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(54) Electric cables.

(57) An electric cable with limited fire survival characteristics comprises at least one insulated conductor insulated with silicone rubber or other organic insulant that leaves an insulating inorganic residue on thermal breakdown and optionally a bare earth wire. A screening layer is formed by a laminate comprising a centre layer of mineral fibre cloth having one face formed by a layer of metal foil and the the other by a layer of organic material infusible below 200°C, preferably regenerated cellulose or cured isophalate polyester film. An extruded sheath of flame-retardant polymeric material contacts, but does not adhere to, the infusible film layer of the laminate.

This separation of the screening layer from the sheath ensures that it can be cut back for termination with negligible risk of damage to the conductor insulation and minimal risk of damage to the essential metal layer of the screening laminate. After it has been so cut back, the projecting end of the laminate may be turned back over the cut end of the sheath to expose a metal layer that is sufficiently supported to make an effective screen connection by mechanical means.

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This invention relates to electric cables for use in fire alarm circuits and other installations requiring maintanance of circuit integrity under fire conditions. In virtually all such applications, mineral-insulated cables of appropriate design will perform best, but in some of them a more limited fire survival capacity may be acceptable and such factors as ease of installation and modification may indicate the use of a polymeric-insulated cable with limited fire survival capacity.

Cables intended for such applications have been available for some years and British Standard BS 7629 has been adopted in respect of them. The current market leader (GB 1500121) uses silicone-rubber insulated conductors enclosed together with a bare earth wire in a composite sheath comprising a main structural sheath of a PVC compound lined with an aluminium foil/thermoplastic laminate. The aluminium foil faces inwards and must contact the earth wire and the thermoplastic layer faces outwards and ensures adhesion to the main structural sheath.

Because the aluminium foil in this cable is adhered fo the main structural sheath, the only practicable way of preparing the end of the cable for jointing or termination is to cut back the sheath and remove a length of it as a whole. It has been found that there is a risk that the cut-back edge of the tough composite sheath may sometimes be so sharp and burred that it may cause damage to the underlying insulation of relatively fragile silicone rubber, with a potential for electrical failure; and the design is entirely reliant on the reliability of the contact between the earth wire and the aluminium foil for effective electromagnetic screening.

It is therefore an object of the invention to provide an improved form of cable in which, without significant detriment to fire performance, the sheath and screening layer can be cut back separately and the screening layer can be terminated directly, without relying on its contact with an earth wire.

The cable in accordance with the invention comprises at least one insulated conductor which, or each of which, is insulated with a polymer-based insulant which leaves an insulating inorganic residue on thermal breakdown; optionally a bare earth wire; a screening layer which is a laminate comprising a centre layer of mineral fibre cloth having one face formed by a layer of metal foil and the the other by a layer of an organic film infusible below 200°C; and an extruded sheath of flame-retardant polymeric material which contacts, but does not adhere to, the organic film layer of the laminate.

Separation of the screening layer from the sheath ensures that it can be cut back for termination with negligible risk of damage to the conductor insulation and minimal risk of damage to the essential metal layer of the screening laminate. After it has been so cut back, the projecting end of the laminate may be turned back over the cut end of the sheath to expose a metal layer that is sufficiently supported to make an effective screen connection by mechanical means.

The conductors will normally be of copper, with or without a coating of tin (to facilitate contact) or nickel (to resist oxidation at high temperatures).

The insulant is preferably based on silicone rubber, conventional grades of which may be used; alternatively some heavily filled grades of ethylene-vinyl acetate copolymer, ethylene-propylene copolymer rubber and ethylene-propylene-diene terpolymer rubber can be used. Especially in the alternative case, the polymer-based insulant may if desired be supplemented by mica tape, glass fabric or other inorganic insulating material, preferably applied under the polymer-based insulant. Supplementary organic insulating materials that do not leave an insulating inorganic residue should normally be avoided.

The central layer of the laminate is preferably a woven glass fabric and its inner face preferably of aluminium foil, though copper foil can be used and may improve screening performance under fire conditions, at least in some circumstances.

