

Cable Jointing

This invention relates to jointing of electric cables, using the word "jointing" in a broad sense to include not only the jointing of one cable length directly to another (or others) but also the connection of a cable to a separable connector part (such as a plug or socket) or to terminal equipment of any kind.

There are many applications in which it is desirable to joint cables by means of moulded fittings of a cured elastomeric material, hereinafter for brevity called "rubber", because such fittings are resistant to thermal and mechanical damage. Hitherto it has been assumed that this is only possible if the cable(s) used have sheaths of rubber, or at least of material that resists softening up to the curing temperature of the rubber. This restricts the choice of cable to be used, and may in particular cases require the use of a cable that is more expensive and/or is inferior in other desirable properties (such as fire performance properties).

We have now discovered a means by which moulded fittings of rubber can be satisfactorily applied to cables sheathed with at least some ordinary thermoplastic materials (with softening points below the curing temperature of the rubber). This allows additional flexibility in the choice of cable, which can be applied for either technical or economic ends.

In accordance with one aspect of the invention, a method of jointing a cable with a sheath of polymeric material comprises the steps of making an electrical connection to at least one conductor of the cable and enclosing it by moulding a body of rubber to enclose that connection and engage an adjacent part of the cable

sheath and curing that body *in situ* and is characterised in that the said polymeric material of the cable sheath is a thermoplastic material softening at a temperature below the curing temperature of the said rubber and in that a preformed sleeve of a cured
5 rubber is applied, before the said body is moulded, to surround a part of the cable sheath that is to extend partly inside and partly outside the said moulded body.

The invention includes the resulting cable joint.

When the cable joint involves more than one length of cable
10 with such a thermoplastic sheath, each such length will, of course, need to be provided with a preformed sleeve as described.

The preformed sleeve could be a tight fit on the sheath of the cable when circumstances permit, which they will usually only do if the joint is being formed at the end of a cable, when the
15 sleeve may be rolled onto the cable end or applied by stretching it with a suitable tool or by use of compressed air. We have found however that a close fit is in no way necessary, and that satisfactory results can be obtained using a preformed sleeve fitting over the cable sheath with a sufficient clearance to allow
20 the sleeve to slide freely along the cable.

Preferably the preformed sleeve and the moulded rubber body are of compatible materials so that they securely bond together in the moulding process. It may be advantageous for the two materials to be compatible also with the cable sheath and for the
25 temperature of the preformed sleeve to rise during the moulding process to a temperature at which the thermoplastic material of the cable sheath will adhere to the material of the sleeve, though not so high a temperature that there is a risk of significant

distortion of any part of the cable sheath not enclosed in the mould.

The step of moulding the rubber body may be essentially conventional, except that in most cases it will be necessary to take steps to limit the temperature of the part of the mould that engages the preformed sleeve to form a seal around it. In most cases we believe it will be sufficient and convenient to provide the mould with gripping parts of metal or other thermally conductive material that are thermally insulated from the main body of the mould. Alternatively, or in addition, the gripping parts can be fitted with cooling fins and/or may be force cooled by passing water or suitable cool fluid through passages in them (or in a heat exchanger in good thermal contact with them). A further possibility is to make the gripping parts of the mould of a suitable thermally insulating material, such as a machinable engineering ceramic.

The invention will be further described by way of example with reference to the accompanying drawings in which Figures 1 and 2 show two forms of cable joint in accordance with the invention as used in a "harness" for providing an electric supply for lighting and other purposes on a major building or civil engineering site and Figure 3 is a sketch illustrating how the joint of Figure 1 may be moulded.

The harness is made in units of any convenient length, typically around 250 metres; at an appropriate number of positions on the length of each section it is provided with a tapping joint of the form shown in Figure 1, and the ends of the sections are fitted with through couplings of the forms shown in Figure 2.

Referring first to Figure 1, the harness of this particular example is formed using a cable 1 having five conductors (three phase conductors, neutral and earth) individually insulated with a cured polyethylene (XLPe) composition but enclosed in a

5 thermoplastic sheath 2 based on an ethylene/vinyl acetate polymer (EVA), without curatives, formulated with water-evolving fillers and other ingredients to give flame retardance and low smoke and fume properties under fire conditions. At the positions where tapping joints are to be made, the sheath 2 is cut away to expose
10 the conductors 3. These could remain uncut, in which case sleeves 4 of cured EVA would be passed over one or both the free ends of the cable and slid into position as required; for example, for a cable with an external sheath diameter of 18mm, the sleeve may have a radial wall thickness of 3mm and a nominal radial clearance
15 over the cable of 0.25 to 0.5mm, which is adequate to allow free sliding over the cable sheath; it may be desirable to use a preformed tube which has been cured on a mandrel in order to ensure that it is closely circular, as an additional aid to free sliding. For convenience, however, we prefer to cut the
20 conductors and re-join them using compression ferrules 5 after the sleeves 4 have been slid over the cut ends. The preformed sleeves 4 should be positioned close to the cut-back ends of the cable sheath 2 such that any distortion of the exposed end part of the sheath during the moulding process is insignificant.

