional main body portions 23 connected to each other are firmly coupled to each other by a coupling portion 29.

20 The coupling portion 29 is a member for firmly coupling, to each other, the two convex end portions 30 adjacent to and connected to each other. Here, as described below, the coupling portion 29 includes (1) an arm 29a and a hook 29b of a snap lock that are disposed respectively in side surfaces in the y-axial direction (plate-like side surfaces in the xz plane) of the two convex end
25 portions 30 adjacent to each other, (2) a mandrel 29c and an insertion hole 29d that are disposed respectively in side walls in the x-axial direction (plate-like side surfaces in the yz plane that each include a recess corresponding to the cable mounting base 31 as illustrated in FIG. 7(a)) located at tips of the two convex end portions 30 adjacent to each other, and that are fitted to each other,
30 and (3) a protrusion 29e and a recess 29f that are disposed respectively in side surfaces in the x-axial direction located at the tips of the two convex end portions 30 adjacent to each other, and that are fitted to each other.

According to design, the coupling portion 29 may not include some of the components (1), (2), and (3), or other components may be added. In
35 addition, instead of the snap lock of (1), a string including one end fixed to one of the convex end portions 30 may be disposed, and a projection for winding the string may be disposed in the other of the convex end portions 30, and the convex end portions 30 adjacent to each other may be fixed to each other.
[0024]

40 Next, hereinafter, the three components of the coupling portion 29 will be described.

5 First, the snap lock of the component (1) will be described. The snap lock is also referred to as a draw latch, and is constituted by a set of the arm 29a and the hook 29b. The snap lock is a locking tool that hooks and biases the arm 29a fixed to a member on the hook 29b fixed to the other member, and thus fixes the arm 29a and the hook 29b to each other.

10 As illustrated in FIG. 2(c), the two snap locks are disposed to sandwich the convex end portions 30 adjacent to each other, from the y-axial direction.

The arm 29a and the hook 29b are disposed, for example, as follows. As illustrated in FIG. 6(a), the hook 29b is disposed in the convex end portion 30 of the main body portion 18 of the tip guide tube 13. In this case, as illustrated in FIG. 6(b), the arm 29a is disposed in the convex end portion 30 protruding in the +x-axial direction of the additional main body portion 23 of the additional guide tube 14 connected to the tip guide tube 13. At this time, the hook 29b is disposed in the convex end portion 30 protruding in the - x-axial direction of the additional main body portion 23.

20 However, as long as the convex end portions 30 adjacent to each other can be fixed by the arm 29a and the hook 29b, the arm 29a may be disposed in the convex end portion 30 of the main body portion 18, and the hook 29b may be disposed in the convex end portion 30 in the +x-axial direction of the additional main body portion 23.

25 In other words, the other end of the main body portion 18 including the one end connected to the tip portion 17 is provided with one of the arm 29a and the hook 29b of the snap lock. In addition, the one end of the additional main body portion 23 that is connected to the other end of the main body portion 18 is provided with the other of the arm 29a and the hook 29b of the snap lock.

30 Note that FIG. 6(c) illustrates a state where the tip guide tube 13 and the additional guide tube 14 (first additional guide tube 14a) connected to the tip guide tube 13 are fixed by the corresponding one of the arm 29a and the hook 29b.

[0025]

35 Next, the mandrel 29c and the insertion hole 29d corresponding to the mandrel 29c of the component (2) will be described. A diameter of the insertion hole 29d is substantially identical to and slightly larger than a diameter of the mandrel 29c. A center axis of the mandrel 29c is disposed along the x-axis. The mandrel 29c and the insertion hole 29d are disposed, for example, as follows.

40 As illustrated in FIG. 7(a), the insertion hole 29d is disposed in the side surface of the tip of the convex end portion 30 of the tip guide tube 13 of FIG. 6(a), and below the recess of the cable mounting base 31. In this case, as

5 illustrated in FIG. 6(b), the mandrel 29c is disposed in the convex end portion 30 protruding in the +x-axial direction of the additional guide tube 14 (first additional guide tube 14a) connected to the tip guide tube 13.

