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(54) **LAYERS OF CONDUCTORS AND INSULATORS FORMING A TERMINAL BLOCK**

(71) Applicant: **KAWASAKI JUKOGYO KABUSHIKI KAISHA**, Kobe (JP)

(72) Inventors: **Atsunori Arai**, Kobe (JP); **Tateki Sakimoto**, Kobe (JP); **Hayato Hirota**, Kobe (JP); **Tatsuya Okuwa**, Kobe (JP); **Hikaru Maesato**, Kobe (JP); **Sho Sakamoto**, Kobe (JP)

(73) Assignee: **KAWASAKI JUKOGYO KABUSHIKI KAISHA**, Kobe (JP)

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H01R 9/24 (2006.01)
F02C 7/266 (2006.01)

(52) **U.S. Cl.**
CPC ***H01R 9/2416*** (2013.01); *F02C 7/266* (2013.01)

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CPC H01R 9/2416; H01R 9/18
See application file for complete search history.

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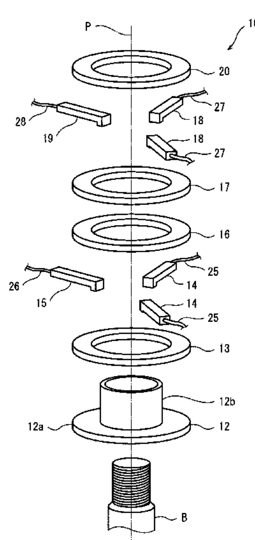
Primary Examiner — Vanessa Girardi
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

A terminal block of a gas turbine engine includes: at least one electric conductor on and with which terminals of electric wires of electric parts and an electric device are laminated in a first direction and are in contact; at least two insulators laminated so as to sandwich the terminals and the electric conductor in the first direction; a stopper opposed to a first-end insulator located at a first end side in the first direction among the at least two insulators; and a spring arranged between the stopper and a second-end insulator located at a second end side in the first direction among the at least two insulators, the spring pressing the terminals against the electric conductor in the first direction.

5 Claims, 4 Drawing Sheets



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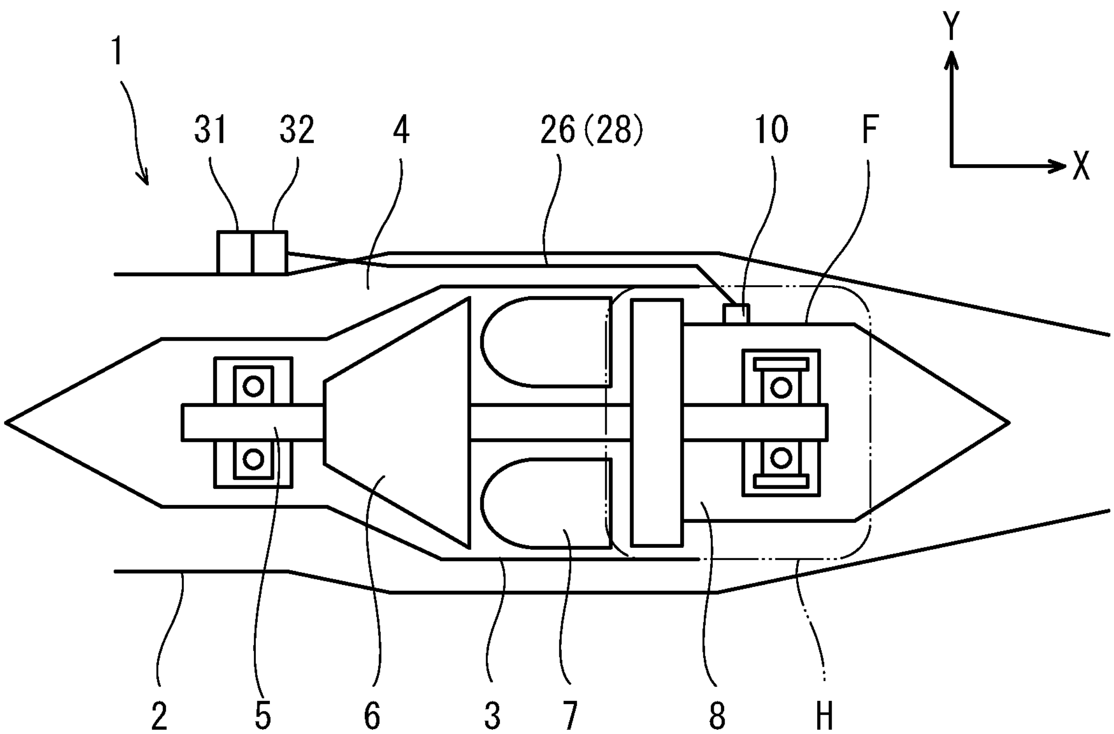