25 The cable conductors 3 are now connected to respective ones of sockets 6 on a mould insert 7 by short lengths of insulated conductor 8 soldered to respective ones of the ferrules 5. An EVA moulded body 9 is applied (as further described below) to complete

the "fixed" female half of a separable coupling.

The corresponding "mobile" male part 10 in this particular example has only three pins 11 for mating with three of the five sockets 5 so as to make connections to neutral, earth and a selected one of the three phases. It is appropriate to colour code the moulded body 12 of such a plug to indicate which of the three supply phases it will provide connection to. This male part 10 may be a conventional half coupler on a rubber sheathed cable, but preferably (as illustrated) it is also based upon a thermoplastic-sheathed cable 1 in which case a preformed sleeve 4 corresponding to that on the "fixed" cable will be applied as described.

Figure 2 shows one end of the main cable 1 terminated with a plug 14 and the other with a corresponding socket 15, each having a metal shell 16 and an EVA moulded body 17; these are entirely conventional except for the presence of preformed cured EVA sleeves 4 to permit the use of the thermoplastic sheathed cable.

Figure 3 is a diagrammatic front view showing the formation of the main moulded body 9 of the tapping connection of Figure 1. The body 9 is formed in a two part mould 18 which is conventional except that the two end parts 19, 19 that engage the sleeves 4, 4 are thermally insulated from the remainder of the mould by inserts 20, 20 of a heat resisting thermally insulating material. One material we have found suitable is that sold under the trademark (R.T.M.) Durestos, which we believe to be based upon major amounts of mineral wool and filler with minor amounts of a heat resistant resin binder, but many other materials could be used.

In the particular example using the cable and materials

described, the mould body 9 is about 250mm long and is formed from about 850 grams of curable EVA (half of which is inserted in each of the two parts of the mould in the usual way). About 75mm of each of the preformed sleeves 4 is embedded in the moulded body 9 and about 128mm projects from the end of the moulding.

The mould is assembled with its main part at a temperature of about 140°C and held at that temperature in a press for some minutes, as required to mould and cure the body 9; the thermally insulated end parts 19 (which lose heat to the atmosphere) allow the temperature of at least part of the sleeve 4 to rise to a value (probably around 110°C) at which it adheres to the underlying thermoplastic cable sheath, but the moulding process can be satisfactorily completed without the cable sheath being heated to a temperature at which there is a significant risk of distortion.



Claims

1. A method of jointing a cable with a sheath of polymeric material comprising the steps of making an electrical connection to at least one conductor of the cable and enclosing it by moulding a body of rubber to enclose that connection and engage an adjacent part of the cable sheath and curing that body *in situ*, characterised in that the said polymeric material of the cable sheath is a thermoplastic material softening at a temperature below the curing temperature of the said rubber and in that a preformed sleeve of a cured rubber is applied, before the said body is moulded, to surround a part of the cable sheath that is to extend partly inside and partly outside the said moulded body.

2. A method as claimed in claim 1 in which the preformed sleeve is a tight fit on the sheath of the cable and is rolled onto the cable end or applied by stretching it with a suitable tool or by use of compressed air.

3. A method as claimed in claim 1 in which the preformed sleeve fits over the cable sheath with a sufficient clearance to slide freely along the cable.

4. A method as claimed in any one of the preceding claims in which the preformed sleeve and the moulded rubber body are of compatible materials so that they securely bond together in the moulding process.

5. A method as claimed in claim 4 in which the said materials are compatible with the cable sheath and the temperature of the preformed sleeve rises during the moulding process to a temperature at which the thermoplastic material of the cable sheath adheres to the material of the sleeve, though not so high a



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temperature that there is a risk of significant distortion of any part of the cable sheath not enclosed in the mould.

6. A method as claimed in any one of the preceding claims comprising using a mould with gripping parts of metal or other thermally conductive material that are thermally insulated from the main body of the mould.

7. A method as claimed in any one of the preceding claims which comprising using a mould in which the gripping parts are fitted with cooling fins and/or force cooled by passing cool fluid through passages in them (or in a heat exchange in good thermal contact with them).

8. A method as claimed in any one of claims 1 - 5 comprising using a mould with gripping parts of thermally insulating material.

9. A method of jointing a cable substantially as described by way of example with reference to the drawing.

10. A cable joint made by the method claimed in any one of the preceding claims.

