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SPECIFICATION



G00002

CONTROLGEAR

TECHNICAL FIELD

The present invention relates to a controlgear (generally it is called control center) implemented in the form of a power distribution console for realizing a start control and protection or the like of electric motors employed in an electric power plant and others. More particularly, the present invention is concerned with a controlgear or power distribution console which accommodates therein a plurality of functional units.

RELATED BACKGROUND

The controlgear is electrically connected by wiring conductors to equipments/machineries such as electric motors, illumination equipments and others employed in an electric power plant or the like for supplying distributively electric power to various equipments/machineries and at the same time for controlling the equipments/machineries. In general, in the controlgear, there are accommodated functional units which are electrically connected to the individual equipments/machineries by means of wiring conductors and the bus bars through which electric power is supplied to the functional units.

The functional unit incorporates therein a breaker or a switch fuse and additionally a relay, a switch and others for the purpose of controlling the equipments/machineries mentioned above and is implemented in a unitary structure. The functional unit is designed to distribute electric power to the equipments/machineries from the bus bar while controlling the power distribution in conformance with control signals supplied externally or in response to manual operation performed externally. Additionally, the functional unit serves to protect the equipment/machinery against a fault current by means of a breaker or a fuse.

In the hitherto-known or conventional controlgear or power distribution console of the arrangement described above, heat

is generated in the functional units during electric conduction because the functional unit incorporates therein the breaker, the switch and so forth. When the temperature of the functional unit reaches a predetermined level due to the heat generation, there arises fear that erroneous operation should take place and/or the devices might be damaged.

On the other hand, there exists in the recent years a trend for miniaturization of the controlgear with a compacted structure. To this end, lots of functional units have to be packaged in a single controlgear or power distribution console with high density, presenting a problem to be solved.

This invention has been made with a view to solving the problem mentioned above and thus an object of the invention is to provide a controlgear which is capable of packaging a large number of functional units with high density, while ensuring enhanced functional unit cooling performance.

DISCLOSURE OF THE INVENTION

The controlgear according to this invention includes a unit chamber formed in a substantially box-like shape and having opening portions at a front side thereof for accommodating therein a plurality of functional units in a horizontal direction, a power distributor disposed at a rear side of the unit chamber for distributing electric power to the plurality of functional units, respectively, and a discharge chamber disposed adjacent to the power distributor and extending in a vertical direction of the controlgear, wherein the power distributor has an inner ventilation space and is provided with air inlet ports at the side adjacent to the unit chamber for sucking heated air coming from the functional units, while an air outlet port is provided at the side adjacent to the discharge chamber for discharging the heated air from the functional units, and wherein the discharge chamber has an inner ventilation space so that the heated air from the functional units is discharged exteriorly by way of the power distributor and the discharge chamber.

In the controlgear described above, the discharge chamber may be implemented as a bus chamber accommodating therein bus bars for supplying electric power to the power distributor.

Further, the discharge chamber may be implemented as a wiring conductor chamber accommodating therein wiring conductors which extend to external equipment/machinery from the functional units.

Furthermore, the unit chambers may be provided at a plurality of stages in a vertical direction so that a plurality of the functional units are disposed in vertical and horizontal directions generally in a gridiron-like pattern.

Moreover, the air inlet ports and the air outlet port provided in the power distributor may be formed each in a slit-like shape.

Further, the air outlet port provided in the power distributor may serve also as an opening for dispelling arc produced internally of the power distributor.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front view showing a controlgear (power distribution console) according to an exemplary embodiment of this invention.

Figure 2 is a perspective view of the controlgear (power distribution console).

Figure 3 is a sectional view taken along a line III-III shown in Figs. 1 and 2 and viewed in the direction indicated by arrows.

Figure 4 is a sectional view taken along a line IV-IV shown in Fig. 1 and viewed in the direction indicated by arrows.

Figure 5 is an enlarged fragmental view showing a portion of Fig. 4.

Figure 6 is a perspective view showing one functional unit.

Figure 7 is a perspective view of the functional unit as viewed from the rear side.

Figure 8 is a perspective view showing the controlgear in the state in which all the functional units have been removed from the controlgear with a door of a wiring conductor chamber also having been removed.

Figure 9 is a sectional view showing one unit chamber

in the state where the functional unit has been removed therefrom.

Figure 10 is a perspective view showing a shelf board forming the unit chamber.

Figure 11 is a top plan view of the shelf board.

Figure 12 is a perspective view of a partitioning plate for defining the unit chamber.

Figure 13 is a front view of the partitioning plate.

Figure 14 is a side view of the partitioning plate.

Figure 15 is a perspective view showing in what manner functional units and a power distributor are connected to each other.

Figure 16 is a perspective view of the power distributor.

Figure 17 is an enlarged fragmental perspective view showing major lateral portions of the functional units accommodated within the control gear.

Figure 18 is a sectional view showing connections between a power distributor and vertical branch bus bars.

Figure 19 is an exploded perspective view showing major components accommodated within the console.

Figure 20 is a top plan view of the power distributor.

Figure 21 is a right-hand side view of the power distributor.

Figure 22 is an exploded perspective view showing constituent parts of the power distributor.

Figure 23 is a perspective view showing in detail internals of the power distributor.