FIG. 1

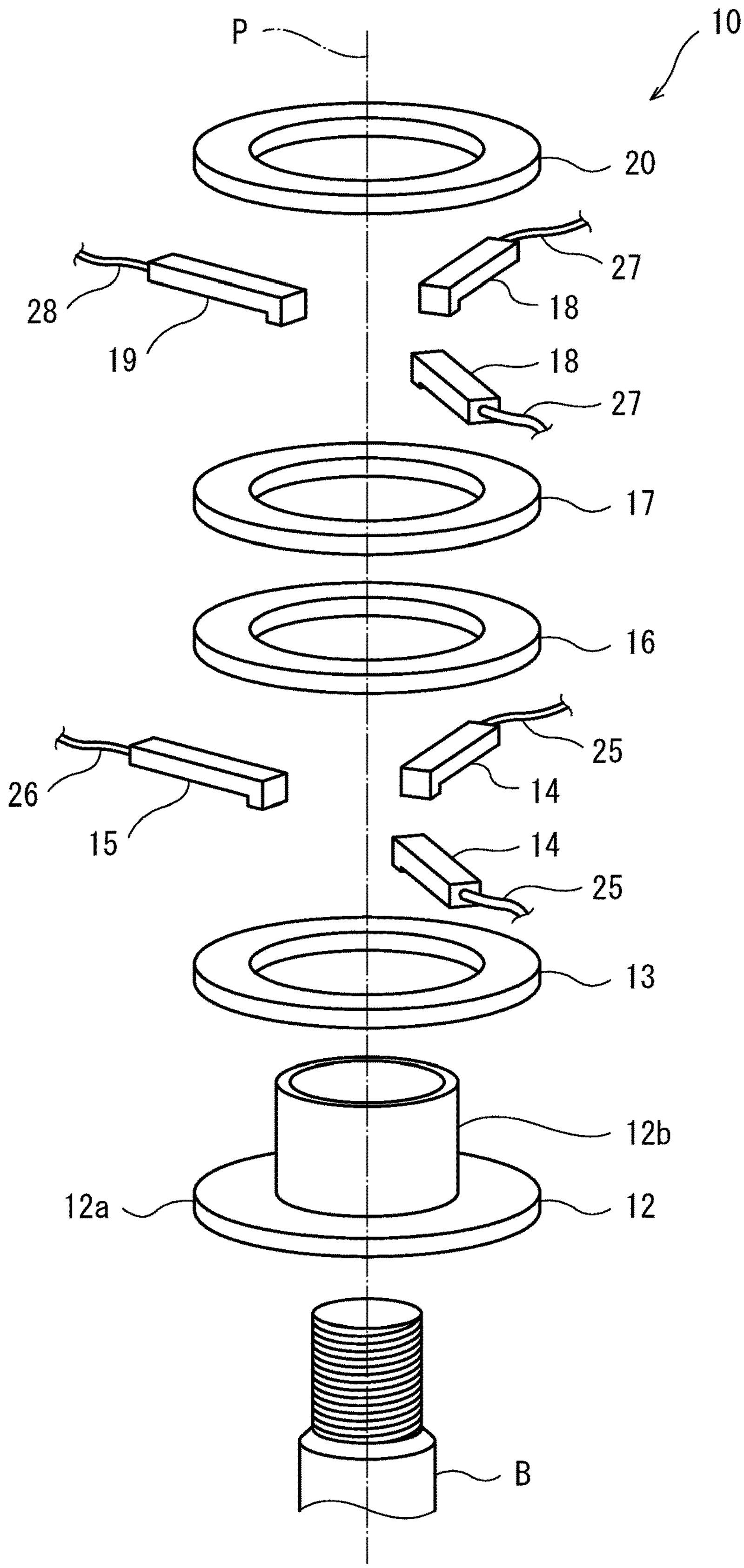
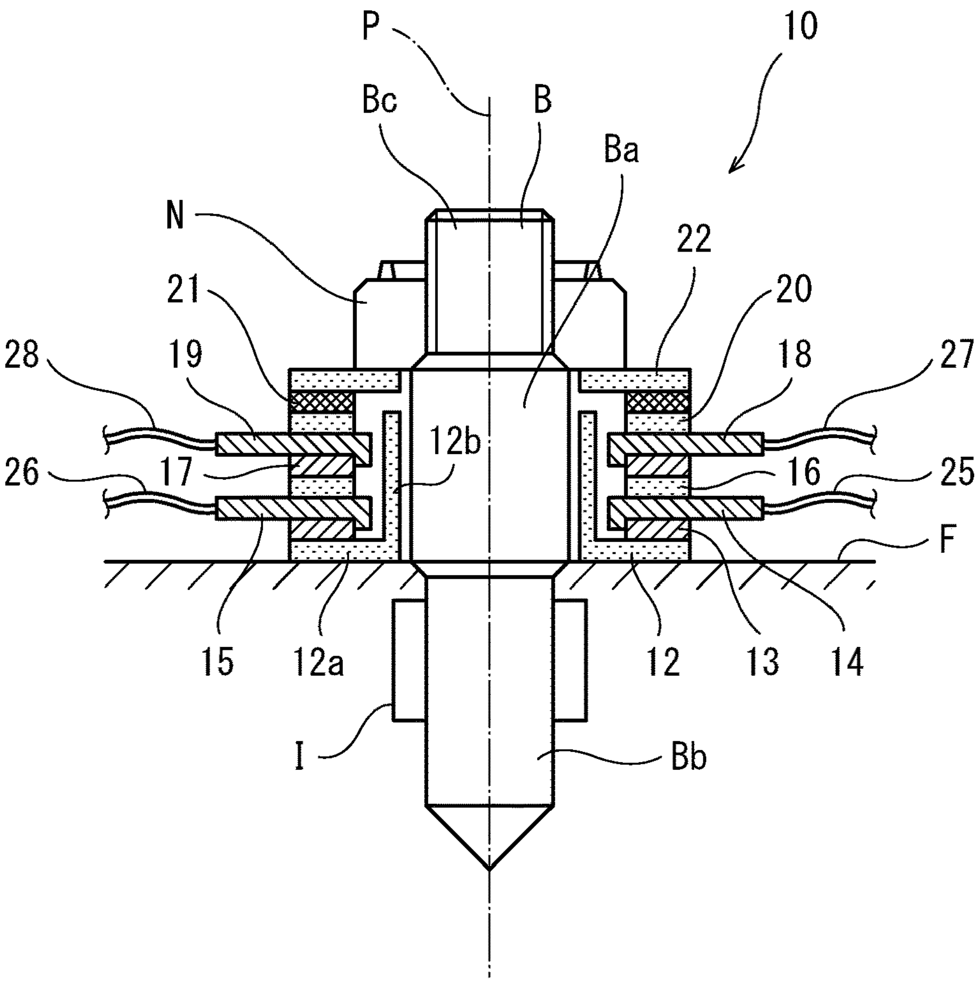


FIG. 2


P
10
Bc
B
Ba
N
22
21
20
28
19
18
27
12b
26
17
16
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F
15
12a
12
13
14
I
Bb

