

A LOW-VOLTAGE ELECTRICAL DISTRIBUTION SYSTEM

TECHNICAL FIELD

[0001] This invention relates to a low-voltage electrical distribution system. More particularly, this invention relates to a busbar unit, a connector, an adapter, and a power block of a low-voltage electrical distribution system.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] A low-voltage electrical distribution system distributes electrical power from a three-phase supply system to a number of outgoing power supply terminals. Typically, the low-voltage electrical distribution system includes one or more bus conductors or busbars which run the length of an electrical distribution board. Electrical loads are connected to these busbars through miniature circuit breakers (MCBs). The MCBs protect the electrical loads from overload and short-circuit currents. MCBs include one-pole MCBs, two-pole MCBs, three-pole MCBs and four-pole MCBs. The one-pole MCB is connected to one of the L1, L2, L3 phases or neutral, N, of the three-phase supply system. In some electrical distribution system, there are therefore designated MCB slots in the electrical distribution board for connecting to each of these L1, L2, L3 phases and N. For load balancing during use, it is sometimes necessary for an electrical load to be switched from drawing current from one phase to drawing current from another phase. In such a case, an MCB would be required to be unplugged from one MCB slot and moved to be plugged to another MCB slot. However, for such designs, the number of available MCB slots are divided amongst the phases and N. There is a limited number of MCB slots associated with each phase or N. Load balancing may thus not be efficiently carried out due to the limited number of each type of MCB slots.

[0004] To solve this problem so as to allow an MCB in any one slot to be connectable to any of the phases or N, an MCB with a connector whose position is

adjustable is required. U.S. Patent No. 7,061,348, entitled "Circuit Breaker with a Moveable Plug Contact" to Schalk et al. discloses one such MCB. Such an MCB is however complicated in design, costly to manufacture, and is typically proprietary and expensive. The contact of the MCB disclosed in Schalk is a tulip-shaped clip and if the MCB is not properly latched in place, it is possible that the MCB may jump out of its socket during short circuit tests, posing a safety risk to users. And adapters are available to allow MCBs that are commonly available in the market to be connected to a busbar unit of a system in Schalk. Each adaptor includes a positionable clip for engaging a busbar and the clip is electrically connected to a power-source-side terminal of an MCB via an electrical cable. These cables between the adapters and the MCBs are not quite aesthetically pleasing and possibly an additional source of failure.

[0005] There is therefore a need for a system which addresses, at least in part, one or more of the forgoing problems.

SUMMARY

[0006] According to an aspect of the present disclosure, there is provided an electrical distribution system for receiving at least one circuit breaker having a power-source-side terminal. The electrical distribution system includes a busbar unit and a connector. The busbar unit has multiple spaced apart busbars for receiving the circuit breaker in a fixed spatial relation thereto. The connector, which is separate from the busbar unit, is releasably connectable to the power-source-side terminal of the circuit breaker to allow the circuit breaker to be plugged to the busbar unit so as to be electrically connected to one of the busbars. The connector is selectable from connectors having at least two different lengths depending on which of the busbars the circuit breaker is to be connected to.

[0007] In some embodiments, each of the connectors includes an intermediate section that defines the length of the connector, wherein the intermediate section includes a first surface and a second surface opposite the first surface. The connector further includes a first end section extending from the first surface at a first end of the connector, the first end section being pluggable to the busbar unit. The connector further includes a second end section extending from the second surface at a second

end of the connector, the second end section being connectable to the power-source-side terminal of the circuit breaker.

[0008] In some embodiments, the spaced apart busbars include four spaced apart bus bars. The circuit breaker is positioned in relation to the busbar unit such that the power-source-side terminal is located in a medial position of the four spaced apart busbars. As a result, only conductors of two different lengths are required for the power-source-side terminal to be connected to any one of the four spaced apart busbars.

[0009] In some embodiments, the electrical distribution system further includes an adapter that is releasably attachable to the circuit breaker to allow the circuit breaker to be slidable along a base to be plugged to the busbar unit.

[0010] In some embodiments, the base comprises at least one guide slot and the adapter comprises at least one corresponding guide protruding from a bottom surface thereof that is insertable into the at least one guide slot in the base to be thereby guided when slid on the base.

[0011] In some embodiments, the adapter further includes a latch that is biased to engage a corresponding detent hole in the base when the adapter is in a locked position on the base.

[0012] In some embodiments, the adapter further comprises means for releasably attaching it via its side to at least another adapter.

[0013] In some embodiments, the circuit breaker includes a DIN rail receiver channel, and the adapter is releasably attachable to the circuit breaker via the DIN rail receiver channel.