Figure 24 is a front view showing a manner in which branch conductors are laid internally of the power distributor.

Figure 25 is a sectional view taken along a line XXV-XXV shown in Fig. 24 and viewed in the direction indicated by arrows.

Figure 26 is an exploded perspective view showing structures of a branch conductor and a distributing conductor, respectively.

Figure 27 is a sectional view showing the state in which one functional unit has been withdrawn to a test position.

Figure 28 is a sectional view taken along a line XXVIII-XXVIII shown in Fig. 27 and viewed in the direction indicated by arrows, showing the functional unit at a connected position.

Figure 29 is a sectional view taken along a line XXVIII-XXVIII shown in Fig. 27 and viewed in the direction indicated by arrows, showing the functional unit at a test position.

BEST MODES FOR CARRYING OUT THE INVENTION

Embodiment 1

Figure 1 is a front view showing a controlgear (power distribution console) according to an exemplary embodiment of this invention. Figure 2 is a perspective view of the controlgear (power distribution console). Referring to Figs. 1 and 2, accommodated within the controlgear (power distribution console) 1 implemented in the form of a substantially rectangular box-like shape are a plurality of functional units 3 disposed regularly in a gridiron-like array in the vertical and horizontal directions. In the case of the controlgear 1 according to the instant embodiment of the invention, four functional units 3 are disposed in each of the horizontal rows with ten stages of the functional units being provided in the vertical direction. Thus, the forty functional units 3 in sum total are accommodated within the controlgear 1.

Figure 3 is a sectional view taken along a line III-III shown in Figs. 1 and 2 and viewed in the direction indicated by arrows. Figure 4 is a sectional view taken along a line IV-IV shown in Fig. 1 and viewed in the direction indicated by arrows. Figure 5 is an enlarged fragmental view of Fig. 4. Referring to Figs. 3 to 5, a power distributor 4 of a substantially thin box-like shape is disposed at a rear side of each row of the four functional units 3 arrayed in the horizontal direction. It should be noted that one power distributor 4 is provided for the four functional units 3 juxtaposed in each stage. To say in another way, one power distributor 4 is provided in association with one stage of the functional units 3. The power distributor 4 serves for the function to distribute electric power to the four functional units 3, as will be described later on.

The power distributor 4 is formed with air inlet ports 4a and air outlet ports 4b and 4c which will hereinafter be described in detail.

Further formed at the rear side of the power distributors

4 is a bus chamber 5 extending over the whole height of the center 1. Disposed within the bus chamber 5 and extending vertically are vertical branch bus bars (also referred to simply as the bus) 16 for supplying electric power to the power distributors 4. The vertical branch bus bars 16 serve to feed three-phase four-pole electric power to the interior of the control gear 1 from the exterior. The vertical branch bus bars 16 are composed of four electric conductors of three phases and a neutral phase, respectively, wherein three electric conductors are each formed in an L-like shape in cross-section with the other one electric conductor being formed in an I-shape in cross-section. The interior of the bus chamber 5 presents a ventilation space.

On the other hand, a wiring conductor compartment or chamber 6 is formed at one side of the functional units 3 and the power distributors 4 over the whole height of the control gear 1. Accommodated within the wiring conductor chamber 6 are wiring conductors (not shown) extending from the functional units 3 to external equipment/machinery. Also formed internally of the wiring conductor chamber 6 is a ventilation space.

Figure 6 is a perspective view showing one functional unit 3. Figure 7 is a perspective view of the functional unit 3 as viewed from the rear side. The unitary functional unit 3 is implemented in a substantially rectangular box-like shape having elongated lateral sides extending in the direction depthwise of the control gear 1. The functional unit 3 has a front plate 31 covering a front side thereof, a unit base 32 covering a bottom side and one lateral side of the functional unit 3, and a main circuit connector mounting fixture 38 and a control circuit connector mounting fixture 40 both covering the rear side. The unit base 32 is composed of a narrow plate portion 32a formed at and along one side of the top of the functional unit and a side plate portion 32b which covers wholly the one lateral side of the functional unit. The top portion of the functional unit 3 and the other lateral side portion thereof which is located in opposition to the unit base 32 are not tightly closed but opened extensively. Owing to this feature, the efficiency of work involved in assembling the functional unit 3 can be enhanced.

The functional unit 3 has various devices mounted therein

for controlling the external equipment/machinery. More specifically, a breaker device 34 constituted by a switch fuse or circuit breaker is mounted on the functional unit at the front side thereof. Further, an electromagnetic switch 35 is mounted at the rear side of the functional unit. More specifically, the electromagnetic switch 35 is composed of an electromagnetic contactor 35a and a thermal relay 35b.

Mounted on the functional unit 3 at the front side thereof is a manipulating handle 33 for turning of/off the breaker device 34. The manipulating handle 33 extends through the front plate 31 to be operatively coupled to the breaker device 34. By rotating the manipulating handle 33 clockwise or counterclockwise around the longitudinal axis, the breaker device 34 can be turned on or off, i.e., closed or opened.

On the other hand, on the rear side of the functional unit 3, a power-supply-side main circuit connector (unit-side power supply grip) 36 and a load-side main circuit connector (unit-side load grip) 37 are mounted on the main circuit connector mounting fixture 38 disposed at the upper portion, being juxtaposed with each other in the vertical direction. Further mounted on the control circuit connector mounting fixture 40 disposed at the lower portion is a unit-side control circuit connector 39 in a horizontal orientation.