FIG. 3

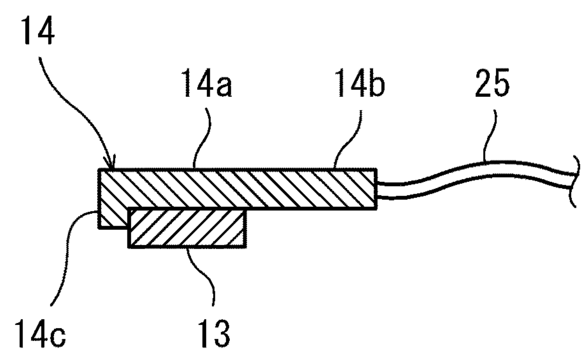
14
14a
14b
25
14c
13

FIG. 4

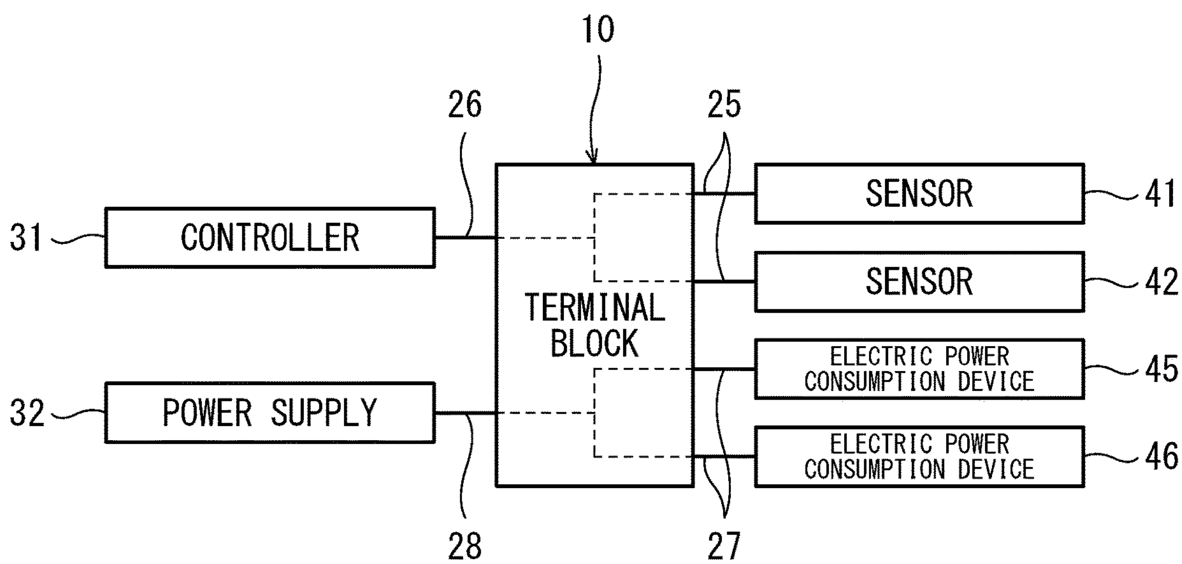
10
26
25
31
CONTROLLER
SENSOR
41
SENSOR
42
TERMINAL BLOCK
ELECTRIC POWER CONSUMPTION DEVICE
45
32
POWER SUPPLY
ELECTRIC POWER CONSUMPTION DEVICE
46
28
27

FIG. 5

LAYERS OF CONDUCTORS AND INSULATORS FORMING A TERMINAL BLOCK

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a National Stage of International Application No. PCT/JP2021/006117, filed Feb. 18, 2021, claiming priority to U.S. Provisional Patent Application No. 62/978,965, filed Feb. 20, 2020, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a terminal block used for wires extending from electric parts located inside a casing of a gas turbine engine to electric devices located outside the casing.

BACKGROUND ART

A gas turbine engine in which a compressor, a combustor, and a turbine are arranged along a rotating shaft has been known.

CITATION LIST

Patent Literature

PTL 1: Japanese Laid-Open Patent Application Publication No. 2003-31280

SUMMARY OF INVENTION

Technical Problem

In the gas turbine engine, wires need to be arranged within a limited mounting space. A compact and low-cost terminal block which collects wires of sensors and devices arranged in a high-temperature region in a casing of the engine and enables the wires to extend to an outside of the casing is required.

