

ELECTRIC CABLE CONNECTION

The invention relates to an electric cable connection for a single or multi-core energy and control cable, in which the electrically insulating and sealing coating is produced in a known manner by means of a cast resin or shrink sleeve. With such a cable connection (DE 35 33 375 C2) it is known to surround the cores in the region of the connectors with a dimensionally stable layer of inorganic and/or ceramic fibre material and to enclose the layer with a heat-shrinkable sleeve covering the core insulation. The layer of fibre material must be fire-resistant and can consist of a winding or a moulded body.

With such cable connections the essentially dimensionally stable layers shall be preserved in case of fire and shall prevent any contact between the cores which results in short-circuits when the plastic parts of the cable connection have already melted and/or been burned. The danger of this harmful contact of the cores results due to the mechanical forces caused by the thermal linear deformations, and can be reduced if the cable cores are secured in their positions, spaced apart by known devices (DE 90 04 349 U1).

However, in case of high thermal loads cable connections of this type have not shown sufficient resistance and workability.

Also, cable connections became known where heat-shrinkable sleeves made of self-extinguishing material are used for a certain fire protection. However, in case of fire these cannot withstand high thermal loads either. They burn completely when exposed to flames for a certain period of

time, and then no longer guarantee the workability of the cable connection. Known cast resin moulding materials, which are used with additives for self-extinguishing, also display only a limited effectiveness in case of fire and are not suited to meet the high requirements set out in the relevant standards IEC 331 or DIN 4102 part 12.

These plastics are mainly equipped with a halogenated flame proofing agent and antimony trioxide as synergists. It is also known to equip the plastics with halogen-free flame proofing agents such as, e.g. hydroxides or also phosphor compounds. Through these systems it can be achieved, in connection with further flameproof materials such as mica tape windings etc. on the individual cores, that the cables are flameproof for a sufficient period of time.

The high requirements laid down for the fireproofing and workability of the cables and/or cable connections, which are required especially for public buildings and parts of buildings such as e.g. elevator shafts, or also on oil-drilling platforms, necessitate a specific design of the cable connections. This design ensures that the insulation (FE) or functioning (E) of the cable connections is preserved for at least 30 up to 180 minutes, in dependence on the respective local conditions.

A cable connection according to the above cited DE 35 33 375 C2, in which a fire-resistant fibre material is arranged below the heat-shrinkable sleeve of the core connection, does not reliably meet the required workability, owing to the high thermal and mechanical loads occurring in case of fire.

Also known are solutions with extensively filled protective winding whose disadvantage it is that they fuse under the

influence of heat. In this way a fireproof layer is formed which is, however, porous. Despite the good thermal resistance of this layer, it has the disadvantage that the occurring moisture of the combustible components of the cable and/or cable connection diffuses into this porous layer, and that thereby conductive paths are formed between the individual cores or one or several cores and the earth potential, which may result in short circuits.

Furthermore, experience has shown that under the effect of the strong mechanical forces occurring in case of fire due to the influence of heat, and despite the use of spacing devices, the single core connections are displaced with respect to each other or the layers of fibre material can be compressed such that a reliable electric connection without short circuits cannot be guaranteed.

A further considerable disadvantage of this known cable connection resides in the fact that the installation is very complicated and requires a lot of time. Both the individual windings around the single core connections and also the entire cable connection make it necessary, in particular with the complicated assembly situations on site which are often given, to work with great care, which in turn requires a lot of time, in order to produce a safe and reliable cable connection. Quite often the cable carrying elements are located in places that are difficult to access, e.g. directly under the ceiling or in the corners of a room, and the installer then has to carry out the different work steps in very cramped conditions. In particular the application of flame proofing windings made of fire-resistant fibre material to the core connections has proven complicated since this requires a sufficiently large installation space. This requirement can often not be met at such locations.