[0014] In some embodiments, the busbar unit further includes multiple biasing strips, each biasing bar being spaced apart from a corresponding busbar to define a space therebetween for receiving the connector to be electrically connected to the busbar.

[0015] In some embodiments, each biasing strip includes multiple leaf spring contacts spaced apart along its length, each leaf spring contact for urging a corresponding inserted connector to be in contact with the busbar.

[0016] In some embodiments, the busbar unit further includes a slotted housing having channels defined therein, wherein each busbar is slidable into a channel. The busbar unit also further includes multiple locking crossbars that is arranged

transversely to the busbars, each locking crossbar having spaced apart fingers. Each finger urges against a section of a corresponding busbar to lock it in place in the slotted housing.

[0017] In some embodiments, the busbar unit further includes a retractable cover plate for covering an opening in the circuit breaker through which a locking screw connected to the power-source-side terminal is exposed.

[0018] In some embodiments, the cover plate is biased to an outward position to cover the opening in the circuit breaker.

[0019] In some embodiments, the electrical distribution system further includes a power block. The power block includes a housing, multiple layers and multiple planar connectors. The layers are arranged in a stepped configuration in the housing. Each layer has a planar slot defined therein that is exposed at an end of the housing. The layer further has a top opening defined therein that is connected to the planar slot. The connectors have different lengths, each connector being receivable in a corresponding planar slot for coupling to a cable via the top opening.

[0020] In some embodiments, the power unit further includes a dividing wall that separates the layers into a first half and a second half, and wherein the top openings of the layers are alternately located in the first half and the second half.

[0021] According to another aspect of the present disclosure, there is provided an adapter that is releasably attachable to a circuit breaker having a DIN rail receiver channel. The adapter includes an adaptor body having a top surface and a bottom surface. The adapter further includes protrusions on the top surface that are receivable in the DIN rail receiver channel of the circuit breaker and at least one guide protruding from the bottom surface.

[0022] In some embodiments of the adapter, the adapter further includes a latch that is biased to be exposed on the bottom surface.

[0023] According to another aspect of the present disclosure, there is provided a busbar unit that includes multiple spaced apart busbars and multiple spaced apart biasing strips. Each biasing strip is offset from a corresponding busbar to define a space therebetween for receiving a connector to be electrically connected to the busbar.

[0024] In some embodiments of the busbar unit, each biasing strip comprises a plurality of multiple leaf spring contacts spaced apart along its length, each leaf spring

contact for urging a corresponding connector inserted in the space between the busbar and the leaf spring contact to be in contact with the busbar.

[0025] According to another aspect of the present disclosure, there is provided a power block. The power block includes a housing, multiple layers, and multiple connectors. The layers are arranged in a stepped configuration in the housing. Each layer has a planar slot defined therein that is exposed at an end of the housing. The layer further includes a top opening defined therein that is connected to the planar slot. The connectors have different lengths, each connector being receivable in a corresponding planar slot for coupling to a cable via the top opening.

[0026] According to yet another aspect of the present disclosure, there is provided a method of distributing electricity. The method includes connecting busbars to a three-phase supply system; positioning a circuit breaker having a power-source-side terminal in a fixed spatial relation to the busbars; and releasably connecting the power-source-side terminal of the circuit breaker to one of the busbars using a connector selectable from connectors having at least two different lengths depending on which of the busbars the circuit breaker is to be connected to.

[0027] Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0028] The invention will be better understood with reference to the drawings, in which:

Figure 1 is an isometric drawing of an electrical distribution system having a mounting panel, a busbar unit mounted to the mounting panel, multiple adapters and a power block according to an embodiment of the invention;

Figure 2 is an isometric drawing of the electrical distribution system in Figure 1 showing the power block plugged to the busbar unit and the adapters latched in position on the mounting panel;

Figure 3 is a cross-sectional drawing showing an adapter in Figure 2 connected to a circuit breaker that is plugged to the busbar unit via a connector;

Figure 4 is an isometric drawing of the mounting panel in Figures 1 and 2;

Figure 5 is an isometric drawing of the busbar unit in Figures 1 and 2, showing a front of the busbar unit;

Figure 6 is an isometric drawing of the busbar unit in Figure 5, showing a rear of the busbar unit;

Figure 7 is a cross-sectional drawing of the busbar unit in Figures 5 and 6;

Figure 8 is an enlarged isometric drawing of a locking crossbar that is used with the busbar unit in Figures 1 and 2;