Solution to Problem

A terminal block of a gas turbine engine according to one aspect of the present disclosure is a terminal block used for wires extending from electric parts located inside a casing of the gas turbine engine to an electric device located outside the casing. The terminal block includes: at least one electric conductor on and with which terminals of electric wires of the electric parts and the electric device are laminated in a first direction and are in contact: at least two insulators laminated so as to sandwich the terminals and the electric conductor in the first direction: a stopper opposed to a first-end insulator located at a first end side in the first direction among the at least two insulators; and a spring arranged between the stopper and a second-end insulator located at a second end side in the first direction among the at least two insulators, the spring pressing the terminals against the electric conductor in the first direction.

According to the above configuration, the terminal block used for the wires extending from the electric parts located inside the casing of the gas turbine engine to the electric device located outside the casing can be made compact and simple.

Advantageous Effects of Invention

According to one aspect of the present disclosure, the terminal block used for the wires extending from the electric parts located inside the casing of the gas turbine engine to the electric device located outside the casing can be made compact and simple.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a sectional view of a gas turbine engine according to an embodiment.

FIG. **2** is an exploded perspective partial view of a terminal block of FIG. **1**.

FIG. **3** is a sectional view of the terminal block of FIG. **2**.

FIG. **4** is an enlarged view of a terminal and an electrically-conductive ring in the terminal block of FIG. **3**.

FIG. **5** is a block diagram for explaining an electrical connection of the terminal block of FIG. **3**.

DESCRIPTION OF EMBODIMENTS

Hereinafter, an embodiment will be described with reference to the drawings.

FIG. **1** is a sectional view of a gas turbine engine **1** according to the embodiment. As shown in FIG. **1**, the gas turbine engine **1** includes a compressor **6**, a combustor **7**, and a turbine **8** which are arranged along a rotating shaft **5**. Air compressed by the compressor **6** is combusted by the combustor **7**, and its combustion gas rotates the turbine **8**. Thus, the rotating shaft **5** is driven. A direction in which an axis of the rotating shaft **5** extends is referred to as an axial direction X, and a direction orthogonal to the axial direction X is referred to as a radial direction Y.

The compressor **6**, the combustor **7**, and the turbine **8** are covered with an outer shell **3**. A casing **2** is located outside the outer shell **3** in the radial direction Y. A bypass passage **4** is located between the casing **2** and the outer shell **3**. A controller **31** (first electric device) and a power supply **32** (second electric device) are arranged outside the casing **2**. A region located at an inner side of the casing **2** in the radial direction Y and a downstream side of the combustor **5** is a high-temperature region H having a temperature higher than 650° C. A terminal block **10** is arranged in the high-temperature region H.

The terminal block **10** is fixed to a frame F that is located downstream of the combustor **7** in the casing **2** and disposed outside the turbine **8** in the radial direction Y. For example, the terminal block **10** is arranged inside the casing **2** in the radial direction Y and outside the frame F in the radial direction Y. For example, when a reverse flow combustor is adopted as the combustor **7** of the gas turbine engine **1**, the terminal block **10** may be disposed at a portion of the outer shell **3** which portion is located downstream of the combustor **7** in the axial direction X of the gas turbine engine **1** and outside the turbine **8** in the radial direction Y.

FIG. **2** is an exploded perspective partial view of the terminal block **10** of FIG. **1**. FIG. **3** is a sectional view of the terminal block **10** of FIG. **2**. FIG. **4** is an enlarged view of a terminal and an electrically-conductive ring in the terminal block **10** of FIG. **3**. FIG. **5** is a block diagram for explaining an electrical connection of the terminal block **10** of FIG. **3**. As shown in FIGS. **2** to **5**, the terminal block **10** includes a stud bolt B, an insulator **12**, an electrically-conductive ring **13** (electric conductor), terminals **14** and **15**, an insulating ring **16** (insulator), an electrically-conductive ring **17** (electric conductor), terminals **18** and **19**, an insulating ring **20** (insulator), a spring washer **21**, an insulating ring **22**, and a nut N (stopper).

