

Bus-bar Arrangement For Electric Distribution

Field of Invention

[0001] The present invention relates to a bus-bar arrangement for an electric distribution panel that meets short-circuit testing requirements.

Background

[0002] A distribution panel or board is typically located in a central location inside a premises and serves as the point from where electricity is distributed to different areas or floors of the premises. Inside the distribution panel, there is an isolator for connecting or disconnecting electric power to the premises; often, there is an additional earth leakage protection built into the isolator. According to the number of distribution channels, a moulded case circuit breaker (MCCB) is connected to the bus-bars after the isolator for distributing electricity to the respective area or floor.

[0003] Bus-bars are often modularly designed to allow easy assembly of a distribution panel for a required configuration; thus, additional bus-bars can be added easily when a need arises. Whilst all components in distribution panels meet national and/or international codes of practice and safety certification standards, not all distribution panels are tested or type-tested for short-circuiting. For example, most bus-bars are selected based on allowable current density and tested for temperature rise but entire distribution panels may not be type certified to extreme short-circuit tests.

[0004] During short-circuit testing, the bus-bars in a distribution panel may carry up to about 30 times the rated current for one to four seconds. The bus-bars must then be sized to carry such a transient current load in terms of heat dissipation, structural strength, vibration and so on, including the strength of the bus-bar supporting members.

[0005] It can thus be seen that there exists a need for a new design of a distribution panel that is type-tested to withstand at least short-circuiting.

Summary

[0006] The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not intended to identify key features of the invention. Rather, it is to present some of the inventive concepts of this invention in a generalised form as a prelude to the detailed description that is to follow.

[0007] In one embodiment, the present invention provides a bus-bar assembly for an electricity distribution panel. The bus-bar assembly comprises: a bus-bar body for each of three phases of electricity; wherein each bus-bar body has contact fingers being integrally formed and bent, together with the contact finger supporting members, from the respective bodies, so that the three bus-bars are operable to be placed substantially parallel to and apart from each other, with the contact fingers of the bus-bars being interspersed and ordered in a cyclic manner for 3-phase electricity, and each contact finger is dimensioned to both fit and engage with an input point of an associated circuit breaker (CB) for electricity distribution.

[0008] In another embodiment, the present invention provides a kit for an electricity distribution panel. The kit comprises: two types of bus-bars, wherein each bus-bar comprises a body and each body has contact fingers being integrally formed and bent, together with the contact finger supporting members, from the respective body, so that the bus-bars are operable to be mounted substantially parallel to and apart from each other, with the contact fingers of the bus-bars being interspersed and ordered in a cyclic manner for 3-phase electricity, and each contact finger is dimensioned to both fit and engage with an input point of an associated circuit breaker (CB) for electricity distribution.

[0009] In one embodiment of the present invention, the bus-bars are mounted on a base plate such that two peripheral bus-bars are mounted higher from the base plate than the centre bus-bar. In another embodiment, the peripheral bus-bars are substantially identical to each other but are mounted as mirror images of each other. In one

embodiment, the bus-bars are removably mounted on the base plate with M8 size screws and nuts. The mounting screws may be disposed on a pitch of about 95 mm or on an unequal pitch.

[0010] In another embodiment of the present invention, the heights of the peripheral bus-bars are predetermined by a height of a shoulder of a stepped bushing whilst the height of the centre bus-bar is predetermined by a height of a shoulder of a stepped boss. The heights of the peripheral and centre bus-bars may be varied by adding one or more spacers between each shoulder of the stepped bushing or boss and relevant body of the bus-bar. In another embodiment, the body of each bus-bar comprises two or more bodies, so that the current rating of the bus-bar assembly is varied according to a desired current density.

[0011] In another embodiment of the present invention, a section of three contact fingers associated with the three separate bus-bars for electricity distribution through an MCB is separated by a cover. The cover comprises a base cover, a middle cover and a top cover. The base cover is associated with the centre bus-bar and hollow boss. The middle cover has an opening through its U-shaped body, and the same ends of two middle covers are butted to each other so that the contact fingers of the centre bus-bar extend through the combined opening of the two butted middle covers; the contact fingers of the peripheral bus-bars are disposed on each of the two sides of the contact fingers of the centre bus-bar and each contact finger is electrically insulated from each other by vertical walls on the U-shaped body. In one embodiment, the bushing, boss, spacer, base cover, middle cover or top cover is made of flame-retardant and self-extinguishing thermoplastics.