Figure 9 is an enlarged isometric drawing of a cover plate that is used with the busbar unit in Figures 1, 2, 3, 5 and 6;

Figure 10 is an isometric drawing of the adapters in Figures 1 and 2, showing a bottom surface thereof;

Figure 11 is a cross-sectional drawing of an adapter in Figures 1, 2 and 10;

Figure 12 is an isometric drawing of the power block in Figures 1 and 2, showing a top surface and a distal end thereof;

Figure 13 is an isometric drawing of the power block in Figure 12, showing a bottom surface and a proximal end thereof;

Figure 14 is a cross-sectional drawing of the power block in Figures 12 and 13, showing connectors of different lengths received in planar slots of the power block;

Figure 15 is a cross-sectional drawing of the power block in Figure 14 shown plugged to the busbar unit in Figures 1 and 2 with connectors inserted therein;

Figure 16 is a drawing showing a plan view of a connector in Figures 14 and 15;

Figure 17 is an enlarged isometric drawing of connectors in Figure 3 for connecting the circuit breaker to the busbar unit; and

Figure 18 is a flowchart of a method of distributing electricity according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0029] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to.”

[0030] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be

understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0031] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0032] As shown in the drawings for purposes of illustration, the invention may be embodied in a safe, simple and less costly electrical distribution system. Existing systems tend to be complex and expensive. Referring to Figure 1, an electrical distribution system generally includes a busbar unit and a connector. The electrical distribution system receives at least one circuit breaker having a power-source-side terminal. The busbar unit includes multiple spaced apart busbars for receiving the circuit breaker in a fixed spatial relation thereto. The connector, which is separate from the busbar unit, is releasably connectable to the power-source-side terminal of the circuit breaker to allow the circuit breaker to be plugged to the busbar unit so as to be electrically connected to one of the busbars. To allow the same circuit breaker to be electrically connected to the different busbars from its fixed position relative to the busbar unit, at least connectors having two different lengths are provided. Depending on which busbar the circuit breaker is to be connected to, an appropriate one of the connectors is selected to make the electrical connection.

[0033] Specifically, Figures 1 and 2 show an electrical distribution system 2 according to an embodiment of the invention. As described above, the electrical distribution system 2 includes a busbar unit 4 and one or more connector 6 (Figure 17). Optionally, the electrical distribution system 2 further includes a mounting frame 8 to which the busbar unit 4 is mounted, one or more adapters 10 for attaching to one or more circuit breakers 12 (Figure 3), such as miniature circuit breakers (MCBs), and/or a power block 14 for electrically connecting power cables (not shown) to the busbar unit 4.

[0034] In this particular embodiment, miniature circuit breakers (MCBs) 12 conforming to the IEC 60947-2 standard that are widely available in the market are used, although proprietary circuit breakers (not shown) may also be used in the electrical distribution system 2. Figure 3 shows one such MCB 12 electrically connected to the busbar unit 4. Each of these MCBs 12 include amongst others, a power-source-side terminal 16 and a supply-side terminal (not shown). Connected

between the power-source-side terminal 16 and the supply-side terminal is an overcurrent and/or short circuit protection mechanism (not shown) known to those skilled in the art. These components are housed in a circuit breaker housing 18 that defines an external DIN rail receiver channel 20 for typically mounting of the MCB 12 to a DIN rail (not shown).

[0035] Next the mounting frame 8 is described in more detail with the aid of Figure 4 which is an isometric drawing of the mounting frame 8. The mounting frame 8 includes a base 22 and an adjoining mounting wall 24. On the top of the mounting wall is overhang strip 26. Two space apart rectangular through holes 28 are defined in the overhang strip 26. The mounting wall 24 includes a window 30 and two circular through holes 32. The base 22 includes multiple pairs of guide slots 34, 36. Each pair of guide slots 34, 36 includes an elongated guide slot 34 and a T-shaped guide slot 36 with a narrower neck slot section 38 connected to a wider shoulder slot section 40. The elongated guide slot 34 and the T-shaped guide slot 36 are aligned along an axis shown by line X-X' in Figure 4. The elongated guide slot 34 and the neck slot section 38 of the T-shaped guide slot 36 have the same widths, although they may be of different widths. The base 22 further includes one or more detent through holes 42. Each detent through hole 42 is aligned along the axis with each pair of guide slots 34, 36. In this embodiment shown in Figure 4, the mounting frame 8 has a pole-capacity of six, i.e. the mounting frame 8 has six pairs of guide slots 34, 36 for receiving six one-pole MCBs 12, three two-pole MCBs, two three-pole MCBs, etc. or a combination of one-pole, two-pole, three-pole or four-pole MCBs. However, the mounting panel 8 may have other pole-capacities, including but not limited to, 1, 2, 48, 96, etc. The base 22 of the mounting frame 8 further defines four laterally positioned through holes 44 for mounting the mounting frame 8 to support rails in a cabinet (both the support rails and cabinet are not shown). The mounting frame 8 further includes a retainer strip 46 below the base 22 distal from the mounting wall 24. The retainer strip 46 includes multiple through holes 48. The mounting frame 8 is stamped out of a sheet metal such as but not limited to an aluminium sheet, a galvanized steel sheet, a power-coated steel sheet, etc. The sheet metal is about 1.5 mm thick, although sheet metal of other thicknesses may also be used. The stamped sheet metal is then bent into the configuration as described and shown in Figure 4.