The stud bolt B includes an intermediate shaft portion Ba, a root threaded portion Bb. and a tip threaded portion Bc. The root threaded portion Bb projects toward one side of the intermediate shaft portion Ba in an axial direction P of the stud bolt B. The tip threaded portion Bc projects toward the other side of the intermediate shaft portion Ba in the axial direction P. The intermediate shaft portion Ba is larger in diameter than the tip threaded portion Bc. The stud bolt B is fixed to the frame F in such a manner that the root threaded portion Bb is threadedly engaged with an insert screw I embedded in the frame F. The stud bolt B projects outward in the radial direction Y from the frame F. The stud bolt B is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. In the present embodiment, the axial direction P (first direction) of the stud bolt B extends in the radial direction Y of the gas turbine engine **1** but may extend in another direction.

The insulator **12** is made of an insulating material. The insulator **12** is made of, for example, ceramic having an insulation property and heat resistance. The insulator **12** includes an insulating ring portion **12***a* (second-end insulator) and an insulating tube portion **12***b*. The insulating tube portion **12***b* projects from an inner peripheral end of the insulating ring portion **12***a* in a direction perpendicular to the insulating ring portion **12***a*. The insulating ring portion **12***a* has an annular plate shape. The insulating ring portion **12***a* is supported by the frame F. The insulating ring portion **12***a* and the insulating tube portion **12***b* are externally fitted to the stud bolt B with play: The tube portion **12***b* extends in the axial direction P of the stud bolt B. The tube portion **12***b* isolates the stud bolt B from the electrically-conductive rings **13** and **17** and the terminals **14**, **15**, **18**, and **19**.

The electrically-conductive ring **13** is an annular plate made of an electrically-conductive material. The electrically-conductive ring **13** is placed on the insulating ring portion **12***a* in the axial direction P. The electrically-conductive ring **13** is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The electrically-conductive ring **13** is externally fitted to the insulating tube portion **12***b* with play. To be specific, an inner diameter of the electrically-conductive ring **13** is larger than an outer diameter of the insulating tube portion **12***b*. An outer diameter of the electrically-conductive ring **13** is equal to or smaller than an outer diameter of the insulating ring portion **12***a*.

The terminals **14** are connected to respective sensors **41** and **42** (first electric parts), arranged in the casing **2**, through respective electric wires **25**. One example of the sensor **41** is a temperature sensor. The terminal **14** is made of an electrically-conductive material. The terminal **15** is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The terminals **14** are placed on the electrically-conductive ring **13** in the axial direction P.

Each of the terminals **14** includes a placing portion **14***a*, an electric wire connecting portion **14***b*, and a retaining portion **14***c*. The placing portion **14***a* is in contact with a surface of the electrically-conductive ring **13** which surface faces in the axial direction P. The electric wire connecting portion **14***b* is located at an end of the placing portion **14***a*, and the electric wire **25** is connected to the electric wire connecting portion **14***b*. The retaining portion **14***c* projects in a hook shape from an end of the placing portion **14***a* which end is opposite to the electric wire connecting portion **14***b*. To be specific, entirety of the placing portion **14***a* and the retaining portion **14***c* has an L shape.

The terminal **15** is connected to the controller **31**, arranged outside the casing **2**, through an electric wire **26**. The terminal **15** is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The terminal **15** is placed on the electrically-conductive ring **13** in the axial direction P. The number of terminals **15** is smaller than the number of terminals **14**. To be specific, the number of electric wires **26** is smaller than the number of electric wires **25**. Since the shape of the terminal **15** is substantially the same as the shape of the terminal **14**, an explanation thereof is omitted.

The insulating ring **16** is an annular plate made of an insulating material. The insulating ring **16** is made of, for example, ceramic having an insulation property and heat resistance. The insulating ring **16** is placed on the terminals **14** and **15** in the axial direction P. The insulating ring **16** is externally fitted to the insulating tube portion **12***b* with play. To be specific, an inner diameter of the insulating ring **16** is larger than the outer diameter of the insulating tube portion **12***b*.