[0012] In another embodiment of the present invention, the bus-bars are made of high-conductivity copper. The surfaces of the bus-bars may be tinned to minimize surface oxidation. In one embodiment, the copper is half-hard temper so that the contact fingers and the finger' supporting members are operable to be formed and bent with minimum stress and strain discontinuities, yet maintaining sufficient rigidity.

[0013] In another embodiment of the present invention, a neutral phase bus-bar is additionally provided for single-phase and 3-phase electricity distribution.

Brief Description of the Drawings

[0014] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0015] FIGs.1A-1B illustrate a bus-bar assembly in accordance with an embodiment of the present invention; FIG. 1C shows an end view of the bus-bar assembly shown in FIG. 1B; FIG. 1D shows a cross-sectional view of the bus-bar shown in FIG. 1B; FIGs. 1D and 1E show a side view and associated sectional views, respectively, of the bus-bar assembly shown in FIG. 1B;

[0016] FIG. 2A illustrates an exploded view of the bus-bar assembly shown in FIG. 1B; and FIGs. 2B-2D illustrate the exploded view of each of the three bus-bars;

[0017] FIGs. 3A1-3A4 illustrate a base cover for the centre bus-bar according to one embodiment of the present invention;

[0018] FIGs. 3B1-3B4 illustrate a middle cover for interlocking with the base cover shown in FIG. 3A; and

[0019] FIGs. 3C1-3C4 illustrate a top cover for interlocking with the middle cover shown in FIG. 3B;

Detailed Description

[0020] One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific

details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals or series of numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0021] FIG. 1A shows a plan view of a bus-bar assembly 100 according to an embodiment of the present invention. FIG. 1A shows the bus-bar assembly 100 with distribution circuit breakers (CBs) 190 (such as, moulded case circuit breakers MCCBs or miniature circuit breakers MCBs) connected to bus-bars 102,104,106 in the bus-bar assembly 100, while FIG. 1B shows the bus-bar assembly 100 without the CBs but covers 185 for the peripheral the bus-bars 102, 106. As shown, the bus-bar 104 and contact fingers 130 are covered by a plurality of abutting covers 140.

[0022] As shown in FIGs. 1A and 1B, the bus-bar assembly 100 has 3 substantially parallel bus-bars 102,104,106. Each bus-bar 102,104,106 has a rectangular cross-sectional body and contact fingers 130; each contact finger 130 has a supporting member extending from the body of the respective body. As seen in FIGs. 1A and 1B, the left hand end of the bus-bars 102,104,106 are extended (shown in phantom lines) for the purpose of short-circuiting them with a short-circuit bar 108; the short-circuit bar 108 is only used for an assembly that was type-tested by short-circuiting. FIGs. 1C and 1D show the end view and associated end sectional view, respectively, of the bus-bar assembly 100 shown in FIG. 1B. FIGs. 1E and 1F show the side view and associated longitudinal section view, respectively, of the assembly 100. As shown in FIGs. 1E and 1F, the contact fingers 130 of the bus-bar 102,104,106 are dimensioned and arranged so that each contact finger 130 fits with each input contact point on the CB 190. As seen in FIGs. 1C and 1D, the entire bus-bar assembly 100 is mounted on a base-plate 170, which may be mountable in an enclosure (not shown in the figures) safety and ingress protection.

[0023] FIG. 2A shows an exploded view of the bus-bar assembly 100 shown in FIG. 1B. For clarity, FIG. 2B shows an exploded view of the left hand side bus-bar 102 sub-assembly, while FIGs. 2C and 2D show, respectively, those of the centre bus-bar 104 and right hand bus-bar 106 sub-assemblies as seen in FIG. 1C.

[0024] In the present invention, each bus-bar assembly 100 is designed for a particular number of electrical circuits or ways of distributing electricity. The numbers of ways are typically 4, 6, 8, 10 or 12 for 3-phase electricity distribution. If further distribution of electricity is required, an additional bus-bar assembly may be provided from any one of the CBs 190 outlets. Further sub-distribution is again possible. In addition or alternatively, other numbers of ways are possible. According to the present invention, each busbar is an integral piece; there are no joints along a busbar. If only single-phase electricity is distributed, then an 8-way, 3-phase bus-bar assembly in addition to a neutral bus-bar can distribute electricity through 3x8 single-phase CBs.