[0036] The busbar unit 4 is next described with the aid of Figures 5-9. The busbar unit 4 includes a slotted housing 50 having four elongated channels 52 defined therein. A pair of guide rails 54, 56 project from opposite internal sidewalls of the slotted housing 50 that define each channel 52. The pair of guide rails 54, 56 includes a first thinner guide rail 54 and an opposing second thicker guide rail 56. The pair of guide rails 54, 56 divide each channel 52 into two sections, a first channel section 60 (Figure 7) for receiving a biasing strip 62 and a second channel section 58 for receiving a busbar 64 (Figure 3). Each busbar 64 is an elongated copper bar having a rectangular cross-section and a length that extends at least from one end of the slotted housing 50 to the other end of the slotted housing 50. The busbars 64 may be of other cross-sections, lengths, and materials known to those skilled in the art. The biasing strip 62 (Figure 6) includes a main support section 66 extending across the length of a channel 52 and projections 68, 70 that extend laterally from the main support section 66. The projections 68, 70 include separating portions 68 and leaf spring contacts 70 positioned alternately along the length of the main support section 66. During assembly, a busbar 64 is slotted into the second channel section 58 of each channel 52 and a biasing strip 62 is slotted into the first channel section 60 of each channel 52. To lock the busbar 64 and the biasing strip 62 in place in the channel 52, the busbar unit 4 includes optional multiple locking crossbars 72, one of which is shown in detail in Figure 8. Each locking crossbar 72 includes an elongated handle 74 and a number of spaced-apart fingers 76 projecting from a lateral surface of the elongated handle 74. The number of fingers 76 matches the number of busbars 64 and corresponding biasing strips 62. During assembly, each locking crossbar 72 is positioned against the slotted housing 50, transverse to the busbars 64, such that the fingers 76 are inserted into the slotted housing 50 through corresponding openings 78 (Figure 5) in the slotted housing 50 to lock the busbars 64 and biasing strips 62 in place. More specifically, each finger 76 when inserted into the slotted housing 50 will go into a space defined between a busbar 64 and a separating portion 68 (Figure 6) of a corresponding biasing strip 62 to urge the busbar 64 and the biasing strip 62 against a roof and a floor of a chamber 52 respectively to thereby lock them 62, 64 in place within the slotted housing 50. In this manner, the four busbars 64 are spaced apart in their respective positions within the slotted housing 50.

[0037] The busbar unit 4 further include a matrix of openings 80 for receiving the connectors 6. Each opening 80 is aligned with a space between a busbar 64 and a leaf spring contact 70 of a corresponding biasing strip 62 for receiving a connector 6. When a connector 6 is inserted into an opening 80, the leaf spring contact 70 will urge the connector 6 against the busbar 64 to thereby ensure electrical contact therewith. During use, the four busbars 64 will be connected to the L1, L2, L3 phases and neutral N of a three-phase supply system in that sequence. When an MCB 12 is plugged to the busbar unit 4, it is positioned in relation to the busbar unit 4 such that the power-source-side terminal 16 of the MCB 12 is located in a medial position of the four spaced apart bus bars as indicated by line Y-Y' in Figure 3. In this position, the power-source-side terminal 16 is equidistant from the busbars 64 connected to the L2 and L3 phases, and equidistant from the busbars 64 connected to the L1 phase and neutral N. As such, conductors 6 of only two different lengths as shown in Figure 17 are required for the power-source-side terminal 16 to be connected to any one of the four spaced apart busbars 64.