Figure 8 is a perspective view showing the controlgear 1 in the state in which all the functional units 3 have been removed from the controlgear 1 with a door of the wiring conductor chamber 6 also having been removed. Figure 9 is a sectional view showing one unit chamber 2 in the state where the functional unit 3 has been removed therefrom. A plurality of unit chambers 2 are defined in the controlgear 1 in a plurality of stages as viewed in the vertical direction, the unit chambers being partitioned or compartmented by means of shelf boards 1a. The unit chamber 2 defined at each stage is provided with four compartments for accommodating therein the four functional units 3, respectively, the compartments being divided by partitioning plates, respectively, as will be described later on.

Figure 10 is a perspective view showing the shelf board

1a employed for forming or defining the unit chamber 2. Figure 11 is a top plan view of the shelf board 1a. Figure 12 is a perspective view of the partitioning plate 1b for defining the unit chamber 2. Figure 13 is a front view of the partitioning plate 1b. Figure 14 is a side view of the partitioning plate 1b. Formed piercedly in the shelf board 1a are four sets of slits 1a1 which extend in the direction depthwise of the shelf board 1a. Each of the partitioning plates 1b is mounted on the shelf board 1a in an erected state with projections 1b1 formed on the bottom edge of the partitioning plate 1b being inserted into the slits 1a1, respectively. The four partitioning plates 1b are mounted on the shelf board 1a of each stage in the erected state, whereby the unit chamber 2 of each stage is partitioned into four compartments. The partitioning plate 1b is formed in a substantially inverted L-like cross-section and has a vertical side plate 1b2 and a horizontal portion 1b3 formed by bending horizontally a top portion of the vertical side plate 1b2 and a guide edge portion 1b4 of a narrow width bent downwardly from the horizontal portion 1b3.

The functional unit 3 having the substantially rectangular box-like shape and elongated depthwise is accommodated within a substantially rectangular parallelepiped space extending in the depthwise direction. Thus, such a structure is realized that the functional unit can be withdrawn in the direction toward and beyond the front opening in the manner similar to a drawer. In that case, the guide edge portion 1b4 mentioned above serves as a guide means upon accommodation and withdrawal of the functional unit 3, as will be described later on.

Figure 15 is a perspective view showing in what manner the functional units 3 and the power distributor 4 are connected to each other. Although four functional units 3 can be connected to the power distributor 4, it is presumed in the case of the state shown in Fig. 5 that two functional units 3 are connected to the power distributor at both ends thereof, respectively, for the simplification of illustration. The power distributor 4 supplies electric power to a plurality of functional units 3 connected thereto. In the case of the instant embodiment of the invention, the single power distributor 4 is provided in association with the four

functional units 3 disposed in juxtaposition in the horizontal direction. The power distributor 4 includes a casing of a thin rectangular parallelepiped form and is disposed adjacent to the functional units 3 so that a board surface of the power distributor covers the rear surfaces of the four associated functional units 3, respectively. One power distributor 4 is provided for each stage of the unit chambers 2 at the rear side thereof. In other words, a plurality of power distributors 4 are disposed in juxtaposition with one another in the vertical direction such that the rear surfaces of the functional units arrayed generally in the gridiron-like pattern as a whole are entirely covered by the power distributors 4.

As can be seen in Figs. 4 and 5, the bus chamber 5 is disposed at the rear side of the set of the power distributors 4. The bus chamber 5 is so formed as to extend over the whole height of the controlgear 1 as viewed in the vertical direction. Accommodated within the bus chamber 5 are the vertical branch bus bars 16 for supplying electric power to the power distributors 4.

Figure 16 is a perspective view of the power distributor 4. As can be seen in Fig. 16, slit-like air inlet ports 4a for sucking the air heated by the functional units 3 are formed in the front plate of the power distributor 4, i.e., at the side adjacent to the functional units 3. On the other hand, slit-like air outlet ports 4b for discharging the heated air coming from the functional units 3 are formed in the rear plate of the power distributor 4, i.e., at the side adjacent to the bus chamber 5. A ventilation space is defined internally of the power distributor 4 for allowing the heated air originating in the functional units 3 to flow therethrough.

Further defined internally of the bus chamber 5 disposed at the rear side of the group of the power distributors 4 is a ventilation space which extends in the vertical direction. Further, air outlet ports are provided above the bus chamber 5 as well although not shown. Thus, the air heated by the functional units 3 is discharged to the exterior by way of the power distributors 4 and the bus chamber 5. To say in another way, the bus chamber 5 serves as a discharge chamber for expelling exteriorly the heated air flowing through the power distributors 4.

In the controlgear 1 structured in the manner described above, the air flowing into the unit chambers 2 through the openings or apertures formed at the front side thereof is heated by the functional units 3 and flows through the power distributors 4 and the bus chamber 5 which serves as the discharge chamber to expel the hot air to the exterior. In other words, the power distributors 4 can effectively be used as the airflow passages for expelling the hot or heated air to the exterior. Thus, the controlgear 1 according to the instant embodiment of the invention can package therein a large number of functional units 3 with a high density and is capable of expelling the hot air from the functional units 3 without need for providing any especial ventilation structure to this end.