At this time, the insertion hole 29d is disposed in the side surface of the convex end portion 30 protruding in the -x-axial direction of the additional
10 guide tube 14 (first additional guide tube 14a), and below the recess of the cable mounting base 31.

However, as long as the convex end portions 30 adjacent to each other can be fitted to each other by the mandrel 29c and the insertion hole 29d, the mandrel 29c may be disposed in the convex end portion 30 of the tip guide tube
15 13, and the insertion hole 29d may be disposed in the convex end portion 30 in the +x-axial direction of the additional main body portion 23.

In other words, the other end of the main body portion 18 including the one end connected to the tip portion 17 is provided with one of the mandrel 29c and the insertion hole 29d. In addition, the one end of the additional main body
20 portion 23 that is connected to the other end of the main body portion 18 is provided with the other of the mandrel 29c and the insertion hole 29d.

Note that it is necessary to prevent the snap lock of the component (1) from being damaged and to prevent the guide tube 1 from being disassembled. Thus, the mandrel 29c and the insertion hole 29d disposed in the respective
25 convex end portions 30 are designed to be able to sufficiently support weights of the tip guide tube 13 and the additional guide tubes 14 directly or indirectly connected to the tip guide tube 13. In addition, in a case where a large number of the additional guide tubes 14 are added, the mandrel 29c and the insertion
30 hole 29d are designed to suppress deflection due to weights of the additional guide tubes 14. At this time, a side surface (side plate) similar to the side surface of the tip is also disposed at the other end of the convex end portion 30 in which the insertion hole 29d is disposed. Further, the mandrel 29c inserted into the insertion hole 29d is also inserted into the insertion hole in the side surface of the other end. In this manner, the configuration where the mandrel
35 29c is supported at least by the two insertion holes, that is, at least at two points can achieve the stable support.

[0026]

Next, the protrusion 29e and the recess 29f corresponding to the protrusion 29e of the component (3) will be described.

40 The protrusion 29e is, for example, a cylinder extending in the x-axial direction. The recess 29f is, for example, a recess having a diameter and a length that are substantially identical to or slightly larger than a diameter and a

5 length of the cylinder. The recess 29f may be a through-hole. The protrusion 29e and the recess 29f are disposed, for example, as follows.

As illustrated in FIG. 7(a), the recess 29f is disposed in the side wall of the tip of the convex end portion 30 of the tip guide tube 13 of FIG. 6(a), and below the recess of the cable mounting base 31, and at a position different from
10 the position of the insertion hole 29d. In this case, as illustrated in FIG. 6(b), the protrusion 29e is disposed in the convex end portion 30 protruding in the +x-axial direction of the additional guide tube 14 (first additional guide tube 14a) connected to the tip guide tube 13.

At this time, the recess 29f is disposed in the side wall of the tip of the
15 convex end portion 30 protruding in the -x-axial direction of the additional guide tube 14 (first additional guide tube 14a), and below the recess of the cable mounting base 31, and at a position different from the position of the insertion hole 29d.

However, as long as the convex terminals 30 adjacent to each other can
20 be fitted to each other by the protrusion 29e and the recess 29f, the protrusion 29e may be disposed in the convex end portion 30 of the tip guide tube 13, and the recess 29f may be disposed in the convex end portion 30 in the +x-axial direction of the additional main body portion 23.

In other words, the other end of the main body portion 18 including one
25 end connected to the tip portion 17 is provided with one of the protrusion 29e and the recess 29f. In addition, the one end of the additional main body portion 23 that is connected to the other end of the main body portion 18 is provided with the other of the protrusion 29e and the recess 29f.

Even when the mandrel 29c and the insertion hole 29d disposed in the
30 respective convex end portions 30 can sufficiently support the weights of the tip guide tube 13 and the additional guide tubes 14 directly or indirectly connected to the tip guide tube 13 as described above, different moments centering on the mandrel 29c may be applied to each of the tip guide tube 13 and the additional guide tube 14 that are adjacent to each other, or to each of
35 the additional guide tubes 14 adjacent to each other. In such a case, there is a concern that the snap lock of the component (1) is damaged and the guide tube 1 is disassembled or rotates in the yz plane around the axis of the mandrel 29c.