The film layer of the laminate is preferably a preformed film adhered to the central layer of the laminate with an adhesive, but the use of a film formed from material coated from a liquid or plastic state is not excluded, provided the exposed surface of the film is smooth enough to avoid adhesion when the sheath is applied. Preferably, to minimise contribution to fire hazard, the film is substantially free from organically bonded halogen, sulfur, nitrogen and phosphorus. Preferably the film is selected from regenerated cellulose, cured polyesters (especially cured isophthalates) and polyesters melting above 200°C. In a few cases, polyimide film might be tolerated in spite of its substantial nitrogen content as it is available in thin film with excellent mechanical and low-adhesion properties. It will be understood that films that are similar in composition to the sheath are best avoided because of the difficulty of avoiding adhesion. If desired, a release agent (such as french chalk or silicone oil) can be applied to the outer face of the laminate before application of the sheath.

The laminate in tape form may be helically applied by a driven lapping head, preferably in-line with the extrusion process; but we prefer (when there are two or more conductors) to apply a tape of the laminate "tangentially" by running it in to the laying up die or equivalent from a stationary supply as the conductors are laid up together, so as to acquire a slow twist equivalent to the lay of the conductors.

Conventional flame retardant cable sheathing materials can be used; our preference is for PVC-based sheathing materials or for "LSF" compounds based on halogen-free polymers rendered fire-retardant with a filler (such as alumina trihydrate or magnesium hydroxide) that evolves water under fire

conditions, depending whether mechanical toughness or freedom from dark smoke or hazardous acid fumes under fire conditions has higher priority.

Example 1

A first cable in accordance with the invention comprises three 1.0mm^2 conductors of plain annealed copper insulated with a standard wire-coating grade of silicone rubber and appropriately colour-coded plus a bare earth wire of 1.0mm^2 tinned copper.

These are laid up together with a left-hand lay of 122mm and at the same time a 23mm-wide screening tape is run in to enclose the conductors. This tape is made of a laminate of glass fabric comprising a warp of 1730 ends per metre of 68 tex E-glass regularly interwoven with a weft of 1220 ends per metre of the same fibre, with one face (applied on the inside) covered by an 0.025mm thick pure aluminium foil and the other face covered by an 0.020mm thick regenerated cellulose foil, both bonded to the glass fabric by a thin layer of thermoset polyurethane adhesive. An extruded layer of a conventional "LSF" sheathing compound based on an ethylene/vinyl acetate copolymer filled with alumina trihydrate with a minimum average radial thickness of 0.90mm completes a cable that fully complies with the requirements of BS 7629 and from which the sheath can be easily cut back leaving the screening tape in place; the tape can subsequently be turned back over the cut end of the sheath and a sound electrical connection made to it, independently of the earth wire, by mechanical means, such as a pair of concave zinc alloy members with a radius of curvature of 8mm drawn together with screws.

Example 2

This is similar to Example 1 except that the sheath is made of a conventional hard sheathing grade of PVC.

Example 3

This is similar to Example 1 except that the regenerated cellulose layer is replaced with a layer of cured isophthatlate polyester film of the same thickness.

Claims

1 An electric cable comprising at least one insulated conductor which, or each of which, is insulated with a polymer-based insulant which leaves an insulating inorganic residue on thermal breakdown; optionally a bare earth wire; a screening layer which is a laminate comprising a centre layer of mineral fibre cloth having one face formed by a layer of metal foil and the the other by a layer of an organic film infusible below 200°C; and an extruded sheath of flame-retardant polymeric material which contacts, but does not adhere to, the organic film layer of the laminate.

2 A cable as claimed in claim 1 in which the insulant is silicone rubber.

3 A cable as claimed in claim 1 in which the organic film layer is selected from regenerated cellulose, cured polyesters and polyesters melting above 200°C.

4 A cable as claimed in claim 2 in which the organic film layer is selected from regenerated cellulose and cured isophthalate polyesters.

5 A cable as claimed in any one of the preceding claims in which the laminate is run as a tape in to the laying up die or equivalent as the conductors are laid up together, so as to acquire a slow twist equivalent to the lay of the conductors.

6 A cable as claimed in any one of the preceding Claims in which the sheath is of an "LSF" compound based on a halogen-free polymer rendered fire-retardant with a filler that evolves water under fire conditions.

7 A cable as claimed in any one of the preceding claims in which the projecting end of the laminate has been turned back over a cut end of the sheath to expose a metal layer to which a screen connection has been made by mechanical means.