

1,104,450



PATENT SPECIFICATION

NO DRAWINGS

1,104,450

Inventor:—GEORGE ALEXANDER DODD.

Date of filing Complete Specification (under Section 3 (3) of the Patents Act 1949): September 20, 1966

Application Date: September 20, 1965.

No. 39921/65

Application Date: December 23, 1965.

No. 54641/65

(Patent of Addition No. 995582 dated May 20, 1964.)

Complete Specification Published: February 28, 1968.

© Crown Copyright 1968.

Index at Acceptance:— H1 A(2E3D1, 2E3D2, 2E3D3, 2E3D4, 2E4C, 16).

Int. Cl.:— H 01 b 7/02.

COMPLETE SPECIFICATION

Improvements in or relating to Telecommunication Cables

We, BRITISH INSULATED CALLENDER'S 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 and is an improvement in or modification of the invention claimed in the specification of our Patent No. 995,582 herein-after referred to as "the main patent".

In the specification of the main patent we describe and claim 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.

The telecommunication cable constituting the invention of the main 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. In addition by making the conductor insulation of cellular material, by which we mean of a material containing large numbers of non-communicating cells, the conductor-to-conductor capacitance, i.e. the capacitance between the conductors of each pair where the conductors of the cable are twinned or that between the conductors of each quad where the

conductors are arranged in quads, 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.

In accordance with the present invention we select for the conductor insulation and for the filling material, respectively, a cellular plastics material and a filling material whose respective permittivities are such as to yield a fully-filled cellular plastic insulated multi-conductor cable in which the conductor-to-conductor capacitance of any pair approximates to a predetermined value differing from, but lying within a predetermined range of values whose upper and lower limits lie respectively above and below, the corresponding conductor-to-conductor capacitance of a multi-conductor 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.

Of the materials suitable for the conductor insulation that are at present commercially available, we prefer to use cellular polyethylene or cellular polypropylene. In each case the plastics material is "blown" *in situ* on the conductor to such a degree as will give it a permittivity of such a value that in conjunction with the permittivity of the filling material selected the conductor-to-conductor capacitance will have the required value.

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 and a high dielectric strength.

Examples of filling materials suitable for use in cables whose conductors are insulated with either cellular polyethylene or cellular polypropylene are:—

- (a) mixtures of whiting and castor oil
- (b) microcrystalline petroleum waxes

[Price 4s. 6d.]

50

55

60

65

70

75

80

85

90

(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 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 tapes, 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 water.

By way of example it is mentioned that by varying the extent to which we "blow" the polythene insulation on the conductors to be used in the multi pair telephone cable fully filled with petroleum jelly of which the permittivity is 2.4 we may obtain conductor-to-conductor capacitances of

(a) 0.095 μf per mile with 23% "blowing"

(b) 0.085 μf per mile with 46% "blowing"

(c) 0.076 μf per mile with 69% "blowing"

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 aluminum 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 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.

Since a telecommunication cable in accordance with the present invention 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 may make each of its multiplicity of conductors of aluminium or of aluminium alloy of high conductivity without risk of corrosion of those 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. 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 having each of its multiplicity of conductors made of aluminium or of an aluminium alloy of high conductivity 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.

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, wherein the permittivity of the cellular plastics material and the permittivity of the water-impermeable medium are such that the conductor-to-conductor capacitance of any pair approximates to a predetermined value differing from, but lying within a predetermined range of values whose upper and lower limits lie respectively above and below, the corresponding conductor-to-conductor capacitance of a multi-conductor



(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 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 tapes, 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 water.

By way of example it is mentioned that by varying the extent to which we "blow" the polythene insulation on the conductors to be used in the multi pair telephone cable fully filled with petroleum jelly of which the permittivity is 2.4 we may obtain conductor-to-conductor capacitances of

(a) 0.095 μ f per mile with 23% "blowing"

(b) 0.085 μ f per mile with 46% "blowing"

(c) 0.076 μ f per mile with 69% "blowing"

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 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.

Since a telecommunication cable in accordance with the present invention 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 may make each of its multiplicity of conductors of aluminium or of aluminium alloy of high conductivity without risk of corrosion of those 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. 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 having each of its multiplicity of conductors made of aluminium or of an aluminium alloy of high conductivity 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.

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, wherein the permittivity of the cellular plastics material and the permittivity of the water-impermeable medium are such that the conductor-to-conductor capacitance of any pair approximates to a predetermined value differing from, but lying within a predetermined range of values whose upper and lower limits lie respectively above and below, the corresponding conductor-to-conductor capacitance of a multi-conductor



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.

5 2. A telecommunication cable as claimed in Claim 1, wherein the water-impermeable medium is a mixture of microcrystalline petroleum waxes and oils.

3. A telecommunication cable as claimed in Claim 1, wherein the water-impermeable medium is a mixture of whiting and castor oil.

4. A telecommunication cable as claimed in Claim 1, wherein the water-impermeable medium is a microcrystalline petroleum wax.

15 5. A telecommunication cable as claimed in Claim 1, wherein the water-impermeable medium is a low molecular weight, high Melt Flow Index polyethylene of a semi-solid or grease-like nature.

20 6. A telecommunication cable as claimed in Claim 1, wherein the water-impermeable medium is a mixture of petroleum jelly, microcrystalline petroleum waxes, polyisobutylene and aluminium stearate.

25 7. A telecommunication cable as claimed in any one of the preceding Claims, wherein a wrapping of tape of insulating material overlies the outer layer of insulated conductors.

8. A telecommunication cable as claimed in Claim 7, wherein the tape is of paper.

9. A telecommunication cable as claimed in any one of the preceding Claims, wherein the insulated conductors are arranged in quads.

35 10. A telecommunication cable as claimed in any one of the preceding Claims, wherein the dielectric of each conductor is cellular polyethylene.

40 11. A telecommunication cable as claimed in any one of Claims 1 to 9, wherein the dielectric of each conductor is cellular polypropylene.

12. A telecommunication cable comprising a multiplicity of conductors arranged in quads,

each conductor having a dielectric of cellular polyethylene, 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, wherein the permittivity of the cellular polyethylene and the permittivity of the petroleum jelly are such that the conductor-to-conductor capacitance of any pair approximates to a predetermined value differing from, but lying within a predetermined range of values whose upper and lower limits lie respectively above and below, the corresponding conductor-to-conductor capacitance of a multi-conductor cable of similar form in which each of the conductors has a dielectric of polyethylene of the same kind but of non-cellular form and in which the interstices are air filled.

13. A telecommunication cable as claimed in any one of the preceding Claims, wherein each of the multiplicity of conductors is made of aluminium alloy of high conductivity.

14. A telecommunication cable as claimed in Claim 13, wherein each of the multiplicity of conductors is made of a hard drawn aluminium which is at least 99.7% pure.

15. A method of manufacturing a telecommunication cable in accordance with any one of the preceding Claims, wherein the plastics material of each conductor is 'blown' in situ to such a degree as will give it a permittivity of such a value that in conjunction with the permittivity of the water-impermeable medium the conductor-to-conductor capacitance of any pair approximates to the required predetermined value.

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

or of aluminium



* C L M S *