Figure 17 is an enlarged fragmental perspective view showing major lateral portions of the functional units 3 accommodated within the controlgear 1. As can be seen, a wiring conductor chamber 6 is formed at the lateral sides of the groups of the functional units 3 and the power distributors 4. The wiring conductor chamber 6 is designed to accommodate therein the wiring conductors for interconnecting the functional units 3 and external equipment/machinery and defined by a space formed over the substantially whole height of the controlgear 1. A ventilation space is defined internally of the wiring conductor chamber 6, which space is large enough to allow the heated air originating in the functional units 3 to flow through the chamber 6.

Formed in the front plates of the power distributors 4 located adjacent to the functional units 3 are the slit-like air inlet ports 4a for sucking the air heated by the functional units 3, as described previously. On the other hand, the lateral sides of the power distributors 4 located adjacent to the wiring conductor chamber 6 are entirely opened, wherein the opening forms an air outlet port 4c for expelling or discharging the heated air from the functional units 3. A ventilation space is defined internally of the wiring conductor chamber 6 to allow the heated air originating in the functional units 3 to flow through the chamber 6. The ventilation space extends heightwise of the controlgear 1 and an air outlet port or ports are provided at the top of the wiring conductor

chamber 6 although not shown. The air heated by the functional units 3 is discharged to the exterior by way of the power distributors 4 and the wiring conductor chamber 6. To say in another way, the wiring conductor chamber 6 serves as a discharge chamber for expelling exteriorly the heated air traveling through the power distributors 4.

In the controlgear implemented in this manner, the air flowing into the unit chambers 2 through the openings or apertures formed at the front side thereof is heated by the functional units 3 to flow through the power distributors 4 and the wiring conductor chamber 6 which serves as the discharge chamber. To say in another way, the power distributors 4 can effectively be used as the airflow passages for expelling the heated air to the exterior. Thus, there can be realized the controlgear which can package therein a large number of functional units 3 with a high density and can effectively expel the hot air from the functional units 3 to the exterior without need for providing any especial ventilation structure to this end.

On the other hand, the air outlet ports 4c formed at the lateral sides of the power distributors 4 serve also as openings or apertures for dispelling or putting off the electric arcs generated internally of the power distributors 4. More specifically, a room formed atop the power distributor 4 provided with the air inlet ports 4a and the air outlet ports 4c is intrinsically a free space in which no devices are installed. To say in another way, this space is provided especially for the purpose of gas discharge.

Consequently, a gas such as, for example, an arc gas produced due to a trouble of the functional unit 3 can easily be discharged through the space mentioned above, and thus there arises no fear that the bus bars accommodated within the bus chamber 5 might be subjected to adverse influence of the arc gas. Thus, the trouble or accident taking place in the unit chamber(s) 2 can positively be prevented from spreading.

Figure 18 is a sectional view showing connections between the power distributors 4 and the vertical branch bus bars 16. Figure 19 is an exploded perspective view showing major components accommodated within the console. Disposed at the rear side of the power distributors 4 are four vertical branch bus bars 16 which

are connected to the external bus bars and extend substantially vertically within the controlgear console. The vertical branch bus bars 16 are each formed of a conductive material in an L-like or I-like cross-section, and aligned in a row in the vertical direction, being juxtaposed with one another with broad lateral sides facing oppositely to each other. The four vertical branch bus bars 16 are so disposed as to extend vertically over the substantially whole height of the controlgear console 1 at the rear side of the plural power distributors 4 juxtaposed with one another in the vertical direction. These four vertical branch bus bars 16 serve to feed three-phase four-pole electric power into the controlgear console 1.

Figure 20 is a top plan view of the power distributor 4. Figure 21 is a right-hand side view of the power distributor 4. Figure 22 is an exploded perspective view showing constituent parts or components of the power distributor 4. Figure 23 is a perspective view showing in detail the internals of the power distributor. Figure 24 is a front view showing a manner in which the branch conductors are laid internally of the power distributor 4. Figure 25 is a sectional view taken along a line XXV-XXV shown in Fig. 24 and viewed in the direction indicated by arrows. Figure 26 is an exploded perspective view showing structures of the branch conductor 8 and the distributing conductor 9, respectively.

Referring to Figs. 20 to 26, the power distributor 4 is implemented in the form of a substantially elongated thin box-like rectangular parallelepiped and has a planar front panel 4d which is destined to be disposed at the rear side of the functional units 3 and a rear panel 4e at the front side of the vertical branch bus bars 16. Further, disposed, being elected, on the rear surface of the power distributors 4 are four pairs of common power grips 7 serving as the bus engaging means, which grips extend to the vertical branch bus bars 16, respectively.

The four pairs of the common power grips 7 are disposed at the positions which correspond to those of the four vertical branch bus bars 16, respectively. Each of the common power grips 7 includes a pair of terminals 7a and 7b facing oppositely to each other, where the four vertical branch bus bars 16 are each sandwiched

between the two terminals 7a and 7b to thereby form a so-called clip connection. The pair of terminals 7a and 7b are disposed substantially in parallel with each other with a predetermined distance therebetween, wherein the inner portions of the tip ends of the terminals are each chamfered slightly. Further, the tip end portions and the oppositely facing inner portions of the terminals are each offset stepwise. The pair of terminals 7a and 7b are moved in the direction in which they are erected, i.e., in the direction depthwise of the controlgear console 1, to sandwich the vertical branch bus bar 16 therebetween for thereby form electrical connection therewith.