[0025] For purposes of illustration, the bus-bar assembly 100 according to the present invention is shown with 8-ways of 3-phase electricity distribution. As shown in FIGS. 2A and 2B, the bus-bar 102 has a flat and elongate body 110 and two contact fingers 130 formed on each of four supporting arms 111. Each supporting arm 111 is formed to extend horizontally from the right-hand side of the body 110, then bent to extend vertically 112 from one side of the arm 111 and bent 113 another time so that the two contact fingers 130 at two ends of the bent segment 113 are substantially horizontal and parallel in plane to a face of the body 110. The supporting arm 111 and its vertical 112 and horizontal 113 segments are dimensioned such that when the three bus-bars 102, 104, 106 are assembled on the base plate 170, the contact fingers 130 on each bus-bar are spaced apart to fit and to engage with the inlet contact points of the CBs 190. As shown in FIG. 2B, the bus-bar 102 is mounted on the base plate 170 by screws 114 and nuts 115. Screws 114 pass through holes on the body 110. As shown, the bus-bar 102 is isolated from the base plate 170 by bushings 116, spacers 117 and washers 118. Each bushing 116 is substantially cylindrical and has a stepped shoulder. By inserting one or more spacers 117 on the stepped shoulder of the bushing 116, the distance of the body 110 from the base plate 170 can be adjusted according to need. A flat metal washer 119 is provided between the washer 118 and the nut 115; the washer 118 has an outside diameter that is at least 2 mm larger than the outside diameter of the flat metal washer 119 to minimize flash-over during short-circuit testing.

[0026] Now referring to FIGs. 2A and 2C, the bus-bars 104 has contact fingers 130 formed on both sides of the body 120 of the bus-bar 104. Each contact finger 130 is supported by a vertical segment 122 and a horizontal segment 123, with the horizontal segment 123 terminating with the contact finger itself. The contact fingers 130 and vertical segments 122 are displaced along a longitudinal direction of the body 120 of the bus-bar 104 with respect to the positions of the contact fingers 130 on the bus-bar 102, as can be seen in FIGs. 1E or 1F. As seen in FIG. 2A and 2C, both ends of the body 120 of the bus-bar 104 are bent. The bent ends are provided so that the short-circuit bar 108 can contact and bridge all the three bus-bars 102,104,106 at either end in an assembly 100 for short-circuit testing; the end(s) of the body 120 of the bus-bar 104 in a type-tested distribution panel need not be bent.

[0027] Each cover 140 is dimensioned to fit over three contact fingers 130 associated with the bus-bars 102,104,106. As shown in FIG. 2C, each cover 140 is made up of a base cover 141, a middle cover 151 and a top cover 161. FIGs. 3A1-3A4 show the base cover 141 having a base 142 that is substantially rectangular in shape. The base 142 has an inside face and an outside face. Near the centre of the inside face of the base 142 is a hollow boss 143. The boss 143 is of round and cylindrical shape with a stepped shoulder. The height of the shoulder and thickness of the base 142 determine the distance of the body 120 of the bus-bar 104 from the base plate 170. On each of the long sides of the base 142 and diametrically from the boss 143 is a rectangular slot 144. Equally spaced on the long side of the base 142 from each of the slot 144 are two stopper tabs 145. Also equally spaced on the long side of the base 142 from the slot 144 are two pins 146. Along each short edge of the base 142 are two parallel strips 147. Equally spaced from the hollow boss 143 on the outside face of the base 142 and along the long axis of the base 142 are two locating pins 148.