From these circumstances the object of the invention is derived in that a cable connection is to be created which fully meets the high fire protection requirements for public buildings and similar places, and simultaneously permits a simple and also safe installation. In this context the fundamental conditions are to be met, i.e. that the single core connections are reliably protected against high thermal loads occurring in case of fire. To this end the individual core connections are protected against each other by means of suitable fire-resistant moulded parts in such a way that despite the fire products, essentially consisting of water vapour and other conductive gases, released in case of fire on account of the thermal disintegration of the components insulating against dampness and ensuring mechanical stability, conductive contacts, in particular short circuits between the individual cores are reliably prevented. In this way it is achieved that the cable connection still achieves a considerable service life even under the direct influence of fire.

Thus, a considerable intact service life of the cable connection can be achieved with the highest degree of safety even in case of fire under the influence of very high temperatures. According to the teaching conveyed by the invention this is realised in that the single core connections are insulated against each other not only against dampness, but are additionally protected by a highly fire-resistant moulded part which does not absorb moisture. These cable connections can be manufactured by using both the cast resin technique and the shrinkage technique.

The above described requirements are met by the cable connection according to the invention, in which - proceeding

from the described prior art - besides the electrically insulating and damp-proofing protection, there is arranged over each electric core connection an electrically insulating, damp-repellent, high-temperature-resistant and thus fire-resistant moulding remaining dimensionally stable under the action of heat as a casing for each individual core connection permanently spaced apart by heat-resistant spacers.

Spacers as such are known, e.g. from DE 90 04 349 U1. The known spacers are in most cases injection moulded parts made of plastic that is not heat-resistant or flameproof.

Cable connections having a protection against thermal loads have also become known through further publications, apart from the above cited patent specification.

With the known cable connections the cable sheaths and core insulations, as well as the heat-shrinkable sleeves and cast resin moulding materials are burned and thus deformed in case of fire, owing to the high thermal loads and the mechanical forces which may occur simultaneously, so that short circuits can result very quickly between the cores and also between one or several cores and the surroundings, the earth potential. In that case the functioning of the cable connection is no longer guaranteed.

Quite often this also applies to cable connections where heat-shrinkable sleeves made of self-extinguishing material are used for insulation and a certain fire protection. However, these cannot effectively resist the high thermal loads in case of fire too. When subjected to flames for a certain period of time they burn and the workability of the cable connection is then no longer given. The plastics which

can be used to this end, and the addition thereto of flame proofing agents, is described in the technical literature, as well as in DE 14 94 922 A1 and DE 15 69 123 A1.

Cast resin moulding materials as insulating materials with additives for self-extinguishing are known, too. However, as mentioned, these exhibit a limited stability in case of fire and are not suited to meet the requirements set out in the relevant standards IEC 331 or DIN 4102 Part 12.

The plastics to be used for the cable connections according to the invention must be equipped with a halogenated flame proofing agent and antimony trioxide as synergists. By equipping the plastics with halogen-free flame proofing agents such as, e.g. hydroxides or phosphor compounds, this purpose can be achieved as well. Through these systems it is achieved that, in connection with further flameproof materials such as mica tape windings etc. on the individual cores, the cables are made flameproof for a sufficient period of time.

The embodiment according to DE 35 33 375 C2 - corresponding to EP 0 216 613 A2 - cited above with respect to the prior art, does not meet the requirements laid down either, since the fireproof fibre material used therein under the heat-shrinkable sleeve can also not stand higher flame loads, on account of its fibre structure. This became obvious from practical tests as the structure cannot stand the thermal and mechanical loads.

There are also known core connections with extensively filled protective windings. They have the great disadvantage that the protective winding can fuse because of the fire load, in order to form a fire-resistant, porous layer. This layer has

a certain thermal resistance, but it simultaneously has the tendency to store the moisture of the flammable components of the cable and/or the cable connection in this layer and thus form conductive paths between the single cores or one or more cores and the earth potential, which can result in short circuits.

From the GB 2 295 501 A a high-voltage cable connection with a cast resin sleeve further became known, in which the connectors of the single cores are surrounded by a mastic filling which is covered by a shrink sleeve (RAYVOLVE). The single core connections are fixed in position relative to each other by means of spacers, and inside the cast resin sleeve there is located a dimensionally stable insulating sleeve having a wall thickness of 3 to 10 mm and consisting of a polymer such as PE or PVC, acrylic or another polymer.

However, it cannot be expected that this design is resistant and/or operable in case of fire, for which reason this publication need not be considered in the present case.

