

CABLE TERMINATION FOR PAPER-INSULATED
THREE CORE MEDIUM VOLTAGE CABLES

The invention relates to a cable termination for multi-core electrical cables.

In cable terminations, the free core ends must be sufficiently flexible in order that the desired electrical connections can be made conveniently; however, the geometry and the sealing of the crotch area shall not be disturbingly altered by the movements of the core ends which occur during assembly and operation (for instance movements caused thermally). It is difficult to meet these requirements with cable terminations which are made at the site of application.

According to the internal state of the art of the applicant, a safe solution consists in arranging the cable termination in a mechanically stable casing or box which is filled with an encapsulating resin. That technique can be unduly expensive and; the cable termination made accordingly may require more space than desired.

According to another solution in accordance with the internal state of the art of the applicant, the crotch area is arranged in a multi-shell light plastic casing which has guides for the core end portions and thereby determines the spreading. The plastic casing is filled with an encapsulating resin which hardens to provide the desired mechanical strength to the cable termination. With that solution, a variety of plastic shells must be kept available for different cable sizes. Moreover, the hardened resin forms hard bending edges for the core end portions extending therefrom, whereby the core insulation may become damaged there.

Furthermore, there are cable terminations known from the internal state of the art of the applicant where a termination sleeve of flexible sheet material is provided instead of the rigid casing. Thereby, the required space can be greatly reduced, and the preparation of the cable termination at the site of application is simplified. The present invention proceeds from such a cable termination.

In a cable termination of the kind stated, in accordance with the internal state of the art of the applicant, the flexible termination sleeve is filled with a slowly hardening encapsulating resin after the sleeve has been arranged at the termination. The resin hardens so slowly that sufficient time is available to connect the free core ends and to set the desired spreading in the crotch area. After the connecting of the core ends, there will be only slight movements of the core ends, for instance caused by heating in use. With that known cable termination, the setting of the spreading is uncertain and depends upon the care and skill of the assembling personnel, and until hardening, movement of the core end portions may still occur which alter the spreading.

The present invention provides a cable termination which is particularly suited for paper-insulated electrical medium voltage cables, which can be conveniently made without problems at the site of installation, which can be immediately put into operation after its manufacture and which requires a minimum of space.

According to the present invention there is provided a cable termination for electrical cables having a plurality of cores and a cable sheath, the termination comprising a crotch area in the area of the cable sheath end from which extend exposed core end portions, a multi-fingered termination sleeve, the termination sleeve having a finger for each cable core to seal around each core end portion and the cable sheath, and enclosing an encapsulating resin which forms a solid insulating body surrounding the crotch area, the cable termination additionally comprising in the crotch area an essentially rigid spreading body which determines the spreading of each core end portion and is interposed between the cores, wherein the areas where the termination sleeve seals around the core end portions, the termination sleeve and any encapsulating resin present between the

5 termination sleeve and the core portions area
sufficiently flexible to be capable of yielding to
movements of the free ends of the core end portions
during assembly and use, the termination sleeve
consisting of a permanently resilient material which fits
10 under resilient bias on the core end portions, the cable
sheath and the insulating body.

In the cable termination according to the invention,
the spreading is determined and reliably set by the
essentially rigid spreading body, and consequently is no
15 longer dependent upon the care applied in the manufacture
of the cable termination. By movements of the core ends,
as they occur during assembly or in operation, no gap-
forming forces can be transmitted to the crotch area
because the finger-shaped ends of the termination sleeve
20 enclose the core end portions flexibly and do not cause a
stiffening of the core end portions. However, in the
crotch area and its surrounding, the cable encapsulating
resin forms a solid body in which the core end portions
are reliably held securely on the spreading body. A
25 rapidly hardening cable encapsulating resin can be used.
The core ends are connected after the hardening, and then
the cable termination is immediately capable of use.

The invention will be described in more detail by way of examples in connection with the drawings in which Figure 1 is an elevation view, partially in section, of an embodiment of a cable termination according to the invention. Figure 2 is a perspective view, on a larger scale than Figure 1, of a spreading body for a cable termination according to the invention. Figure 3 is a partial view corresponding to Figure 1 illustrating wrapped core sleeves. Figure 4 is an elevation view, partially in section, of a core having a shifted-on core sleeve. Figure 5 illustrates, in a partial view corresponding to Figure 1, the making of core sleeves from resiliently expanded sleeves in a cable termination in accordance with the invention. Figure 6 is an illustration corresponding to Figure 1, showing a partially completed cable termination including an expanded termination sleeve which is resiliently shrinkable to form the termination sleeve.