[0028] FIGs. 3B1-3B4 show the middle cover 151 according to one embodiment of the bus-bar assembly 100. As shown in FIG. 3B1, the middle cover 151 has an inverted U-shaped body 152. On one open end of the U-shaped body 152 is an opening 153. Near both the open end and opening 153 of the U-shaped body 152 and on each vertical side of the U-shaped body 152, there are two locating pins 154. The locating pins 154 are longer than the vertical side of the body 152 and extend downward thereof. At the open

end of the body 152 that is opposite the opening 153, there are two hollow posts 155 on the vertical sides of the body 152, as shown in FIGs. 3B3 and 3B4. On a horizontal face 152a of the U-shaped body 152 are two vertical walls 156, 157 that are transverse to the body 152. The vertical wall 156 is near the end of the body 152 on the same end as the hollow posts 155, whilst vertical wall 157 is near the opening 153 of the body 152. Extending along the centre of the vertical wall 157 is a pin 158. The pin 158 extends beyond the height of the vertical wall 157.

[0029] FIGs. 3C1-3C4 show the top cover 161 according to one embodiment of the bus-bar assembly 100. As shown in FIG. 3C1, the top cover 161 is elongate. The top cover 161 has an upper surface 162 along the long axis and centre of the top cover and a downward sloping surface 164 joined to each of two long edges of the centre surface 162. As shown in FIG. 3C1 and 3C2, the centre surface 162 has four slots 163 that are equally spaced along the length of the centre surface 162. Each slot 163 opens through the thickness of the centre surface. On a reverse side of the top cover, there are four walls 165, 167 extending transversely and downwardly. The end walls 165 have a step on an inside transverse edge. As shown in FIG. 3C3, at the centre of each intermediate wall 167, there is a hollow post 168 extending downward and along the intermediate wall 167. The walls 165, 167 are equally spaced so that when the top cover 161 is fitted over the middle cover 151, the end wall 165 and adjacent intermediate wall 167 abut the vertical walls 156, 157 of two middle covers 151 as shown in FIG. 2A; in addition, the post 158 extending from the height of the vertical wall 157 of the middle cover 151 fits into the hollow post 168 of the top cover 161.

[0030] In use, the locating pins 148 locate the base cover 141 on holes on the base plate 170. The centre bus-bar 104 is then mounted on a series of base covers 141 by locating holes on the bus-bar with the hollow bosses 143. The middle cover 151 is snapped, over the bus-bar 104, onto the base cover 141 by engaging the locating pins 154 with the slots 144 and the hollow posts 155 with pins 146, such that the contact fingers 130 of bus-bar 104 extend through the opening 153.

[0031] Now referring back to FIGs. 2A and 2D, the bus-bars 106 with the contact fingers 130 and supporting arms are formed and spaced identically to those on bus-bar

102. However, the bus-bar 106 is mounted on the base plate 170 so that the contact fingers 130 are on the left hand side of the bus-bar 106, as seen in FIG. 2A. In other words, bus-bars 102 and 106 are mounted on the base plate as mirror images of each other. In another embodiment, the bus-bars 102 and 106 are identical to each other.

[0032] As can be seen from FIGs. 2A-2D, the each bus-bar 102,104,106 has an additional respective body stacked thereunder. The additional bus-bar body allows the bus-bar assembly 100 to be configured for different current rating. For example, with an additional body of cross-sectional area $5 \times 40 \text{ mm}^2$, each bus-bar 102,104,106 having a combined sectional area of $10 \times 40 \text{ mm}^2$ is able to carry a rated current of more than 1200A. In another example, the additional busbar body may comprise a combination of 2.5mm thick and 5 mm thick bus-bars. As can also be seen from FIGs. 2A-2D, the stepped shoulder of the bushing 116 (under bus-bar 102 and 106) is higher than the stepped shoulder of the boss 143. This allows the contact fingers 130 of bus-bars 102 and 106 to be interspersed with the contact fingers 130 of bus-bar 104, yet maintaining spaced apart relations between the bus-bars 102,104,106 and contact fingers 130, as can be seen also in FIG. 1D. As can be seen from FIG. 2A, the bus-bars are mounted substantially parallel to but spaced apart from each other such that the contact fingers of the separate bus-bars are arranged in a cyclic order for 3-phase electricity. In one embodiment of the bus-bar assembly 100, the screws and nuts, for example, screws 114 and nuts 115, are M8 size or bigger. In another embodiment, the pitch of the contact fingers is about 95 mm when the three bus-bars 102,104,106 are assembled on the base plate 170; the corresponding pitch of the mounting holes on the body of each bus-bar 102,104,106 is also about 95 mm. In another embodiment, the mounting holes on the body of each bus-bar are of unequal pitch but are mirror-images about the centre of each respective bus-bar, so that they are equi-distances from the imaginary mirror. In either embodiment, the corresponding mounting holes on the base plate 170 are symmetrical about the centre of the base plate 170. In yet another embodiment, the base plate is galvanized steel of about 1.5 mm thickness, or more.