Thus, when the power distributor 4 is disposed in the controlgear console 1, the power distributor 4 is simply moved toward the vertical branch bus bar 16 in the direction in which the common power grips 7 extend so that the common power grips 7 sandwich or grip therebetween the vertical branch bus bar 16, whereby the common power grips 7 and the vertical branch bus bar 16 are connected to each other.

Next, description will be made of the internal structure of the power distributor 4. As can clearly be seen in Fig. 23, each of the four branch conductors 8 is clamped at one end portion thereof 8a by means of a bolt 8c to be thereby electrically connected to the common power grip 7. The other end portions 8b of the four branch conductors 8 are individually so laid within the power distributor 4 as to be connected to the distributing conductors 9, respectively. These four distributing conductors 9 are disposed within the power distributor 4 in parallel with one another in the horizontal direction. For the four distributing conductors 9, four distributor-side power supply grip tabs 10 are provided at predetermined positions, respectively, to serve as the power-supply-side main circuit engaging means. Each of the four distributor-side power supply grip tabs 10 includes a plate-like portion protruding toward the functional unit 3. The four distributor-side power supply grip tabs 10 are disposed in a vertical row at the position corresponding to the associated functional unit 3 so that the plate-like portions lie in a same plane. Each of the four distributor-side power supply grip tabs 10 is connected to the corresponding distributing conductor

9 at one side while being clipped at the other side by the unit-side power supply grip 36 of the functional unit 2 described hereinafter to thereby form a so-called clip connection so that electric power is supplied to the functional unit 3 from the vertical branch bus bar 16.

Further, distributor-side load grip terminal mounts 11 are installed on the power distributor 4 at the positions corresponding to the functional units 3, respectively, to serve as the load-side main circuit engaging means. The distributor-side load grip terminal mount 11 includes four meshing members 11a aligned in the vertical direction. Each of the four meshing members 11a is clipped by the unit-side main circuit connector 37 of the functional unit 3 described hereinafter to thereby form a so-called clip connection for outputting distributively the electric power led out from the functional unit 3. Further, the distributor-side load grip terminal mount 11 is provided with screw lock members 11b corresponding to the four meshing members, respectively. Connected to the screw lock members 11b are wiring conductors which extend from the equipment/machinery through the medium of an external cable terminal mount not shown.

Further provided at the positions in the power distributor 4 which correspond to the functional units 3, respectively, are distributor-side control circuit connectors 12, respectively. Each of the distributor-side control circuit connectors 12 is composed of two connectors extending linearly and having convex and concave cross-sections, respectively. The distributor-side control circuit connector is adapted to mesh with the unit-side control circuit connector 39 of the functional unit 3 to be electrically connected thereto for supplying control signals to the functional unit 3 and output the control signal from the functional unit 3. A control signal line led out from a control console is connected to the distributor-side control circuit connectors 12 through the medium of the external cable terminal mount not shown.

Turning back to Fig. 16, the distributor-side power supply grip tabs 10 of the power distributor 4, the distributor-side load grip terminal mounts 11 and the distributor-side control circuit connectors 12 mentioned previously are all disposed in a

substantially same plane as that of the front panel 4d. More specifically, the distributor-side power supply grip tabs 10 and the distributor-side load grip terminal mounts 11 lie in the respective slit-like openings or apertures pierced in the front panel 4d. On the other hand, the distributor-side control circuit connectors 12 are disposed on the front panel 4d, protruding therefrom.

Next, description will be directed to a rear side structure of the functional unit 3 which faces in opposition to the front panel 4d of the power distributor 4. As can be seen in Fig. 7, the power-supply-side main circuit connector (unit-side power supply grip) 36 is disposed on the rear surface of the functional unit 3 at the positions corresponding to the distributor-side power supply grip tab 10 of the power distributor 4, projecting from the rear side of the functional unit. Further, the load-side main circuit connector (unit-side load grip) 37 is mounted at the position corresponding to the distributor-side load grip terminal mount 11, protruding from the rear side of the functional unit.

Each of the unit-side power supply grips 36 and the unit-side load grip 37 includes four grip connecting terminals aligned in the vertical direction. Each of the grip connecting terminal is composed of two nipper-like terminal members disposed in opposition to each other, wherein a gap between the two opposite terminal members is increased at the tip end portions thereof. When these opposite terminal members are moved in the extending or erecting direction, the distributor-side power supply grip tab 10 and the meshing member 11a of the distributor-side load grip terminal mount 11 disposed oppositely to the terminal members are sandwiched between the terminal members to be electrically connected thereto.

Furthermore, the unit-side control circuit connector 39 is mounted at the position corresponding to the distributor-side control circuit connector 12 of the power distributor 4, projecting from the rear surface of the functional unit. The unit-side control circuit connector 39 is composed of two connector members extending linearly and having convex and concave cross-sections, respectively, so as to engage with the distributor-side control circuit connector 12 for establishing electrical connection.