However, the protrusion 29e and the recess 29f of the convex end
portions 30 adjacent to each other are fitted to each other. Thus, even in a case
40 where the moments are applied, the tip guide tube 13 and the additional guide tube 14 that are adjacent to each other, or the additional guide tubes 14 adjacent to each other are restricted to move in an identical manner in the yz plane.

5 Accordingly, damage of the snap lock, and disassembly or rotation of the guide tube 1 can be prevented.

Note that the protrusion 29e and the recess 29f of the convex end portions 30 adjacent to each other are fitted to each other. Thus, the main body portion 18 and the additional main body portion 23 that are adjacent to each other, or the two additional main body portions 23 adjacent to each other are aligned to each other. Accordingly, as viewed in the yz plane, positions of the side surfaces correspond to each other.

The guide tube 1 including the coupling portion 29 described above includes a simple structure that enables a worker to quickly and easily perform connection, and includes a structure that firmly keeps integrity and that further facilitates workability of a worker.

[0027]

Now, the tip guide tube 13, unlike the additional guide tube 14, includes a strut portion 32. As illustrated in FIGS. 6 and 7, the strut portion 32 includes two shaft bearings 32g, a coupling shaft 32f, two struts 32a, a lever 32b, a first projection 32c, and a second projection 32d. The two shaft bearings 32g are disposed at both ends in the y-axial direction of a bottom surface (a surface facing the lid portion 19) of the main body portion 18, respectively. The coupling shaft 32f is inserted into the shaft bearings 32g. The two struts 32a are connected to both ends of the coupling shaft 32f, respectively and are pivotable around the coupling shaft 32f in synchronization with each other. The lever 32b includes one end that is pivotably connected near the center of the strut 32a. The first projection 32c fixes the other end of the lever 32b when the strut 32a is disposed along the length direction (x-axial direction) of the tip guide tube 13. The second projection 32d fixes the other end of the lever 32b when the strut 32a is disposed along a direction perpendicular (z-axial direction) to the length direction.

The first projection 32c and the second projection 32d are formed to protrude from one of side surfaces in the y-axial direction of the main body portion 18. The lever 32b includes notches that enter the first projection 32c and the second projection 32d from above, respectively.

In addition, the strut 32a is expandable and contractible, and includes bearings 32e at both ends, respectively. In FIG. 7, the strut 32a is illustrated as a square pillar, but may be a cylinder or a polygon. The strut 32a can physically or mechanically expand and contract by an expansion and contraction mechanism using a biasing member such as a spring, or a gear or the like.

5 Due to the weight of the guide tube 1 including the additional guide tube
14 connected to the tip guide tube 13, it may be difficult to continuously insert
the guide tube 1 in parallel to the x-axial direction, which is the axial direction
of the header 3. Then, when the tip guide tube 13 is inserted into the tube base
5, the strut 32a is laid down along the length direction of the tip guide tube 13.
10 Subsequently, immediately after the strut 32a of the tip guide tube 13 is
completely inserted into the inside of the header 3, a worker operates the lever
32b from the outside of the tube base 5. Accordingly, the strut 32a is rotated
and fixed in a direction perpendicular to the length direction of the tip guide
tube 13. The above-described operation may be performed inside the header 3
15 when a hand can enter the inside of the header 3 from the tube base 5. Then, a
worker extends and fixes the strut 32a such that the bearings 32e at both the
ends of the strut 32a come into contact with an inner wall of the header 3.
Accordingly, even the guide tube 1 including the additional guide tube 14
connected to the tip guide tube 13 can be inserted easily and continuously in
20 parallel to the axial direction of the header 3. Note that inversion and
expansion and contraction of the strut 32a may be automated. For example,
when a biasing member is placed inside the strut 32a and biased against a
member supporting the bearings at both ends in advance, the expansion and
contraction of the strut 32a can be automated. If the expansion and contraction
25 of the strut 32a is automated, the guide tube 1 is also applicable to a header
having a small inner diameter that is difficult to work with.