[0038] Optionally, the busbar unit 4 further includes one or more retractable cover plates 82, one of which is shown enlarged in Figure 9. Each cover plate 82 covers a hole opening (not shown) in a top portion 84 of an MCB 12 when plugged to the busbar unit 4 so that a screw (not shown) connected to the power-source-side terminal 16 of the MCB 12 accessible through the hole opening of the MCB 12 is not exposed. Each cover plate 82 is a flat rectangular-shaped plastic piece having a distal end 84 slightly wider than a proximal end 86 thereof. The cover plate 82 is inserted into a corresponding channel 88 (Figure 6) of the busbar unit 4. A central bore 90 abuts the channel 88. During assembly, the cover plate 82 is inserted into the channel 88 proximal end first via a rear of the busbar unit 4. This proximal end 86 will protrude from an opening 92 of the channel 88 having a width that is narrower than the distal end 84 of the cover plate 82 so that the cover plate 82 is retained within the channel 88. A compression helical spring 94 (Figure 7) is then inserted into the central bore 90 to abut the distal end 84 of the cover plate 82 before the rear opening of the channel 88 is sealed with a plug (not shown). The helical spring 94 biases the cover plate 82 outwards to cover the top portion 84 of the MCB 12 as described above. When required, a user can slide the cover plate 82 inwards into the channel against the force of the helical spring to retract it so that the screw of the power-source-side terminal 16

of the MCB may become accessible. The housing of the busbar unit is of molded polycarbonate resin although other suitable electrically insulating material may be also be used.

[0039] Next the adapter 10 is described in more detail with the aid of Figures 1, 2, 3, 10 and 11 which show different views of the adapter 10. Figure 1 shows four adapters 10 positioned side-by-side before assembly to the base 22 of the mounting frame 8. The adapter 10 is releasably attachable to the MCB 12 via its DIN rail receiver channel 20 to allow the two to be connected to each other. Each adaptor 10 includes a body 90 having a top surface 92 and a bottom surface 94. On the top surface 92 of the body 90 is a pair of engagement portions 96, 98 for mating with the MCB housing 18 that defines the DIN rail receiver channel 20. One of the engagement portions 96 projects in the direction of a proximal end 100 of the adaptor 10 while the other engagement portion 98 projects in the direction of a distal end 102 of the adaptor 10. Located on the bottom surface 94 of the body 90 is a hook-shaped guide 104 and a T-shaped guide 106 arranged along a length of the body 90. A bore 110 is defined in the body 90 extending from the top surface 92 to the bottom surface 94. The bore 110 has an opening 112 at the bottom surface 94 that is of a smaller diameter than an opening at the top surface 92. The adapter 10 further includes a ball bearing (not shown) located in the bore 110. The ball bearing is of a size that allows a portion thereof to protrude from the opening 112 at the bottom surface 94. Abutting the ball bearing in the bore 110 is a compression helical spring 114 that biases the ball bearing in the direction of the opening 112 at the bottom surface 94. A cap 116 covers an opening at the top surface 92 to enclose the helical spring 114 and the ball bearing in the bore 110. With this arrangement, the biased ball bearing functions as a latch for engaging the detent hole 42 in the base 22 of the mounting panel 8 when the adapter 10 is slid along the base 22 to be latched in position on the base 22. Additional force is required to push the ball bearing back into the bore 110, compressing the helical spring 114 to allow the adaptor 10 to be dislodged from the locked position on the base 22. Adjacent the bore 110 towards the distal end 102 of the adapter 10 is a tool-engagement bore 120 that extends from the top surface 92 to the bottom surface 94 of the body 90. This engagement bore 120 allows a tool to be inserted therein to allow the assembly of the adapter 10 and the MCB 12 to be unplugged from the busbar unit 4 with ease compared to using bare hands. The body 90 of the adapter further includes

holes 122 on each side of the body 90 to allow insertion of connecting pins (not shown) so that two or more adapters 10 may be coupled together for attaching to corresponding larger two-pole MCBs, three-pole MCBs or four-pole MCBs. The adapter 10 may be of different widths to accommodate the different types of MCBs. The MCB may also include those without any DIN rail receiver channel. For such MCBs, the adapter 10 may be releasably attached thereto via any suitable mechanical interlocking means. It is also to be noted that the adapter 10 merely provides support for the MCB 12; it does not include any electrical interconnection between the MCB 12 and the busbar unit 4. The adapter is of molded polycarbonate resin although other suitable electrically insulating material may be also be used.