As described hereinbefore, the partitioning plate 1b is formed in a substantially inverted L-like shape, wherein the horizontal portion 1b3 bent horizontally is provided with the narrow guide edge portion 1b4 bent downwardly. It is further noted that the partitioning plate 1b is mounted in such erected disposition that it covers the narrow plate portion 32a and the side plate portion 32b of the functional unit 3. A guide section of a substantially C-like cross-section having an opening defined by the horizontal portion 1b3 and the guide edge portion 1b4 atop the partitioning plate 1b is adapted to engage with the narrow plate portion 32a with a small gap so that the narrow plate portion 32a can move in the direction in which the functional unit 3 is taken in and out. The functional unit 3 is inserted into the controlgear console 1 with a predetermined accuracy, being guided by the partitioning plate 1b upon disposition of the functional unit 3 on the shelf board 1a. By virtue of this arrangement, the unit-side power supply grips 36, the unit-side load grip 37 and the unit-side control circuit connector 39 of the functional unit 3 can properly engage or mesh with the distributor-side power supply grip tab 10, the distributor-side load grip terminal mount 11 and the distributor-side control circuit connector 12, respectively, of the power distributor 4. In this manner, the side plate portion 32b of the unit base 32 and the partitioning plate 1b cooperate to constitute a guide means for guiding the functional unit 3 relative to the power distributor 4 in the inserting and withdrawing directions.

In the controlgear of the structure described above, the electric power supplied from the vertical branch bus bars 16 is fed to a plurality of the functional units 3, being distributed by the power distributor 4. The functional unit 3 outputs the received electric power to the unit-side load grip 37 while controlling the electric power in accordance with the control signal inputted through the unit-side control circuit connector 39 or in conformance with the manual operation performed externally. The electric power outputted to the unit-side load grip 37 is distributed to the external equipment/machinery through the medium of the distributor-side load grip terminal mount 11.

As is apparent from the foregoing, the power distributor 4 according to the instant embodiment of the invention includes the distributor-side power supply grip tabs 10 connected to the branch conductor 8 at one side and gripped at the other side by the unit-side power supply grips 36 of the functional unit 3 to thereby deliver the electric power to the functional unit 3 from the vertical branch bus bars 16, the distributor-side load grip terminal mount 11 grip-connected to the unit-side load grip 37 of the functional unit 3 for delivering the electric power distributed by the functional unit 3 to the external, and the distributor-side control circuit connector 12 connected to the unit-side control circuit connector 39 of the functional unit 3 to deliver the control signals to the functional unit 3 and output the control signals to the external. Thus, it is possible to move the functional unit 3 toward and away from the power distributor 4 for connection thereto and disconnection therefrom upon addition/exchange of the functional unit 3, whereby the functional unit 3 can be added or exchanged without involving service interruption of the vertical branch bus bars 16.

Further, the power distributor 4 is provided with a plurality of the distributor-side power supply grip tabs 10, a plurality of the distributor-side load grip terminal mounts 11 and a plurality of the distributor-side control circuit connectors 12 in correspondence to the functional units 3, respectively, wherein the distributor-side power supply grip tabs 10, the distributor-side load grip terminal mounts 11 and the distributor-side control circuit connectors 12 are disposed substantially in flush with one another at one stage within the controlgear 1. By virtue of this arrangement, the accommodation/storage efficiency or capacity of the controlgear can be enhanced.

Figure 27 is a sectional view showing the state in which one functional unit 3 is withdrawn to a test position. Figure 28 is a sectional view taken along a line XXVIII-XXVIII shown in Fig. 27 and viewed in the direction indicated by arrows, showing the functional unit 3 at the connected position. Figure 29 is a sectional view taken along a line XXVIII-XXVIII shown in Fig. 27 and viewed in the direction indicated by arrows, showing the functional unit

3 at the test position.

The functional unit 3 is adapted to move forward and rearward on and along the top surface of the shelf board 1a disposed beneath the functional unit 3 and can be connected to the power distributor 4 by means of the power-supply-side main circuit connector 36 and the load-side main circuit connector 37 mounted on the main circuit connector mounting fixture 38 such that the phase terminals are aligned in the vertical direction, to thereby receive the main circuit power supply from the vertical branch bus bars 16.

Furthermore, even in the state where the functional unit 3 has been moved forward on and along the shelf board 1a with the main circuit connectors 36 and 37 having been pulled out from the power distributor 4 with the main circuit being broken, there can be realized such test position state in which the control circuit connector mounting fixture 40 mounting the unit-side control circuit connector 39 is capable of sliding forwardly or rearwardly on and along the unit base 32 without being electrically disconnected from the distributor-side control circuit connector 12.

At this juncture, it should be recalled that the individual phase terminals of the power-supply-side main circuit connector 36 and those of the load-side main circuit connector 37 are disposed in juxtaposition with each other so that the individual terminals of the connectors 36 and 37, respectively, are aligned in the vertical direction.

With the arrangement mentioned above, the main circuit connectors 36 and 37 can be disposed with a relatively small occupation space, thus allowing the high-density package to be satisfactorily realized.

Concerning the main circuit connectors 36 and 37, it should further be added that the individual phase terminals of the power-supply-side main circuit connector 36 and those of the load-side main circuit connector 37 may be disposed in such alignment that the individual phase terminals are positioned side by side in the horizontal direction.