 Note that the tip portion 17 described below is bent at about 90° from
the length direction of the tip guide tube 13 toward the above-described bottom
surface side. Thus, in a case where the heat transfer tube 2 is not connected in
30 the z-axial direction of the header 3 and below the header 3, the guide tube 1
connected to the wire operating device 11 is rotated in the axial direction of the
header 3 together with the wire operating device 11. At this time, the strut 32a
remains in contact with the inner wall of the header 3. Further, since the tip
guide tube 13 is supported at four points by the two struts 32a, the guide tube 1
35 can appropriately guide the sensor 6 to the heat transfer tube 2.

 Although the configuration in which only the tip guide tube 13 includes
the strut portion 32 is described, in addition to the tip guide tube 13, the
additional guide tube 14 may include the strut portion 32. In addition, although
the struts 32a are described as the two struts 32a that are pivotable around the
40 coupling shaft 32f in synchronization with each other, according to design,
there may be a configuration where only one strut 32a is provided, or a

5 configuration in which three or more struts 32a are provided, or in some cases, a configuration where the length of each of the struts 32a is changed.

Since the guide tube 1 including the strut portion 32 described above can be easily inserted by a worker along the center axis of the header 3, the guide tube 1 has a structure that facilitates workability of a worker.

10 [0028]

Lastly, the tip portion 17 connected to the main body portion 18 will be described. The tip portion 17 includes a sensor housing portion 17a, a bent portion 17b, and an imaging device 17c. The sensor housing portion 17a releasably houses the sensor 6, and is formed into a cylindrical shape. The bent portion 17b is connected to the sensor housing portion 17a, and is bent in one direction toward the above-described bottom surface side such that a center axis of the sensor housing portion 17a becomes in a direction of about 90° from the length direction of the main body portion 18. The imaging device 17c is disposed in the sensor housing portion 17a and images in a direction opposite to a direction in which the bent portion 17b is disposed along the above-described center axis, in other words, images the front of the sensor housing portion 17a.

However, as long as the front of the guide tube 1 can be imaged clearly, the imaging device 17c may be attached at any position near the tip of the sensor housing portion 17a.

The sensor housing portion 17a and the bent portion 17b can use the configurations disclosed in the Citation List.

Note that as described above, the wire operating device 11 winds the additional wire 22a by the bending reel 11a while loosening the stretching reel 11b. Accordingly, the bending wire 16a (see FIG. 6(a)) including one end connected to the additional wire 22a by the slide terminal 21 and the other end fixed to a bottom surface (a lower surface of surfaces in the z-axial direction) of the sensor housing portion 17a is pulled. As a result, the tip portion 17 of the tip guide tube 13 of the guide tube 1 is bent. In addition, the wire operating device 11 winds the additional wire 22b by the stretching reel 11b while loosening the bending reel 11a, and accordingly, the stretching wire 16b including one end connected to the additional wire 22b by the slide terminal 21 and the other end fixed to a top surface (an upper surface of the surfaces in the z-axial direction) of the sensor housing portion 17a is pulled. As a result, the tip portion 17 of the tip guide tube 13 of the guide tube 1 is stretched.

The imaging device 17c is a device such as a CMOS (complementary MOS) sensor or a CCD (charge coupled device) that can immediately transmit

5 an imaged video or image. Although not illustrated, wiring that is connected to the imaging device 17c and used to transmit a video or an image is connected to the analysis device 8. To prevent the occurrence of failure such as disconnection due to contact with the cable 7 that is moved forward and backward inside the guide tube 1, the wiring is connected to the analysis device 10 8 not through the recess of the cable mounting base 31 but through a space between the cable mounting base 31 and the main body portion 18 or the additional main body portion 23. Then, the analysis device 8 causes the display device 9 to display a video or an image imaged by the imaging device 17c. Accordingly, a worker can appropriately and easily guide the sensor 6 to the 15 desired heat transfer tube 2 connected to the header 3. Note that the above-described wiring used to transmit a video or an image may be directly connected to a portable display device independent of the analysis device 8 and the display device 9, and an imaged video may be displayed by the portable display device, instead of being displayed by using the analysis device 8 and 20 the display device 9.

[0029]

Although the embodiments of the present invention are described in detail above, the technical scope of the present invention is not limited to the embodiments, and includes a design change or the like that does not depart 25 from the gist of the present invention.

