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PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: GEORGE ALEXANDER DODD

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COMPLETE SPECIFICATION

Improvements in or Relating to Telecommunication Cables

We, BRITISH INSULATED CABLES LIMITED, a BRITISH COMPANY, of Norfolk House, Norfolk Street, London W.C.2., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to telecommunication cables of the kind comprising a multiplicity of plastics insulated conductors enclosed within a water-proof sheath. If such cables, whether buried in the ground or drawn into ducts, become locally damaged to an extent to allow water to enter through the damaged sheath, the water will travel along the cable through the interstices between the insulated conductors and between the conductors and the sheath and so will have an adverse effect upon the electrical characteristics of the whole cable length.

With the object of limiting the extent to which water that has entered through a defective sheath or a defective joint casing may travel along the cable, it has been proposed to incorporate barriers at intervals along the length of the cable, such barriers locally filling the interstices between the insulated conductors and those between the assembly of conductors and the cable sheath. Although such barriers limit the length of cable damaged electrically or otherwise by the entry of water to the distance between the two barriers between which entry of water has occurred, accurate localisation of the damage will be difficult, unless the barriers are closely spaced. The introduction of such barriers especially when they are closely spaced in itself produces an adverse effect upon the electrical characteristics of the cable, in particular, the inter-

conductor capacitance, as compared with a similar cable without barriers. This adverse effect may be such as to preclude the use of a cable for carrier systems. Accordingly a complete solution to the problem of preventing travel of water along a multiple conductor plastics insulated telecommunication cable has not hitherto been found.

By the present invention we provide a novel form of plastics insulated multiple conductor tele-communication cable which has electrical characteristics equivalent to those of barrier-less cables of known construction but which prevents water from travelling along the cable away from its point of entry into the cable.

Our novel form of cable comprises a multiplicity of conductors each having a dielectric of plastics material of cellular form, a water-proof sheath enclosing the insulated conductors and, filling the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a water-impermeable medium which will not drain under the influence of gravity or such hydrostatic pressure as may arise in the event of damage to the cable sheath but which will permit relative sliding movement of the cellular plastics insulated conductors over one another during such bending of the cable as occurs during manufacture and installation of the cable.

The conductors in our novel cable may be twinned before being laid up or otherwise assembled together to form a multiple conductor cable but we prefer to arrange the conductors in quads as this results in a smaller aggregate volume of interstices within the cable as compared with a cable having the same number and size of conductors associated in pairs.

[Price 4s. 6d.]

By making the conductor insulation of cellular material, preferably of cellular polythene or cellular polypropylene, by which we mean of a material containing large numbers of non-communicating cells, the capacitance between the conductors of each pair or that between the conductors of each quad is reduced to an extent substantially to compensate for the increase in capacitance due to the presence of filling compound in the interstices throughout the cable length.

The composition used to fill the interstices within the cable should be one which, in addition to having the characteristics previously referred to, is compatible with the particular insulating material used to insulate the individual conductors and with the material of the sheath, has a high coefficient of bulk resistivity, a high dielectric strength, and preferably a low electrical permittivity.

Examples of compositions suitable for use in cables whose conductors are insulated with either cellular polythene or cellular polypropylene are:

- a) Mixtures of whiting and castor oil
- b) microcrystalline petroleum waxes
- c) mixtures of microcrystalline petroleum waxes and oils, for instance petroleum jelly
- d) low molecular weight, high Melt Flow Index polyethylenes of a semi-solid or greaselike nature
- e) mixtures of petroleum jelly, microcrystalline petroleum waxes, polyisobutylene and aluminium stearate.

The filling composition may be introduced into the cable by a vacuum impregnation process as a final step in the manufacture of the cable but we prefer to introduce it in stages as the cable is being manufactured, for instance as a step preceding or immediately following the application of each layer of conductors or pairs or quads to the underlying assembly of conductors, pairs or quads. In this latter case the filling composition is introduced into the cable at each die which is modified to provide an annular space allowing the composition to flow completely around each layer of conductors. After removing any excess filling composition by means of a final snugging die, we may apply about the outer layer of conductors a lapping of insulating tape, preferably of paper, to form a layer of insulating material impregnated with the filling composition, which layer will itself form a barrier to the ingress of water.