The electrically-conductive ring **17** is an annular plate made of an electrically-conductive material. The electrically-conductive ring **17** is placed on the insulating ring **16** in the axial direction P. The electrically-conductive ring **17** is located away from the electrically-conductive ring **13** in the axial direction P. The electrically-conductive ring **17** is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The electrically-conductive ring **17** is externally fitted to the insulating tube portion **12***b* with play: To be specific, an inner diameter of the electrically-conductive ring **17** is larger than the outer diameter of the insulating tube portion **12***b*.

The terminals **18** are connected to respective electric power consumption devices **45** and **46** (second electric parts), arranged in the casing **2**, through respective electric wires **27**. One example of each of the electric power consumption devices **45** and **46** is an igniter. Each of the terminals **18** is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The terminal **18** is placed on the electrically-conductive ring **17** in the axial direction X. Since the shape of the terminal **18** is substantially the same as the shape of the terminal **14**, an explanation thereof is omitted.

A terminal **19** is connected to the power supply **32**, arranged outside the casing **2**, through an electric wire **28**. The terminal **19** is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The terminal **19** is placed on the electrically-conductive ring **17** in the axial direction P. The number of terminals **19** is smaller than the number of terminals **18**. To be specific, the number of electric wires **28** is smaller than the number of electric wires **27**. The terminals **18** and **19** are located away from the terminals **13** and **14** in the axial direction P. Since the shape of the terminal **19** is substantially the same as the shape of the terminal **14**, an explanation thereof is omitted.

The insulating ring **20** is an annular plate made of an insulating material. The insulating ring **20** is made of, for example, ceramic having an insulation property and heat resistance. The insulating ring **20** is placed on the terminals **18** and **19** in the axial direction P. The insulating ring **20** is externally fitted to the insulating tube portion **12***b* with play. To be specific, an inner diameter of the insulating ring **20** is larger than the outer diameter of the insulating tube portion **12***b*.

The spring washer **21** is an annular disc spring. The spring washer **21** is placed on the insulating ring **20** in the axial direction P. The spring washer **21** has elasticity in the axial direction P. The spring washer **21** is externally fitted to the stud bolt B with play.

The insulating ring **22** is an annular plate made of an insulating material. The insulating ring **22** is made of, for example, ceramic having an insulation property and heat resistance. The insulating ring **22** is placed on the spring washer **21** in the axial direction P. The insulating ring **22** is externally fitted to the stud bolt B with play. An inner diameter of the insulating ring **22** is smaller than the outer diameter of the insulating tube portion **12***b*.

As described above, the insulating ring portion **12***a*, the electrically-conductive ring **13**, the terminals **14** and **15**, the insulating ring **16**, the electrically-conductive ring **17**, the terminals **18** and **19**, the insulating ring **20**, the spring washer **21**, and the insulating ring **22** are laminated on each other in this order from the frame F to constitute a laminated body **30**. The laminated body **30** is externally fitted to the intermediate shaft portion Ba of the stud bolt B with play. The terminals **14**, **15**, **18**, and **19** project outward beyond a group of the electrically-conductive rings **13** and **17**, the insulating rings **16**, **20**, and **22**, and the spring washer **21** in a direction orthogonal to the axial direction P.

The nut N is threadedly engaged with the tip threaded portion Bc of the stud bolt B projecting from the laminated body **30** and is opposed to the insulating ring **22** (first-end insulator). The laminated body **30** is sandwiched between the frame F and the nut N. The nut N is made of, for example, metal (for example, superalloy mainly containing a Fe group, a Ni group, or a Co group) having heat resistance and electrical conductivity. The nut N is positioned at such a position as to press the insulating ring **22** against the spring washer **21** in the axial direction P. Specifically, the nut N is positioned at such a predetermined position that the spring washer **21** is bent but has still room for further elastic deformation. With this, based on a limit that is the elastic force of the spring washer **21**, the terminals **14** and **15** are pressed by the electrically-conductive ring **13**, and the terminals **18** and **19** are pressed by the electrically-conductive ring **17** in the axial direction P.