In Figures 2 to 6, parts which correspond to parts in Figure 1 have the same last two digits as in Figure 1 but with a prefixed number designating the Figure number. Figure 1 illustrates a cable termination for a paper-insulated electrical three core medium voltage cable 1, particularly about 7 to 18 kV. The cable 1 has a cable sheath 3 which ends in a cable sheath end portion 5. In the embodiment illustrated, the cable sheath 3 comprises an oil paper layer 7, a semi-conductive paper layer 9, a metallic corrugated tube armor 11, and a plastic outer sleeve 13. The cable 1 includes three cores with paper insulation. In a cable end portion which is freed from the cable sheath 3, exposed core end portions 15, 17, 19, having paper insulations 21, 23, 25, extend from a crotch area 27 in which an essentially wedge-shaped spreading body 29 is inserted between the cores and into the area of the cable sheath end portion 5 whereby in the crotch area 27, the exposed core end portions are fixed in the space between the spreading body 29 and the cable sheath end portion 5. Since the illustrated embodiment has upper-insulated cores, the core end portions

each are provided with an additional core sleeve 31, 33, 35. In the embodiment illustrated, these consist of sleeves of permanently resilient, flexible elastic material. The core sleeves form a contact with a mechanical tension and also may have stress-controlling properties, if desired. In the embodiment illustrated, the core sleeves 31, 33, 35 extend as far as into the area of the spreading body 29; there, they sit with their cable-adjacent ends on a projecting shoulder 37 of the spreading body 29. With this kind of construction, the spreading body 29 preferably is introduced after the core sleeves 31, 33, 35 have been applied, with the core sleeves being positioned so that the spreading body 29 will snap with its shoulder 37 under the cable-adjacent ends of the core sleeves and thus will be fixed without gaps in its illustrated installed position. In the illustrated embodiment, the core sleeves 31, 33 and 35 are each made from resiliently expanded core sleeves (not illustrated in Figure 1) by resiliently shrinking the sleeves, the expanded core sleeves having an oversize and thus being easily shiftable onto the cores.

The exterior seal is provided by a glove-like multi-fingered termination sleeve 39 of permanently resilient, flexible material. The termination sleeve 39 has core fingers 41, 43, 45 fitting under mechanical tension on the core sleeves 31, 33, 35, a cable finger 47 fitting under mechanical tension on the outer sleeve 13 of the cable sheath 3 and a bead area 49 therebetween. The termination sleeve 39 is also found as an expanded sleeve which has an oversize each in the portions thereof which are provided to form the fingers 41, 43, 45, 47 and which had been shrunk after having been shifted onto the cable end. In the bead area 49, the expanded sleeve is only a little oversized. In the illustrated embodiment, the expanded sleeves (which are not illustrated in Figure 1) are each held oversized in a pre-expanded condition by mechanical supporting devices which may be removed selectively to form the sleeves. Preferably, the supporting devices each consist of a removable supporting

helix. Such mechanically pre-expanded sleeves are described in U.S. Patent No. 3,515,798 to which reference is made hereby. Prior to shrinking the sleeve and after a preliminary seal (not illustrated), e.g. by means of adhesive tape, had been applied at the lower end of the termination sleeve, a curable encapsulating resin is filled into the expanded termination sleeve 39. Upon shrinking of the termination sleeve the encapsulating resin is forced into the bead area 49 and all interstices which possibly may exist, and after curing forms an electrically insulating cable encapsulating resin 51 which sealingly fills those interstices. Moreover, the core end portions 15, 17, 19 are insulatingly enclosed by the encapsulating resin in the bead area 49 and fixed on the spreading body 29. The spreading body 29 is essentially rigid and consists for instance of hard polyethylene. By means of the spreading body 29 and the relatively rigid encapsulating resin, a mechanically strong bonded structure is obtained.

The cable sheath 3 is pre-treated in its end portion 5 in accordance with the structure of the cable. In the embodiment illustrated, the outer cable sleeve 13 and the metallic armor 11 are removed approximately as far as to the line 51, and the projecting insulating paper (oil paper) is wrapped with a layer 55 of high tension insulating tape. Any insulating paper which thereafter is still excessive has been torn away.

In the embodiment illustrated, the fixation of the cores in the crotch area 27 is further improved in that the cable sheath end portion 5 is secured against expansion by a reinforcement. In the embodiment illustrated, such reinforcement is formed by a wrapper 57 of a non-extensible cord. Also the layer 55 of high tension insulating tape acts as such a reinforcement.

Figure 2 illustrates an essentially rigid spreading body 229 with depressions 59, 61, 63 for guiding the cores. Moreover, the illustrated spreading body 229 includes the already described projecting shoulder 237 at its

end which is remote from the cable in the installed position (Figure 1). In the installed position, the inner ends of the core sleeves 31, 33, 35 sit on the shoulder 235 under mechanical tension.

5 Figure 3 illustrates core sleeves 331, 333 wound from resilient insulating tape. That embodiment can be made with simple equipment at the site of installation.

 Figure 4 illustrates a core sleeve 431 which had been shifted under resilient expansion onto the respective
10 core 415. To facilitate the shifting, the core sleeve 431 has ribs on its interior surface so that it makes contact in localized areas only and thus can be shifted on easily, even over irregularities which may be present, as it is the case particularly with paper-insulated cores.