The present invention provides a telecommunication cable which has a fully-filled cross-section from end to end of the cable length with no interstices between the insulated conductors or between them and the cable sheath along which water or water vapour can pass and in which the effective permittivity between conductors of any pair

approximates to that between those of a pair in a telecommunication cable of similar form but in which the conductors are insulated with non-cellular plastics material of the same kind and are enclosed in an air-filled cable sheath. By way of example the effective permittivity between conductors of any pair in an air-filled telecommunication cable whose conductors are arranged in quads and are insulated with non-cellular polyethylene having a permittivity of 2.3, will be in the region of 1.8 to 1.9. The same effective permittivity will be provided between conductors of any pair in a cable of similar form in accordance with the present invention where the cellular plastics insulation of the conductors has a permittivity of 1.6 and the interstices in the cable are filled with petroleum jelly having a permittivity of 2.4.

WHAT WE CLAIM IS:—

1. A telecommunication cable comprising a multiplicity of conductors each having a dielectric of plastics material of cellular form, a water-proof sheath enclosing the insulated conductors and, filling the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a water-impermeable medium which will not drain under the influence of gravity or such hydrostatic pressure as may arise in the event of damage to the cable sheath but which will permit relative sliding movement of the cellular plastics insulated conductors over one another during such bending of the cable as occurs during manufacture and installation of the cable.

2. A telecommunication cable comprising a multiplicity of conductors each having a dielectric of plastics material of cellular form, a water-proof sheath enclosing the cellular plastics insulated conductors and, filling the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a water-impermeable medium which will not drain under the influence of gravity or such hydrostatic pressure as may arise in the event of damage to the cable sheath but which will permit relative sliding movement of the cellular plastics insulated conductors over one another during such bending of the cable as occurs during manufacture and installation of the cable, the permittivity of the cellular plastics material and the permittivity of the water-impermeable medium being such that the effective permittivity between the cellular plastics insulated conductors of any pair is approximately the same as the effective permittivity between the conductors of a pair in a cable of similar form in which each of the conductors has a dielectric of plastics material of the same kind but of non-cellular form and in which the interstices are air-filled.

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insulated



insulated

By making the conductor insulation of cellular material, preferably of cellular polythene or cellular polypropylene, by which we mean of a material containing large numbers of non-communicating cells, the capacitance between the conductors of each pair or that between the conductors of each quad is reduced to an extent substantially to compensate for the increase in capacitance due to the presence of filling compound in the interstices throughout the cable length.

The composition used to fill the interstices within the cable should be one which, in addition to having the characteristics previously referred to, is compatible with the particular insulating material used to insulate the individual conductors and with the material of the sheath, has a high coefficient of bulk resistivity, a high dielectric strength, and preferably a low electrical permittivity.

Examples of compositions suitable for use in cables whose conductors are insulated with either cellular polythene or cellular polypropylene are:

- a) Mixtures of whiting and castor oil
- b) microcrystalline petroleum waxes
- c) mixtures of microcrystalline petroleum waxes and oils, for instance petroleum jelly
- d) low molecular weight, high Melt Flow Index polyethylenes of a semi-solid or greaselike nature
- e) mixtures of petroleum jelly, microcrystalline petroleum waxes, polyisobutylene and aluminium stearate.

The filling composition may be introduced into the cable by a vacuum impregnation process as a final step in the manufacture of the cable but we prefer to introduce it in stages as the cable is being manufactured, for instance as a step preceding or immediately following the application of each layer of conductors or pairs or quads to the underlying assembly of conductors, pairs or quads. In this latter case the filling composition is introduced into the cable at each die which is modified to provide an annular space allowing the composition to flow completely around each layer of conductors. After removing any excess filling composition by means of a final snugging die, we may apply about the outer layer of conductors a lapping of insulating tape, preferably of paper, to form a layer of insulating material impregnated with the filling composition, which layer will itself form a barrier to the ingress of water.