[0033] In one embodiment of the present invention, the material of the bus-bar 102,104,106 is high-conductivity copper. In one embodiment of the bus-bar, the copper bus-bar 102,104,106 is tinned, for example, to a thickness of about 2 to about 5 micron

to minimize surface oxidation. In another embodiment of the bus-bar, the bus-bar 102,104,106 is stamped or cut out from a plate or strip, and the vertical and horizontal sections are formed by bending, such as, by press forming or die forming. Preferably, the copper for use in the present invention is half-hard temper and has a corresponding yield strength for cold forming. This hardness/yield strength allows the fingers 130 and supporting arms/segments to be formed and bent with minimum strain and stress discontinuities, such as microscopic cracks, in the bent section, yet providing sufficient rigidity to the contact fingers, supporting arms/segments and the entire bus-bars. In yet another embodiment of the bus-bar, each bent section is formed with a bend radius of at least half the thickness of the bus-bar 102,104,106; to reduce stress and strain concentration at the bend radius, the corners of the section to be formed by bending are made with a radius of at least half the bus-bar thickness, for example, by drilling holes on the bus-bar before each bus-bar being is being formed into the shapes shown above.

[0034] In one embodiment of the present invention, the material of the bushings 116, spacers 117, washers 118 and base covers 141 is flame-retardant and self-extinguishing thermoplastics, such as, polycarbonate, polyamide, polybutylene terephthalate, polyethylene terephthalate, polyester and so on. In addition, the middle covers 151 and top covers 161 are also made of such flame-retardant and self-extinguishing thermoplastics.

[0035] As shown in FIGs. 1C and 1D, the base plate 170 is formed with two U-shaped channels. The height the U-shaped channel is selected so that the height of the inlet contact points of the CBs matches the contact fingers 130 of the bus-bars 102,104,106. In another embodiment, a DIN rail is used to mount a CB 190 on the base plate; the corresponding height of the U-shaped channel is lower than that in the first embodiment. In another embodiment, the U-shaped channel is made up of two U-shaped channels, that is, with a removable U-shaped channel mountable on the U-shaped channel which is integrally formed with the base plate 170. In yet another embodiment, there is an adapter plate disposed between the U-shaped channel formed on the base plate 170 and a DIN rail for mounting a CB.

[0036] With the present invention, the bus-bar assembly 100, together with the short-circuit bar 108 and 8 CBs, was found to withstand short-circuit testing of 30kA alternating current for 3 seconds and 50kA for one second according to the procedure specified under IEC 60439-1 or BS EN 60439-1 for an assembly that was rated at 630A. During testing, the short-circuit current reached a peak of about 105kA. As is known, the peak in the test current dropped quickly; the transient fluctuations in the short-circuit current created a tremendous amount of vibration to the bus-bars 102,104,106. In addition, the short-circuit current flow during testing created very strong magnetic and electric fields around each bus-bar; due to proximity of the bus-bars, the adjacent bus-bars experienced tremendous amount of attractive or repulsive force. The bus-bars 102,104,106 were also found to meet 8 other tests specified under IEC 60439-1, for example, temperature rise test due to the short-circuit current; dielectric or flashover test; clearance and creep test; and earth protection test, and so on.

[0037] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the invention. For example, one or two additional neutral bus-bar may be added to the bus-bar assembly 100 so that single-phase and three-phase electricity may be distributed directly from the distribution panel of the present invention.