[0040] The busbars 64 in the busbar unit 4 may be connected to the three-phase power system by directly connecting them to corresponding electrical cables. However, it is also possible to connect the busbars 64 to the electrical cables via the power block 14, an embodiment of which is shown in Figures 12 and 13. The power block 14 includes a housing 130 and four layers 132, 134, 136, 138 arranged in a stepped configuration in the housing 130, with a top layer 132 having a shortest length and each subsequent lower layer 134, 136, 138 having a length that is longer than a preceding top layer 132, 134, 136. Each layer 132, 134, 136, 138 has a planar slot 140 defined therein that is exposed at a proximal end 142 of the housing 130. Each layer has a top opening 150 exposing the planar slot 140 thereunder. In each layer, a cavity 152 that has a nut 154 located therein is defined beneath the top opening 150. A planar connector 156 (Figure 16) having a bifurcated end 158 is received in each planar slot 140 with its bifurcated end 158 exposed at the proximal end 142 of the housing 130. In other words, the planar connectors 156 have different lengths corresponding to the length of the planar slots 140 into which they are to be received. One such planar connector is shown in Figure 16. Each planar connector 156 also includes a through hole positioned such that it is aligned with the cavity 152 in the layer 132, 134, 136, 138 when the planar connector 156 is received into the planar slot 140 of the layer 132, 134, 136, 138. The power block 14 may also include a dividing wall 160 on top of the layers 132, 134, 136, 138 that separates the layers into a first half 162 and a second half 164. The top openings 150 of the layers 132, 134, 136, 138 are located alternately in the first half and the second half in a staggered manner as shown

in Figure 12. The power block 14 is of polycarbonate resin although other suitable electrically insulating material may be also be used.

[0041] For this particular embodiment, each MCB 12 is mounted such that the power-source-side terminal 16 is positioned at a medial level of the busbar unit indicated by line Y-Y' shown in Figure 5. As described above, with such a spatial relationship, only connectors 6 of two different lengths are required for connecting the power-source-side terminal 16 of an MCB 12 to each of the four busbars 64 of the busbar unit 4. Figure 17 shows two connectors 6 of different lengths. Each connector 6 is Z-shaped and includes an intermediate section 170 that defines the length of the connector 6. The intermediate section 6 has a first surface 172 and a second surface 174 opposite the first surface 172. The connector has a first end section 176 extending from the first surface 172 at a first end of the connector 6. This first end section 176 is pluggable into the busbar unit 4. The connector 6 also has a second end section 178 extending from the second surface 174 at a second end of the connector 6. The second end section 178 is connectable to the power-source-side terminal 16 of the MCB 12.

[0042] Next, the assembly and use of the electrical distribution system 2 is described according to a particular sequence. However, assembly may be carried out in a different sequence or in parallel. During assembly, the busbar unit 4 is mounted to the mounting frame 8. The busbar unit 4 is held at a slight angle off a normal so that the engagement portions 180 on the top of the busbar unit 4 may be brought to engage the through holes 28 on the overhang portion 26 of the mounting frame 8 so as to allow the busbar unit 4 to hang against the mounting wall 24 of the mounting panel 8. The busbar unit 4 is then fastened to the mounting wall 24 of the mounting frame 8 with any suitable fasteners, such as but not limited to, screws, bolts and nuts, rivets, etc.

[0043] Each adapter 10 is slid sideways under an MCB 12 such that the engagement portions 96, 98 of the adapter 10 engage portions of the MCB housing 18 that defines the DIN rail receiving channel 20 to be thereby releasably connected thereto. A connector 6 is selected depending on which busbar the MCB 12 is to be connected to, or more specifically, a power-source-side terminal 16 of the MCB 12 is to be connected to. For example, if the MCB is to be connected to either the L2 phase or the L3 phase, the shorter connector 6 in Figure 17 is selected. If the MCB 12 is to be connected to either the L1 phase or N, the longer connector 6 is selected. The

connector 6 is then connected to the MCB 12 by connecting the second end section 178 thereof to the power-source-side terminal 16 with the first end section 176 oriented upwards or downwards depending on which of the L1 phase or neutral N the MCB 12 is to be electrically connected to.

[0044] Next the assembly of the MCB 12 and the adaptor 10 is brought into contact with the base 22 of the mounting frame 8 such that the hook-shaped guide 104 and the T-shaped guide 106 of the adapter 10 sit in the elongated guide slot 34 and T-shape guide slot 36 on the base 22 of the mounting frame 8. The adapter 10 is then slid towards the direction of the busbar unit 4. In doing so, the hook-shaped guide 104 and the T-shaped guide 106 will latch onto the undersurface of the base 22 to firmly lock the assembly of the adapter 10 and MCB 12 thereto. In this position, the ball bearing in the adaptor 10, acting against the force of the helical spring, will be pushed against the detent hole 42 in the base 22 to thereby more firmly latch the adaptor 10 in place on the base 22 so that it is not easily dislodged. The first end section 176 of the connector 6 connected to the MCB 12 will also be thereby guided to be inserted through a corresponding opening 80 in the busbar unit 4 to be electrically connected to the busbar 64.