The stud bolt B is fixed to the frame F such that the nut N threadedly engaged with the tip threaded portion Bc is positioned at the predetermined position while being in contact with an end surface of the large-diameter intermediate shaft portion Ba in the axial direction P. To be specific, since the bottom of the nut N located at the tip threaded portion Bc reaches the end surface of the large-diameter intermediate shaft portion Ba in the axial direction P, a distance from the surface of the frame F to the nut N is fixed. With this, excessive axial force is prevented from being applied to the parts constituting the laminated body **30**. Therefore, ceramic that has a low linear expansion coefficient and is fragile can be used for the insulating rings **12**, **16**, **20**, and **22**.

Each of the insulating rings **12***a*, **16**, **20**, and **22** is made of a material having an insulation property and heat resistance and functions even at a high temperature of more than 650° C. Moreover, the terminal block **10** has a simple laminated structure fastened by the stud bolt B and the nut N. Therefore, the terminal block **10** can be made low in cost and can be made compact. On this account, the terminal block **10** can be arranged in the high-temperature region H located downstream of the combustor **7** and the turbine **8**.

The electric wires **26** and **28** pass through the bypass passage **4**, extend to an outside of the casing **2**, and are respectively connected to the controller **31** and the power supply **32**. As above, the terminal block **10** is used for the wires extending from the sensors **41** and **42** and the electric power consumption devices **45** and **46** located inside the casing **2** to the controller **31** and the power supply **32** located outside the casing **2**.

The present disclosure is not limited to the above-described embodiment, and modifications, additions, and eliminations may be made with respect to the configuration of the embodiment. For example, each of the insulating rings **12**, **16**, **20**, and **22** may have an oval ring shape, a polygonal ring shape, or the like instead of a perfect-circle ring shape. Each of the insulating rings **12**, **16**, **20**, and **22** may have another shape (such as a C shape or a circular-arc shape) instead of a ring shape.

As long as the spring washer **21** is interposed between the uppermost insulating ring **22** and the lowermost insulating ring portion **12***a*, the spring washer **21** may be interposed between other layers. The electrically-conductive rings **13** and **17** are two layers but may be one layer or three or more layers. The insulating rings **12***a*, **16**, **20**, and **22** are four layers but may be two layers or five or more layers. The insulating tube portion **12***b* may be opposed to at least the electrically-conductive rings **13** and **18** and the terminals **14**, **15**, **18**, and **19** in the direction orthogonal to the axial direction P and does not have to be opposed to the insulating ring **20** and the spring washer **21**.

The invention claimed is:

1. A terminal block of a gas turbine engine,

the terminal block being used for wires extending from electric parts located inside a casing of the gas turbine engine to an electric device located outside the casing, the terminal block comprising:

at least one electric conductor on and with which terminals of electric wires of the electric parts and the electric device are laminated in a first direction and are in contact;

at least two insulators laminated so as to sandwich the terminals and the electric conductor in the first direction;

a stopper opposed to a first-end insulator located at a first end side in the first direction among the at least two insulators; and

a spring arranged between the stopper and a second-end insulator located at a second end side in the first direction among the at least two insulators, the spring pressing the terminals against the electric conductor in the first direction,

wherein each of the terminals includes:

a placing portion that is in contact with a surface of the electric conductor which surface faces in the first direction;

an electric wire connecting portion to which the corresponding electric wire is connected; and

a retaining portion projecting in a hook shape from an end of the placing portion which end is opposite to the electric wire connecting portion.

2. The terminal block according to claim **1**, wherein the insulators are made of ceramic.

3. The terminal block according to claim **1**, wherein each of the electric conductor and the insulators has a ring shape.

4. The terminal block according to claim **3**, further comprising a stud bolt fixed to a frame in the casing, wherein:

the stud bolt is inserted through centers of the ring-shaped electric conductor and the ring-shaped insulators in the first direction; and

the stopper is a nut that is threadedly engaged with the stud bolt.

5. The terminal block according to claim **4**, wherein:

the second-end insulator is supported by the frame; and

the second-end insulator includes an insulating tube portion that extends in the first direction toward the first-end insulator so as to isolate the stud bolt from the electric conductor and the terminals.

* * * * *