With the arrangement mentioned above, the main circuit connectors 36 and 37 can equally be disposed with a relatively small

occupation space, allowing a high-density package to be satisfactorily realized.

As can now be understood from the foregoing, in the controlgear according to the embodiment of the invention, the breaker device 34 and the electromagnetic switch 35 are disposed in alignment in the longitudinal direction of the functional unit 3 with the power-supply-side main circuit connector 36, the load-side main circuit connector 37 and the unit-side control circuit connector 39 being disposed on the rear wall of the functional unit 3, whereby the high-density package can be realized. Besides, by making use of the unit base 32 formed substantially in the L-shape, the work efficiency can be improved upon assembling of the functional unit 3. Additionally, the test position state in which only the control circuit can be operated is realized in the state in which the main circuit is broken or disconnected, which is advantageous in that the work efficiency can be enhanced in the test without need for the power supply from the external.

In the controlgear 1 according to the illustrated embodiment of this invention which includes a plurality of unit chambers 2 having the respective openings formed at the front side of the console for accommodating therein the functional units 3 while allowing the functional units 3 to be pulled out frontwards, wherein the main circuit connecting modules provided as the components of the power distributors 4 for connecting the main circuits of the functional units 3 to the external main circuit comprised of the bus bars 16 are disposed on the rear side of the unit chambers 2, there are provided the breaker devices 34 constituted by the switch fuses or the circuit breakers having the manipulating handles 33, respectively, the electromagnetic switches 35 designed for carrying out control operations, the main circuit connectors 36 and 37 for connecting the main circuits of the functional units 3 to the power-supply-side external main circuit and the load-side external main circuits, and the control circuit connectors 39 for connecting the control circuits of the functional units 3 to the external circuits such as the motor control circuit(s) and the like, wherein the manipulating handle 33, the breaker device 34, the electromagnetic switch 35 and the main circuit connectors 36 and

37 are disposed in alignment in the direction longitudinally of the functional unit 3 with the control circuit connector 39 being disposed beneath the main circuit connectors 36 and 37 in alignment therewith, while the power-supply-side main circuit connector 36 and the load-side main circuit connector 37 are disposed in juxtaposition so that the individual phase terminals thereof are arrayed vertically or horizontally and wherein the control circuit connector 39 mentioned above is so arranged as to be capable of being connected to the external circuit such as the motor control circuit or the like at the position connected to the main circuit of the functional unit 3 as well as at the test position. By virtue of this structure, the controlgear in which the breaker devices each constituted by the switch fuse or the circuit breaker are employed can satisfactorily be realized with a high package density. Besides, operation only of the control circuit can be ensured even in the state where the main circuit is in the broken or disconnected state, allowing thus the work efficiency to be enhanced upon testing.

As is apparent from the foregoing description, the power distribution console includes the unit chamber formed in the substantially box-like shape and having the opening portions at the front side for accommodating therein a plurality of functional units, respectively, the power distributor disposed at the rear side of the unit chamber for distributing electric power to the functional units, and the bus chamber disposed adjacent to the power distributor and extending in the vertical direction of the power distribution console for accommodating therein the bus for supplying electric power to the power distributor, wherein the power distributor has the inner ventilation space and is provided with the air inlet ports at the side adjacent to the unit chamber for sucking the heated air coming from the functional units, while the air outlet port is provided at the side adjacent to the bus chamber for discharging the heated air from the functional units. The bus chamber includes the inner ventilation space so that the heated air coming from the functional units is expelled exteriorly by way of the power distributor and the bus chamber. By virtue of the arrangement described above, a large number of functional units can be packaged with a high density while enhancing the functional

unit cooling performance.

In the power distribution console described above, a plurality of the functional units which are accommodated within the unit chambers, respectively, can be disposed in the vertical and horizontal directions generally in the gridiron-like pattern. By virtue of this arrangement, a greater number of functional units can be packaged with higher density in a small space while ensuring improved user-friendliness for wiring, maintenance or management, etc. of the power distribution console.

Moreover, the air inlet ports and the air outlet ports provided in the power distributor can be formed each in a slit-like shape. Owing to this feature, the heated air can efficiently be discharged without degrading the mechanical strength of the casing of the power distributor.

Further, the power distribution console can be composed of the unit chamber formed in the substantially box-like shape and having the opening portions at the front side for accommodating therein a plurality of functional units, respectively, the power distributor disposed at the rear side of the unit chamber for distributing electric power to the functional units, the bus chamber disposed adjacent to the power distributor and extending in the vertical direction for accommodating therein the bus for supplying electric power to the power distributor, and the wiring conductor chamber disposed adjacent to the power distributor and extending in the vertical direction of the power distribution console for accommodating therein the wiring conductors which extend from the functional units to the external equipment/machinery, wherein the power distributor has the inner ventilation space and is provided with the air inlet ports at the side adjacent to the unit chamber for sucking the heated air from the functional units, while the air outlet port is provided at the side adjacent to the wiring conductor chamber of the power distribution console for discharging the heated air from the functional units, and wherein the wiring conductor chamber includes the inner ventilation space so that the heated air coming from the functional units is expelled exteriorly by way of the power distributor and the wiring conductor chamber. By virtue of the arrangement described above, a large number of

functional units can be packaged with a high density while enhancing the functional unit cooling performance.