Industrial Applicability

[0030]

According to the present invention, an additional guide tube can be 30 connected to a tip guide tube, and the length of a guide tube can be increased. That is, even in a case where the length of a header is sufficient as compared to the length of a tip guide tube, an additional guide tube can be appropriately connected to the tip guide tube, and thus a sensor can be guided to a heat transfer tube to which a sensor could not be guided only by the tip guide tube.

35 In addition, when the additional guide tube is connected to the tip guide tube, a cable is housed in an additional main body portion, and subsequently an additional lid portion is fitted to the additional main body portion and the additional guide tube can be formed into a cylindrical shape. Thus, connection time of the additional guide tube by a worker can be shortened.

40 Further, a wire of the tip guide tube and an additional wire of the additional guide tube connected to the wire are fixed to surfaces of a lid portion and the additional lid portion, respectively, in a manner movable forward and

5 backward. Then, a connection terminal of the wire and a slide terminal of the
additional wire are connected to each other. In addition, a slide portion
disposed in the surface of the additional lid portion restricts movement of the
slide terminal. Thus, there is no concern that these wires deflect at a large
distance from the tip guide tube and the additional guide tube to cause failure
10 of the guide tube.

Therefore, a guide tube that has a simple structure and that can
appropriately guide the sensor to a heat transfer tube without being affected by
the length of a header can be provided.

15 Reference Signs List

- [0031]
1 Guide tube
2 Heat transfer tube
3 Header
20 4 Corridor
5 Tube base
6 Sensor
7 Cable
8 Analysis device
25 9 Display device
10 Cable winding device
11 Wire operating device
(11a Bending reel, 11b Stretching reel)
12 Work stand
30 13 Tip guide tube
14 Additional guide tube
(14a First additional guide tube, 14b Second additional guide tube, 14c Third
additional guide tube) 15 Connection terminal
16 Wire
35 (16a Bending wire, 16b Stretching wire)
17 Tip portion
(17a Sensor housing portion, 17b Bent portion, 17c Imaging device)
18 Main body portion
19 Lid portion
40 20 Additional connection terminal
21 Slide terminal
22 Additional wire

- 5 (22a Additional wire connected directly or indirectly to bending wire 16a,
22b Additional wire connected directly or indirectly to stretching wire 16b)
- 23 Additional main body portion
- 24 Additional lid portion
- 25 Slide portion
- 10 (25a Exterior portion, 25b Groove)
- 26 Wire guide portion
- 27 Additional wire guide portion
- 28 Locking portion
- (28a L-shaped hook, 28b Hook receiver)
- 15 29 Coupling portion
- (29a Arm, 29b Hook, 29c Mandrel, 29d Insertion hole,
29e Protrusion, 29f Recess)
- 30 Convex end portion
- 31 Cable mounting base
- 20 32 Strut portion
- (32a Strut, 32b Lever, 32c First projection, 32d Second projection,
32e Bearing, 32f Coupling shaft, 32g Shaft bearing)

[Claim 1]

10 A guide tube that contains and guides a sensor and a cable connected to the sensor from an opening of a tube base disposed at one end on a center axis of a header of a boiler to a heat transfer tube connected to the header, the sensor being configured to measure a wall thickness of the heat transfer tube, the guide tube comprising:

- 15 a tip guide tube configured to releasably house the sensor; and
- a first additional guide tube that is connectable to the tip guide tube, the tip guide tube including:
 - 20 a wire including one end at which a connection terminal is disposed, a tip portion to which an other end of the wire is fixed and which is bendable,
 - a main body portion having a rod-like shape and a substantially U-shaped cross section, and including one end to which the tip portion is connected, and
 - 25 a lid portion having a surface to which the wire is fixed in a manner movable forward and backward, and a back surface from which the lid portion is fitted to the main body portion,
 - the first additional guide tube including:
 - 30 an additional wire including one end at which an additional connection terminal is disposed, and an other end at which a slide terminal is disposed,
 - an additional main body portion having a rod-like shape and a substantially U-shaped cross section,
 - an additional lid portion having a surface to which the additional wire is fixed in a manner movable forward and backward, and a back surface from which the additional lid portion is fitted to the additional main body portion, and
 - 35 a slide portion disposed on a surface of the additional lid portion and being configured to restrict movement of the slide terminal in a manner movable forward and backward by a predetermined distance in a length direction of the additional lid portion,
 - wherein the connection terminal is connected to the slide terminal,
 - 40 the sensor is housed in the tip portion, the other end of the main body portion and one end of the additional main body portion are connected to each other, the cable is disposed inside the main body portion and inside the additional main body portion, and the lid portion and the additional lid portion