[0045] Cables of the three-phase supply system are connected to the power block 14. Each cable has a through bolt terminal 157 connected thereto. This through bolt terminal 157 is then bolted to the nut 154 to clamp it to a corresponding planar connector 156. The power block 14 is slid along the base 22 to allow it to be latched to the base 22 in a manner similar to that described for the adapter 10. The bifurcated end 158 of the connectors 156 will also be thereby inserted through corresponding openings 80 in the busbar unit 4 to be electrically connected to the busbars 64 in a similar manner to the connectors 6. The power block 14 is held firmly in place on the base by fastening it to the retainer strip 46 of the mounting frame 8.

[0046] Typically, during use, the current drawn in each phase of a three-phase supply system is monitored using a suitable ammeter. If it is found that more current is drawn from any particular phase, one or more MCBs 12 connected to that phase may be unplugged, have its connector switched around or changed so that the MCB12 may be connected to a different phase of the three-phase supply system. This can be carried out without having to switch the three-phase supply system off or requiring that

the MCB 12 be moved to a different slot location on the base 22. In this manner all MCB slots in the electrical distribution system 2 may be efficiently utilized.

[0047] Figure 18 is a flowchart showing a method 200 of distributing electricity according to another embodiment of the invention. The method 200 starts in a CONNECT BUSBARS step 202, wherein busbars 64 are connected to a three-phase supply system. The method next proceeds to a SELECT AND CONNECT CONNECTOR step 204, wherein a connector 6 is selected from connectors 6 having at least two different lengths depending on which of the busbars 64 an MCB 12 is to be connected to, and releasably connecting the selected connector 6 to a power-source-side terminal 16 of the MCB 12. The method ends in a CONNECT CIRCUIT BREAKER step 206, wherein the MCB 12 is brought into position in a predetermined fixed spatial relation to the busbars 64 to have the connector 6 connected to a busbar 64. Positioning the MCB 12 may include releasably attaching the MCB 12 to an adapter 10 to allow the connected adaptor 10 and MCB 12 to be slidably brought into the fixed spatial relation with the busbars 64. Connecting the connector 6 to the busbar 64 may include urging the connector 6 against the busbar 64 via a suitable biasing means.

[0048] Advantageously, the electrical distribution system 2 is compact, relatively easy to manufacture resulting in a correspondingly lower manufacturing cost, and provides better slot utilization since an MCB may remain in a same slot regardless of which phase of a three-phase supply system the MCB is to be connected to.

[0049] Although the present invention is described as implemented in the above described embodiments, it is not to be construed to be limited as such. For example, although it is described that busbar unit 4 and the mounting frame 8 are separate, it is possible that the mounting frame 8 and the busbar unit 4 are of a unitary design. For example, the busbar unit 4 may have an integral base 22 similar to that of the mounting frame 8 described above. Alternatively, the base 22 may include a flat sheet metal that is attached to a bottom of the busbar unit 4.

[0050] Although the busbar unit 4, the adapter 10, the connectors 6 and the power block 14 are described to be used together in a single embodiment, they may also be used individually with other components. For example, the busbar unit 4 described above may be used on its own with any type of MCB, commonly available in the market or proprietary. As another example, the connectors 6 of different lengths may

be used with any MCB so as to connect its power-source-side terminal to a selected busbar of any busbar unit. One example is the circuit breaker disclosed in U.S. Patent No. 7,061,348, entitled "Circuit Breaker with a Moveable Plug Contact" to Schalk et al. That circuit breaker may be modified to include a fixed power-source-side terminal that is connectable to any busbar unit using the connectors described above. As a further example, the power block 14 may also be used on its own with busbar units of other designs, not necessarily confining its use to the particular busbar unit 4 described above.

[0051] As another example, it is described that when connected to the busbar unit 4, the power-source-side terminal 16 of an MCB 12 is positioned in a medial position of the four busbars 64. However, the invention should not be construed to be limited as such. The MCB 12 may be positioned anywhere in relation to the busbar unit 4 when plugged thereto, requiring connectors of more than two different lengths to connect the power-source-side terminal 16 to the different busbars 64. For example, the connectors 6 may come in three or four different lengths depending on where the MCB 12 is to be positioned relative to the busbar unit 4.