Further disadvantages of the known cable connections are to be seen in that their installation is complicated and therefore requires a lot of time. It must be possible to install both the individual windings around the single core connections and also the entire cable connection safely and reliably, even in case of obscure fitting positions on site. Quite often the cable carrier elements are located at places that are difficult to access, e.g. directly under the ceiling or in the corners of a room, and the installer then has to carry out the different work steps in very cramped conditions. In particular the application of flame proofing windings made of fire-resistant fibre material to the core

connections has proven complicated since this requires more space than is usually available.

The invention overcomes these difficulties by creating a cable connection which fully meets the high fire protection requirements for public buildings and similar places, and simultaneously permits a simple and also safe installation.

Cast resin technique:

In order to assemble a cast resin connecting sleeve the ends of the cables to be connected are carefully stripped and, after the removal of the structural elements of the cable, the single cores are uncovered and prepared for the application of the connector. Insulating mouldings made of fire-resistant material are slid onto the respective single cores of a cable, and subsequently the ends of the single cores are electrically connected to each other through compression or screw joints, using the conventional technique. Subsequently, the fire-resistant mouldings are slid onto these connection sections and the intermediate spaces between the moulded parts and the core insulations are sealed with a filler and/or sealing compound in such a manner that a penetration of the cast resin during casting is reliably prevented. When all core connections have been produced in the described manner, spacers that are known per se, but are made of a material which is non-combustible and/or non-flammable and thus dimensionally stable under heat, and which does not absorb moisture, can be used in an advantageous embodiment of the cable connection to space apart the mouldings on the core connections. The spacers are elongated moulded parts having a multi-pointed star-shaped or multiple U-beam-like design, and preferably extend along the cable axis on both sides beyond the single core connections.

Subsequently, the shell moulds of the cast resin set are mounted on the cable connection in the customary manner and fastened to the cable sheath. The shell moulds on the cable sheaths are also sealed in the well-known manner. Then the hardenable insulating moulding material is prepared in accordance with the manufacturer's instructions and poured into the shell mould. After the hardening of the cast resin the cable connection can stand high mechanical and electrical loads and is guaranteed to be fire-resistant for a longer period of time.

Shrinkage technique:

The cable ends are prepared for connection in a manner similar to that of the cast resin technique. The difference resides in the fact that not only a fire-resistant moulding, but also a heat-shrinkable sleeve is put onto the single cores in the so-called parking position. After the electric core connection has been produced in the customary manner by using connectors, the heat-shrinkable sleeve is slid over the connector as an electrically insulating and damp-proofing casing, and is heat-shrunk onto the connector by means of a heat source, hot air or flame. In this context the heat-shrinkable sleeve is dimensioned such that after shrinking it extends onto the respective core insulations on both sides. Subsequently, the fire-resistant moulding is positioned on the heat-shrinkable sleeve and, if necessary, fixed in place by suitable means, e.g. a piece of insulating tape. In an advantageous embodiment of the cable connection a layer of mica tape may additionally be wound onto the heat-shrinkable sleeve of the core connections.

When the splice, the entirety of the core connections, has been produced, the single core connections can be fixed in

place spaced apart from each other in the above described manner by using a fire-resistant spacer, and then a further heat-shrinkable sleeve is shrunk onto the splice. This sleeve is dimensioned such that it extends onto the cable sheaths on both sides. A further advantageous design of the cable connection consists in that an additional fire-resistant moulded part is slid onto the splice and fixed in place before the outer heat-shrinkable sleeve is shrunk. This additional fire-resistant moulded part is dimensioned such that the splice is completely covered on both sides. After the fire-resistant sleeve according to the invention has cooled down to room temperature, it can stand full mechanical and electrical loads.

The used fire-resistant moulded parts for insulating the single core connections and the auxiliary means for spacing apart the same consist of an electrically insulating, damp-repellent, high-temperature-resistant material which is dimensionally stable under heat, preferably made of a fireproof ceramic and/or a high-temperature resistant quartz glass or quartz substance.

In the cable connections produced by means of the shrinkage technique the heat-shrinkable sleeves are advantageously equipped with a flame proofing agent.