CLAIMS:

1. A bus-bar assembly comprising:
a bus-bar body for each of three phases of electricity; wherein each bus-bar body has contact fingers being integrally formed and bent, together with the contact finger supporting members, from the respective bodies, so that the three bus-bars are operable to be placed substantially parallel to and apart from each other, with the contact fingers of the bus-bars being interspersed and ordered in a cyclic manner for 3-phase electricity, and each contact finger is dimensioned to both fit and engage with an input point of an associated circuit breaker (CB) for electricity distribution.
2. A bus-bar assembly according to claim 1, wherein the bus-bars are mounted on a base plate such that two peripheral bus-bars are mounted higher from the base plate than the centre bus-bar.
3. A bus-bar assembly according to claim 2, wherein the two peripheral bus-bars are substantially identical to each other but are mounted as mirror images of each other.
4. A bus-bar assembly according to claim 2 or 3, wherein the heights of the peripheral bus-bars are predetermined by a height of a shoulder of a stepped bushing whilst the height of the centre bus-bar is predetermined by a height of a shoulder of a stepped boss.
5. A bus-bar assembly according to claim 4, wherein the heights of the peripheral and centre bus-bars are varied by adding one or more spacers between each shoulder of the stepped bushing or boss and relevant body of the bus-bar.
6. A bus-bar assembly according to any one of the preceding claims, wherein each section of three contact fingers associated with the three separate bus-bars for electricity distribution through a circuit breaker is separated by a cover.
7. A bus-bar assembly according to claim 6, wherein each cover comprises a base cover, two middle covers and a top cover.

8. A bus-bar assembly according to any one of claims 4-7, wherein the stepped boss is on the base cover.
9. A bus-bar assembly according to claim 7 or 8, wherein each middle cover has an opening through its U-shaped body and two middle covers are operable to be mounted on the base cover as mirror images of each other so that: the contact fingers of the centre bus-bars extend through a combined opening formed by the openings of the middle covers in abutment, and the contact fingers of the two peripheral bus-bars are disposed on each of the two sides of the contact fingers associated with the centre bus-bar, and each contact finger is electrically insulated from each other by vertical walls on the U-shaped body.
10. A bus-bar assembly according to any one of the preceding claims, further comprising one or more additional body/bodies of the bus-bars, so that the current rating of the bus-bar assembly is varied according to a desired current density.
11. A bus-bar assembly according to any one of the preceding claims, wherein the bus-bars are made of high-conductivity copper, whose surfaces are tinned to minimize oxidation.
12. A bus-bar assembly according to claim 11, wherein the copper is half-hard temper so that the contact fingers and the finger' supporting members are operable to be formed and bent with minimum stress and strain discontinuities, yet maintaining sufficient rigidity.
13. A bus-bar assembly according to any one of claims 4-12, wherein the bushings, covers or washers are made of flame-retardant and self-extinguishing thermoplastics.
14. A bus-bar assembly according to any one of claims 2-13, wherein each bus-bar is removably mounted on the base plate with at least M8 size screws, which are disposed on a pitch of at least about 95 mm.

15. A bus-bar assembly according to any one of the preceding claims, further comprising a neutral phase bus-bar.
16. A kit for an electricity distribution panel, the kit comprising:
two types of bus-bars, wherein each bus-bar comprises a body and each body has contact fingers being integrally formed and bent, together with the contact finger supporting members, from the respective body, so that the bus-bars are operable to be mounted substantially parallel to and apart from each other, with the contact fingers of the bus-bars being interspersed and ordered in a cyclic manner for 3-phase electricity, and each contact finger is dimensioned to both fit and engage with an input point of an associated circuit breaker (CB) for electricity distribution.
17. A kit according to claim 16, further comprising electric insulators for use in mounting each bus-bar on a base plate by means of screws and nuts.
18. A kit according to claim 17, wherein the electric insulator is a hollow bushing or hollow boss, said hollow bushing or boss has a stepped shoulder.
19. A kit according to claim 18, further comprising one or more spacers operable to cooperate with the stepped shoulder.
20. A kit according to claim 18 or 19, wherein the hollow boss is associated with a base cover for a centre bus-bar that is operable to be mounted in between two peripheral bus-bars, whilst the hollow bushings are associated with the peripheral bus-bars.
21. A kit according to claim 20, wherein the base cover has an inter-lockable middle cover and a top cover inter-lockable with the middle cover.
22. A kit according to any one of claims 18-21, wherein the bushing, boss, spacer, base cover, middle cover or top cover is made of a flame-retardant and self-extinguishing thermoplastic.

23. A kit according to any one of claims 16-22, further comprising a neutral phase bus-bar for single phase electricity distribution.