[0052] As yet a further example, a single leaf spring contact is described as urging a connector 6 against a busbar 64. The biasing strip 62 may alternatively include narrower leaf spring contacts such that multiple leaf spring contacts are in contact with each connector to urge it against a busbar 64.

[0053] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.

CLAIMS

[Claim 1] An electrical distribution system for receiving at least one circuit breaker having a power-source-side terminal, the electrical distribution system comprising:

- a busbar unit for receiving the circuit breaker in a fixed spatial relation thereto, the busbar unit including:

- a plurality of spaced apart busbars, and

- a plurality of biasing strips, each biasing strip being spaced apart from a corresponding one of the plurality of busbars to define a space therebetween; and

- a connector, separate from the busbar unit, that is releasably connectable to the power-source-side terminal of the circuit breaker to allow the circuit breaker to be plugged to the busbar unit in the space between one of the plurality of biasing strips and a corresponding one of the plurality of busbars so as to be electrically connected to the one of the plurality of busbars;

- wherein the connector is selectable from connectors having at least two different lengths depending on which of the plurality of busbars the circuit breaker is to be connected to.

[Claim 2] The electrical distribution system according to Claim 1, wherein each of the connectors comprises:

- an intermediate section that defines the length of the connector, the intermediate section having a first surface and a second surface opposite the first surface;

- a first end section extending from the first surface at a first end of the connector, the first end section being pluggable to the busbar unit; and

- a second end section extending from the second surface at a second end of the connector, the second end section being connectable to the power-source-side terminal of the circuit breaker.

[Claim 3] The electrical distribution system according to Claim 1 or Claim 2, wherein the plurality of spaced apart busbars comprises four spaced apart bus bars, and the

circuit breaker is positioned in relation to the busbar unit such that the power-source-side terminal is located in a medial position of the four spaced apart busbars, and only conductors of two different lengths are required for the power-source-side terminal to be connected to any one of the four spaced apart busbars.

[Claim 4] The electrical distribution system according to any one of the preceding claims, further comprising an adapter that is releasably attachable to the circuit breaker to allow the circuit breaker to be slidable along a base to be plugged to the busbar unit.

[Claim 5] The electrical distribution system according to Claim 4, wherein the base comprises at least one guide slot and the adapter comprises at least one corresponding guide protruding from a bottom surface thereof that is insertable into the at least one guide slot in the base to be thereby guided when slid on the base.

[Claim 6] The electrical distribution system according to Claim 5, wherein the adapter further comprises a latch that is biased to engage a corresponding detent hole in the base when the adapter is in a locked position on the base.

[Claim 7] The electrical distribution system according to any one of Claims 4-6, wherein the adapter further comprises means for releasably attaching it via its side to at least another adapter.

[Claim 8] The electrical distribution system according to any one of Claims 4-7, wherein the circuit breaker includes a DIN rail receiver channel, and the adapter is releasably attachable to the circuit breaker via the DIN rail receiver channel.

[Claim 9] The electrical distribution system according to Claim 1, wherein each biasing strip comprises a plurality of leaf spring contacts spaced apart along its length, each leaf spring contact for urging a corresponding inserted connector to be in contact with the busbar.

[Claim 10] The electrical distribution system according to Claim 1 or Claim 9, wherein the busbar unit further comprises:

a slotted housing having channels defined therein, wherein each busbar is slidable into a channel; and

a plurality of locking crossbars that is arranged transversely to the busbars, each locking crossbar having spaced apart fingers, each finger urging against a section of a corresponding busbar to lock it in place in the slotted housing.

[Claim 11] The electrical distribution system according to any one of Claims 1, 9 and 10, wherein the busbar unit further comprises a retractable cover plate for covering an opening in the circuit breaker through which a locking screw connected to the power-source-side terminal is exposed.

[Claim 12] The electrical distribution system according to Claim 11, wherein the cover plate is biased to an outward position to cover the opening in the circuit breaker.

[Claim 13] The electrical distribution system according to any one of the preceding claims, further comprising a power block, the power block comprising:

a housing;

a plurality of layers arranged in a stepped configuration in the housing, each layer having a planar slot defined therein that is exposed at an end of the housing, each layer further having a top opening defined therein that is connected to the planar slot; and

a plurality of planar connectors having different lengths, each planar connector being receivable in a corresponding planar slot for coupling to a cable via the top opening.

[Claim 14] The electrical distribution system according to Claim 13, wherein the power block further comprises a dividing wall that separates the layers into a first half and a second half, and wherein the top openings of the layers are alternately located in the first half and the second half.