A further advantage results if the inner sleeves are arranged not one directly above the other, but offset in longitudinal direction.

Due to the fact that the inner sleeves are sealed off one against the other and, moreover, in their entirety, not only in an electrically insulating and damp-repellent manner, but are also reliably protected against the influence of fire,

the entire cable connection is at the same time highly resistant to fire. For instance, the test criteria of the high fire loads for public buildings of more than 90 minutes at 1000°C (preservation of workability), and e.g. for oil drilling platforms of more than 180 minutes at 750°C (preservation of insulation), could be met in case of the cable connection.

By using the cable connections according to the invention the complete exchange of already laid cables can be avoided when extending buildings or repairing mechanical damages, without the preservation of the insulation or workability of the existing systems being impaired. Thereby, at the same time a lot of material is saved and the maintenance costs reduced.

The individually necessary work steps during the manufacture of the cable connection according to the invention can be easily carried out also at places that are difficult to access and in small spaces, so that compared to the previous technique the installation is not only considerably facilitated but, after all, also becomes safer.

Due to the use set forth in the invention, i.e. of exactly dimensioned, insulating and sealing heat-shrinkable sleeves, as well as the moulded parts made of fire-resistant materials and/or the auxiliary means for spacing apart the inner sleeves, which are also made of fire-resistant materials in relative small sizes, the finished cable connection produced with the shrinkage technique can be very slender, is easy to produce and can easily be disassembled, even in densely occupied cable trays.

The cable connections produced in this manner by using the shrinkage technique and the cast resin technique are both

electrically safe and protected in mechanical respect as well as against high thermal loads in case of fire.

The embodiments of the invention and their special features are illustrated in the drawings and explained in greater detail hereinafter.

- Fig. 1 shows a single core connection of the cable connection produced with the cast resin technique, prepared for installation and partially mounted;
- Fig. 2 shows a partial section of an inner sleeve on the connector of a single core for a cast resin shell mould;
- Fig. 3 shows a completely installed cable connection with four single cores in a cast resin shell mould, into which a hardenable insulating substance may be poured.
- Fig. 4 shows a connection of three single cores prepared for assembly using the shrinkage technique and partially assembled;
- Fig. 5 shows a partial section of the details of an inner sleeve on the connector of a single core for a shrink sleeve;
- Fig. 6 shows a partial section of a cable connection with several single cores as a fully shrunk and operable shrink sleeve.

A fire-resistant cable connection according to the invention is assembled using the cast resin technique in the following work steps:

The outer sheaths 1 of the cables to be connected are removed as specified in the assembly instructions of the manufacturer of the sleeves. Thereupon the single cores 8 are separated to create free space for the installation work, as it is obvious from Fig. 1. The single cores are then stripped. An inner insulating tube 2 is put onto each of the single cores to be connected in a so-called "parking position" and, subsequently, the single strands 13 are electrically connected to each other by means of the provided connectors 5 - in Fig. 1 to 3 chosen as compression joints - so that then the inner insulating tubes 2 can be slid onto the connector to a central position, as it is obvious from Fig. 2.

Now the annular hollow space between the inner insulating tube 2 and the core insulation 8 can be closed at both ends with sealing mastic 11. It is thus prevented that prior to hardening the insulating substance penetrates into this hollow space, between the ends of the insulating tube and the core insulations, and flows under the insulating tubes. It is thus avoided that in case of fire a great mechanical load is applied to the region where the single cores are connected.

After all inner insulating tubes 2 have been sealed in this way, the cast resin shell mould 12 is put around the cable connection section, fastened and sealed, so that the hardenable insulating substance can be poured into the same. After the hardening period the fire-resistant cable connection can be electrically and mechanically loaded.

When employing the shrinkage technique, it is to be proceeded as follows when assembling a fire-resistant cable connection according to the invention:

Similar to the cast resin technique the cable ends to be connected must be prepared by stripping, uncovering and separating the same, so that first the outer insulating tube 9 and the outer heat-shrinkable sleeve 6 can be slid onto one of the cable ends, as it is evident from Fig. 4.