Furthermore, a plurality of the functional units accommodated within the unit chambers, respectively, can be disposed in the vertical and horizontal directions generally in the gridiron-like pattern. By virtue of this arrangement, a great number of functional units can be packaged with higher density within a small space while ensuring improved user-friendliness for wiring, maintenance or management, etc. of the power distribution console.

Moreover, the air inlet ports and the air outlet port provided in the power distributor can be formed each in a slit-like shape. Thus, the heated air can efficiently be discharged without degrading the mechanical strength of the casing of the power distributor.

Besides, the air inlet ports and the air outlet port provided in the power distributor serve as the openings dedicated for discharging the gas. By virtue of this feature, a gas such as, for example, an arc gas produced due to a trouble of the functional unit can easily be discharged through the passage mentioned above, and thus occurrence of such secondary accident that the arc gas or the like might be injected to the bus bars to thereby incur the short-circuit fault can positively be prevented. In other words, spreading of the trouble or accident can effectively be suppressed.

INDUSTRIAL APPLICABILITY

The present invention has provided the control gear which includes the unit chamber formed in the substantially box-like shape and having the opening portions at the front side thereof for accommodating therein a plurality of functional units in the horizontal direction, the power distributor disposed at the rear side of the unit chamber for distributing electric power to the plurality of functional units, respectively, and the discharge chamber disposed adjacent to the power distributor and extending in the vertical direction of the control gear, wherein the power distributor has the inner ventilation space and is provided with air inlet ports at the side adjacent to the unit chamber for sucking heated air coming from the functional units, while an air outlet

port is provided at the side adjacent to the discharge chamber for discharging the heated air from the functional units, and wherein the discharge chamber has the inner ventilation space so that the heated air from the functional units is discharged exteriorly by way of the power distributor and the discharge chamber. By virtue of the arrangement described above, a large number of functional units can be packaged with a high density. Additionally, the functional unit cooling performance can be enhanced because the power distributor for supplying the electric power to a plurality of functional units is made use of as a ventilation passage.

Further, the discharge chamber is so implemented as to serve as the bus chamber for accommodating therein the bus bars for supplying electric power to the power distributor. By virtue of this feature, miniaturization of the controlgear can further be promoted without need for providing any especial chamber as the discharge chamber.

Furthermore, the discharge chamber is so implemented as to serve as the wiring conductor chamber for accommodating therein the wiring conductors which extend to the external equipment/machinery from the functional units. Owing to this feature, the controlgear can further be miniaturized without need for providing any especial chamber as the discharge chamber.

Moreover, the unit chambers are provided at a plurality of stages in the vertical direction so that a plurality of the functional units are disposed in vertical and horizontal directions generally in the gridiron-like pattern. By virtue of this arrangement, a greater number of functional units can be packaged within a small space with higher density while ensuring user-friendliness to the wiring and maintenance or management, etc.

Further, the air inlet ports and the air outlet port provided in the power distributor are formed each in a slit-like shape. Owing to this feature, the heated air can be discharged with improved efficiency without degrading the mechanical strength of the casing of the power distributor.

Additionally, the air outlet port provided in the power distributor serves also as an opening for dispelling arc produced internally of the power distributor. By virtue of this feature,

a gas such as, for example, an arc gas produced due to a trouble of the functional unit can easily be discharged through the passage mentioned above, and thus occurrence of such secondary accident that the arc gas or the like might be injected to the bus bars to incur the short-circuit fault can positively prevented. In other words, spreading of the trouble or accident can effectively be suppressed.

SCOPE OF CLAIMS

1. A controlgear characterized in that said controlgear comprises a unit chamber formed in a substantially box-like shape and having opening portions at a front side thereof for accommodating therein a plurality of functional units in a horizontal direction, a power distributor disposed at a rear side of said unit chamber for distributing electric power to said plurality of functional units, respectively, and a discharge chamber disposed adjacent to said power distributor and extending in a vertical direction of said controlgear,

wherein said power distributor has an inner ventilation space and is provided with air inlet ports at the side adjacent to said unit chamber for sucking heated air coming from said functional units, while an air outlet port is provided at the side adjacent to said discharge chamber for discharging the heated air from said functional units, and wherein said discharge chamber includes an inner ventilation space so that the heated air from said functional units is discharged exteriorly by way of said power distributor and said discharge chamber.

2. A controlgear set forth in claim 1, characterized in that said discharge chamber is implemented as a bus chamber accommodating therein bus bars for supplying electric power to said power distributor.

3. A controlgear set forth in claim 1, characterized in that said discharge chamber is implemented as a wiring conductor chamber accommodating therein wiring conductors which extend to external equipment/machinery from said functional units.

4. A controlgear set forth in claim 1, characterized in that said unit chambers are provided at a plurality of stages in a vertical direction so that a plurality of said functional units are disposed in vertical and horizontal directions generally in a gridiron-like pattern.

5. A controlgear set forth in claim 1, characterized in that said air inlet ports and said air outlet port provided in said power distributor are formed each in a slit-like shape.

6. A controlgear set forth in claim 3, characterized in that said air outlet port provided in said power distributor serves also as an opening for dispelling arc produced internally of said power distributor.