

PATENT SPECIFICATION

1,095,639

NO DRAWINGS.

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Date of filing Complete Specification: Sept. 20, 1966.

Application Date: Sept. 20, 1966. No. 54640/65.
(Patent of Addition to No. 995,582 dated May 20, 1964).

Complete Specification Published: Dec. 20, 1967.

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1,095,639

Index at Acceptance:—H1 A(2E3D1, 2E4C, 16).

Int. Cl.:—H 01 b 7/02.

COMPLETE SPECIFICATION.

Improvements in or relating to Telecommunication Cables.

We, BRITISH INSULATED CABLES LIMITED, a British Company, of 21 Bloomsbury Street, London, W.C.1, 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 previously been proposed to incorporate barriers of water impermeable material 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 axially spaced 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, localisation of the damage can only be ensured by closely spacing the barriers. 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 such a cable for carrier systems.

In the specification of our Patent No. 995,582 we have described and claimed a telecommunication cable which overcomes the aforesaid disadvantage and which 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.

Aluminium, by virtue of its electrical conductivity and specific gravity, provides a relatively cheap alternative to copper for the conductors of an electric cable but, because aluminium is particularly susceptible to corrosion in the presence of water containing soil impurities, it is not suitable for use in cables in which the conductors are likely to be contacted by water if the cable sheath were to be damaged to an extent to allow water to enter the cable through the damaged sheath. For this reason aluminium has hitherto been particularly unsuitable for use in a telecommunication cable of the kind comprising a multiplicity of plastics insulated conductors enclosed in a water-proof sheath. Were water to enter a

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telecommunication cable having plastics insulated aluminium conductors through a defective sheath or a defective joint casing, the water would travel along the cable and, if there were any pin holes in the plastics insulation of any of the aluminium conductors, would contact the aluminium through these pin holes. Corrosion of these aluminium conductors and its resultant adverse effects on the electrical characteristics of the cable would take place and, because the conductors are of relatively small cross-sectional area, in time complete breakdown of some of the circuits might even occur.

We have now found that since the telecommunication cable constituting the invention of the said patent 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 can pass, we are able to use in such cable conductors of aluminium or of a high conductivity aluminium alloy without risk of corrosion of these conductors. The water impermeable filling material prevents water, that has entered the cable through a defective sheath, from travelling along the cable and hence from contacting the conductors through any pin holes that there may be in the cellular material of the conductor insulation whether these are in the neighbourhood of the sheath defect or are remote from it.

Accordingly, the present invention is an improvement in or modification of the invention claimed in the specification of our Patent No. 995,582, hereinafter referred to as the main patent, and comprises a telecommunication cable as described and claimed in the main patent having each of its multiplicity of conductors made of aluminium or of aluminium alloy of high conductivity. We prefer to use for the conductors a hard drawn aluminium which is at least 99.7% pure.

A fully-filled telecommunication cable in accordance with the present invention is especially suitable for use as a so-called telecommunication distribution cable that is usually buried directly in the ground because, although the distribution cable will have a larger overall diameter as compared with a similar cable in which the conductors are of copper, this increase in diameter is not important because the problem of ensuring that the overall diameter of the cable is as small as possible in order that it will not take up excessive duct space does not arise.

By making the conductor insulation of cellular material, 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 compen-

sate for the increase in capacitance due to the presence of filling compound in the interstices throughout the cable length.

Of the materials suitable for the conductor insulation that are at present commercially available, we prefer to use cellular polyethylene or cellular polypropylene.

The filling material to be used 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.

Example of filling materials 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 polyethylene of a semi-solid or grease-like nature
- (e) Mixtures of petroleum jelly, microcrystalline petroleum waxes, polyisobutylene and aluminium stearate
- (f) A blend of two or more of filling materials (a) to (e).

The filling material 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 material is introduced into the cable at each die which is modified to provide an annular space allowing the material to flow completely around each layer of conductors. After removing any excess filling material by means of a final snugging die, we may apply about the outer layer of conductors a wrapping of insulating tape, preferably of paper, to form a layer of fibrous insulation impregnated with the filling composition, which layer will itself form a barrier to the ingress of moisture.

The present invention thus provides a telecommunication cable in accordance with the main patent having conductors of aluminium or of aluminium alloy of high conductivity in which the risk of corrosion is substantially eliminated and in which the permittivity of the cellular plastic material and the permittivity of the water imperme-



Corrosion



70
prefer

75



85



90

caps
grease

95

100

105

110

115

120

125



able medium may be such that the effective permittivity between the conductors of any pair of 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.

WHAT WE CLAIM IS:—

1. A telecommunication cable comprising a multiplicity of conductors each made of aluminium or of aluminium alloy of high conductivity and 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 made of aluminium or of aluminium alloy of high conductivity and 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 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 as claimed in any one of Claims 3 to 12 of Patent No. 995,582, wherein each of the multiplicity of conductors is made of aluminium or of aluminium alloy of high conductivity.

4. A telecommunication cable comprising a multiplicity of conductors arranged in quads, each conductor being made of aluminium or of aluminium alloy of high conductivity and having a dielectric of cellular polythene, a wrapping 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.

5. A telecommunication cable as claimed in any one of the preceding Claims, wherein each of the multiplicity of conductors is made of a hard aluminium which is at least 99.7% pure.

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2. A telecommunication cable comprising a multiplicity of conductors each made of aluminium or of aluminium alloy of high conductivity and 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 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 as claimed in any one of Claims 3 to 12 of Patent No. 995,582, wherein each of the multiplicity of conductors is made of aluminium or of aluminium alloy of high conductivity.

4. A telecommunication cable comprising a multiplicity of conductors arranged in quads, each conductor being made of aluminium or of aluminium alloy of high conductivity and having a dielectric of cellular polythene, a wrapping 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.

5. A telecommunication cable as claimed in any one of the preceding Claims, wherein each of the multiplicity of conductors is made of a hard aluminium which is at least 99.7% pure.

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Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1967.
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2,
from which copies may be obtained.