Advantageously, according to the embodiment depicted in this Fig. 4 the connection sections of the single cores 8 can be arranged in a manner offset from each other in longitudinal direction. Thereupon, one inner insulating tube 2 and one inner heat-shrinkable sleeve 3 each is put onto each single core 8 to be connected in a "parking position". Then the single strands 13 can be electrically connected in the customary manner by means of their connectors 5.

Subsequently, the inner heat-shrinkable sleeves 4 are shrunk onto the connectors 5 by means of a heat source in such a way that the heat-shrinkable sleeves 4 sufficiently cover the insulation of the single cores on both sides. According to the invention, a fire-resistant tape winding 10, e.g. made of mica tape, can be advantageously applied over these heat-shrinkable sleeves 4. Thereupon, the inner insulating tubes 2 are slid over the heat-shrinkable sleeves 4 so as to sufficiently cover these on both ends, and then the outer insulating tube 9 is positioned over the entire connecting region such that all inner sleeves are evenly covered on both sides.

Finally, the outer heat-shrinkable sleeve 9 is shrunk in such a way that the outer insulating tube is evenly covered on

both sides and a tight connection is achieved between the outer heat-shrinkable sleeve 9 and the outer sheath 1. If it is expected that only slight mechanical loads are applied to the cable connection, even in case of fire, the use of the outer insulating tube can be dispensed with so as to produce a particularly slender cable connection.

CLAIMS

1. A cable connection for a single or multi-core power and control cable, in which the electrically insulating and sealing coating consists of a cast resin or shrink sleeve (12, 9) and in which the cores (8) in the region of the connector (5) are enclosed by a dimensionally stable coating (2), enclosed in turn by an outer sleeve covering the core insulation (1),

characterised in that

besides the electrically insulating and damp-proofing protection there is arranged over each electric core connection an electrically insulating, damp-repellent, high-temperature and thus fire-resistant moulding (2) remaining dimensionally stable under the action of heat as a casing for each individual core connection (5) permanently spaced apart by heat-resistant spacers.

2. A cable connection according to claim 1, characterised in that the dimensionally stable moulding (2) consists of a fireproof ceramic or a high-temperature-resistant quartz glass or quartz substance.

3. A cable connection according to claims 1 and 2, characterised in that the dimensionally stable, fire-resistant moulding (2) for coating each individual core connection (5) is formed of internally hollow moulded parts.

4. A cable connection according to claim 3, characterised in that preferably the internally hollow moulded parts are tubes.



5. A cable connection according to claims 1 and 2, characterised in that heat-resistant moulded parts having a multi-pointed star-shaped or multiple U-beam-like cross section are arranged for permanently spacing apart the core connections (8, 5).

6. A cable connection according to any of the preceding claims, characterised in that the single-core connections (5) are disposed along the cable axis in a manner offset from each other.

7. A cable connection produced by using the cast resin technique, according to claims 1 and 2, characterised in that the dimensionally stable and fire-resistant mouldings (2) slid onto the electric core connections (5) are sealed off against the core insulations (8) by means of a sealing mastic (11).

8. A cable connection produced by using the cast resin technique, according to claim 7, characterised in that the internal sleeves consisting of an electric connection (5) and the dimensionally stable, fire-resistant mouldings (2) sealed off against the core insulations (8), are spaced apart by heat-resistant moulded parts.

9. A cable connection produced by using the shrinkage technique, according to one of claims 1 to 6, characterised in that a flame proofing agent is added to the outer (6, 7) and the inner heat-shrinkable sleeves (3, 4), and that these are coated on the inside with a sealing compound, preferably a hot-melt adhesive.

10. A cable connection produced by using the shrinkage technique, according to claim 9, characterised in that the



shrink casing (9) of all core connections (5) is a moulded part having a hollow cross section.

11. A cable connection according to claim 10, characterised in that the inner heat-shrinkable sleeves (4) extend onto the insulation (8) of the individual conductors (13) on both sides, and are completely enclosed by the dimensionally stable and fire-resistant mouldings (2).

12. A cable connection according to claim 9, characterised in that the connectors (5) of the respective single cores (8, 13) are covered with a tape winding (10) made of a fire-resistant winding, preferably a mica tape winding, said winding being extended onto the core insulations (8) on both sides.