The present invention provides a telecommunication cable which has a fully-filled cross-section from end to end of the cable length with no interstices between the insulated conductors or between them and the cable sheath along which water or water vapour can pass and in which the effective permittivity between conductors of any pair

approximates to that between those of a pair in a telecommunication cable of similar form but in which the conductors are insulated with non-cellular plastics material of the same kind and are enclosed in an air-filled cable sheath. By way of example the effective permittivity between conductors of any pair in an air-filled telecommunication cable whose conductors are arranged in quads and are insulated with non-cellular polyethylene having a permittivity of 2.3, will be in the region of 1.8 to 1.9. The same effective permittivity will be provided between conductors of any pair in a cable of similar form in accordance with the present invention where the cellular plastics insulation of the conductors has a permittivity of 1.6 and the interstices in the cable are filled with petroleum jelly having a permittivity of 2.4.

WHAT WE CLAIM IS:—

1. A telecommunication cable comprising a multiplicity of conductors each having a dielectric of plastics material of cellular form, a water-proof sheath enclosing the insulated conductors and, filling the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a water-impermeable medium which will not drain under the influence of gravity or such hydrostatic pressure as may arise in the event of damage to the cable sheath but which will permit relative sliding movement of the cellular plastics insulated conductors over one another during such bending of the cable as occurs during manufacture and installation of the cable.

2. A telecommunication cable comprising a multiplicity of conductors each having a dielectric of plastics material of cellular form, a water-proof sheath enclosing the cellular plastics insulated conductors and, filling the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a water-impermeable medium which will not drain under the influence of gravity or such hydrostatic pressure as may arise in the event of damage to the cable sheath but which will permit relative sliding movement of the cellular plastics insulated conductors over one another during such bending of the cable as occurs during manufacture and installation of the cable, the permittivity of the cellular plastics material and the permittivity of the water-impermeable medium being such that the effective permittivity between the cellular plastics insulated conductors of any pair is approximately the same as the effective permittivity between the conductors of a pair in a cable of similar form in which each of the conductors has a dielectric of plastics material of the same kind but of non-cellular form and in which the interstices are air-filled.



3. A telecommunication cable comprising a multiplicity of conductors each having a dielectric of plastics material of cellular form, a water-proof sheath enclosing the insulated conductors and, filling the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a mixture of microcrystalline petroleum waxes and oils.
4. A telecommunication cable as claimed in Claim 1 or 2, wherein the water-impermeable medium is a mixture of whitening and castor oil.
5. A telecommunication cable as claimed in Claim 1 or 2, wherein the water-impermeable medium is a microcrystalline petroleum wax.
6. A telecommunication cable as claimed in Claim 1 or 2, wherein the water-impermeable medium is a low molecular weight, high Melt Flow Index polyethylene of a semi-solid or grease-like nature.
7. A telecommunication cable as claimed in Claim 1 or 2, wherein the water-impermeable medium is a mixture of petroleum jelly, microcrystalline petroleum waxes, polyisobutylene and aluminium stearate.
8. A telecommunication cable as claimed in any one of the preceding claims, wherein a lapping of tape of insulating material overlies the outer layer of insulated conductors.
9. A telecommunication cable as claimed in Claim 8, wherein the tape is of paper.
10. A telecommunication cable as claimed in any one of the preceding claims, wherein the insulated conductors are arranged in quads.
11. A telecommunication cable as claimed in any one of the preceding claims, wherein the dielectric of each conductor is cellular polythene.
12. A telecommunication cable as claimed in any one of Claims 1 to 10, wherein the dielectric of each conductor is cellular polypropylene.
13. A telecommunication cable comprising a multiplicity of conductors arranged in quads, each conductor having a dielectric of cellular polythene, a lapping of paper tape overlying the assembly of insulated conductors, an outer water-proof sheath and, in the interstices between these insulated conductors and between them and the cable sheath from end to end of the cable length, a filling of petroleum jelly.
14. A method of manufacturing a telecommunication cable in accordance with any one of the preceding claims, wherein the water-impermeable medium is introduced into the cable in stages as the cable is being assembled, each of which stages precedes or immediately follows the application of a layer of cellular plastics insulated conductors, pairs or quads to the underlying assembly of insulated conductors, pairs or quads.

H. H. DAKER,
Agent for the Applicants,
21, Bloomsbury Street,
London, W.C.1.