5 are fitted to the main body portion and the additional main body portion,
respectively, such that the tip guide tube and the first additional guide tube are
integrated into one cylindrical shape; and
the additional connection terminal is pulled to bend the tip portion.

10 [Claim 2]

The guide tube according to claim 1,
wherein the slide terminal includes an opening, and
the connection terminal is inserted into the opening, and the connection
terminal is housed inside the slide terminal such that the connection terminal is
15 connected to the slide terminal.

[Claim 3]

The guide tube according to claim 2,
wherein the lid portion is moved in a length direction of the main body
20 portion so that the lid portion is fitted to the main body portion,
the additional lid portion is moved in a length direction of the additional
main body portion so that the additional lid portion is fitted to the additional
main body portion, and
the additional lid portion comes into contact with the lid portion and is
25 fitted to the additional main body portion so that the lid portion is inseparable
from the main body portion.

[Claim 4]

The guide tube according to claim 3,
30 wherein the other end of the main body portion is provided with one of a
mandrel and an insertion hole that are fitted to each other, and the one end of
the additional main body portion further is provided with the other of the
mandrel and the insertion hole,
the other end of the main body portion is provided with one of a recess
35 and a protrusion that are fitted to each other, and the one end of the additional
main body portion is provided with the other of the recess and the protrusion,
the other end of the main body portion is provided with one of an arm
and a hook of a snap lock, and one end of the additional main body portion is
provided with the other of the arm and the hook, and
40 after the mandrel and the insertion hole are fitted to each other and the
recess and the protrusion are fitted to each other, the arm is hooked on the hook

5 and the snap lock is locked so that the other end of the main body portion and the one end of the additional main body portion are connected to each other.

[Claim 5]

The guide tube according to claim 4, further comprising:

10 a second additional guide tube that has a structure identical to a structure of the first additional guide tube and that is connected to the first additional guide tube integrated with the tip guide tube; and

a wire operating device,

15 wherein an other end of an additional main body portion of the first additional guide tube has a configuration among the mandrel, the insertion hole, the recess, the protrusion, the arm, and the hook that is provided at the other end of the main body portion,

in the same manner as connection between the other end of the main body portion and one end of the additional main body portion of the first
20 additional guide tube, the other end of the additional main body portion of the first additional guide tube and one end of an additional main body portion of the second additional guide tube are connected to each other,

the cable is disposed inside the additional main body portion of the second additional guide tube, and an additional lid portion of the second
25 additional guide tube comes into contact with an additional lid portion of the first additional guide tube and is fitted to an additional main body portion of the second additional guide tube so that the additional lid portion of the first additional guide tube is inseparable from the additional main body portion of the first additional guide tube, and also the tip guide tube, the first additional
30 guide tube, and the second additional guide tube are integrated into one cylindrical shape,

an additional connection terminal of the first additional guide tube is housed inside and connected to the slide terminal of the second additional guide tube, and

35 an additional connection terminal of the second additional guide tube is directly or indirectly pulled by the wire operating device to bend the tip portion.

[Claim 6]

40 The guide tube according to any one of claims 1 to 5,

- 5 wherein the tip guide tube further includes a strut portion including, near
or at one end of the main body portion, a strut that is pivotable and expandable
and contractible,
a bearing is disposed at each of both ends of the strut, and
when the tip guide tube is inserted into an opening of the tube base, the
10 strut is disposed to be substantially parallel to the center axis, and after the tip
guide tube is inserted into the header, the strut pivots to be substantially
perpendicular to the center axis and is stretched such that the bearing comes
into contact with the header.