15 Figure 5 illustrates, in a perspective partial view corresponding to Figure 1, making core sleeves from expanded core sleeves 65, 67, 69. At this stage, the spreading body has not yet been inserted. The expanded sleeves are each mechanically resiliently preexpanded and
20 held oversized by a supporting device 71. In the embodiment illustrated, each supporting device consists of a supporting helix. Its cable-adjacent end (the lower end in Figure 5) continues into a pull tab 73 which projects from the other end of the expanded sleeve. For making the core sleeves 31,
25 33, 35 (Figure 1), the expanded core sleeves 65, 67, 69 are positioned on the exposed core end portions 515, 517, 519 so that their cable-adjacent ends are located substantially at one and the same level close to the end of the cable sheath end portion 505 (which preferably has already been
30 pre-treated as described) in positions suited to let the spreading body 29 (Figure 1) snap in. Thereafter, the supporting helixes are removed by pulling-out the pull tab 73, and thereby the expanded core sleeves 65, 67, 69 shrink to form the core sleeves 31, 33, 35 (Figure 1).

35 Figure 6 shows a partially assembled cable termination. During assembly, as has already been described, the core sleeves 631, 633, 635 are positioned so that the

spreading body (not illustrated in Figure 6) can snap with its shoulder below the cable-adjacent ends of the core sleeves. Then, the spreading body is manually introduced and snapped into position. Thereafter, a glove-like expanded terminal sleeve 75 (already mentioned) of permanently resilient material is shifted onto the cable end until it is seated on the crotch area as illustrated in Figure 6.

The illustrated termination sleeve has three depending finger-like first sleeve portions 77, 79, 81 for forming the core fingers 41, 43, 45 (Figure 1), an oppositely depending second sleeve portion 83 for forming the cable finger 47, and an intermediate portion 85 for forming the bead area 49. In each of the sleeve portions, a mechanical supporting device 87, 89, 91, 93 is provided which can be removed to permit the sleeve to shrink. In the embodiment illustrated, each supporting device consists of a supporting helix. Pull tabs 95, 97, 99, 101 extend from the inner ends of the supporting helixes and form actuating members which when manually pulled unwind and withdraw the supporting helixes permitting, the respective sleeve portion to shrink elastically.

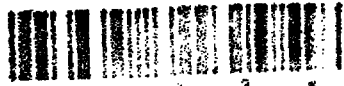
To complete the assembly, starting from the condition illustrated in Figure 6, the cable-associated end of the second elastic sleeve portion 83 of the expanded termination sleeve 75 is sealed to the cable sheath 603 with adhesive tape, and thereafter, while maintaining as far as possible the vertical orientation illustrated in Figure 6, an encapsulating resin is filled into one of the open ends of the first expanded sleeve portions 77, 79, 81. Thereafter, the supporting device 93 of the second sleeve portion 83 is removed by pulling out the pull tab 101, and thereby, the cable finger 47 (Figure 1) tightly shrunk to the cable sheath end portion 605 will be formed from the second sleeve portion 83. Thereafter, the core fingers 41, 43, 45 (Figure 1) are formed in the same manner from the first sleeve portions 77, 79, 81. Upon the shrinking of the first sleeve portions, the encapsulating resin is forced into all interstices which

exist, particularly into the intermeditae portion 85 which
thereby will form the bead area 49 (Figure 1) which is
completely filled with encapsulating resin 51. Everywhere,
the permanently elastic material will seal firmly and
5 intimately to the underlying structure.



CLAIMS

1. A cable termination for electrical cables having a plurality of cores and a cable sheath, the termination comprising a crotch area in the area of the cable sheath end from which extend exposed core end portions, a multi-fingered termination sleeve, the termination sleeve having a finger for each cable core to seal around each core end portion and the cable sheath, and enclosing an encapsulating resin which forms a solid insulating body surrounding the crotch area, the cable termination additionally comprising in the crotch area an essentially rigid spreading body which determines the spreading of each core end portion and is interposed between the cores, wherein the areas where the termination sleeve seals around the core end portions, the termination sleeve and any encapsulating resin present between the termination sleeve and the core end portions are sufficiently flexible to be capable of yielding to movements of the free ends of the core end portions during assembly and use, the termination sleeve consisting of a permanently resilient material which fits under resilient bias on the core end portions, the cable sheath and the insulating body.
2. A cable termination as claimed in Claim 1, in which the spreading body has depressions for guiding the exposed core end portions.
3. A cable termination as claimed in Claim 1 or Claim 2 in which the cable cores are provided with core sleeves and the spreading body has projecting shoulders which receive the inner ends of the core sleeves, the shoulder being provided at the end of the spreading body which in the installed position is remote from the cable.
4. A cable termination as claimed in Claim 3 in which the spreading body is snapped into its installed position.
5. A cable termination as claimed in any preceding claim in which the termination sleeve forms a bead around the crotch area.



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6. A cable termination as claimed in any preceding
5 claim in which the termination sleeve is shrink fitted.

7. A cable termination as claimed in any preceding
claim in which the termination sleeve or any core sleeve
present over the cable cores is formed from an expanded
sleeve by shrinking the expanded sleeve, the sleeve being
10 resiliently expanded to an oversize by means of at least
one supporting device in the form of a supporting helix
which is removed from the expanded sleeve to permit the
sleeve to resiliently shrink.

8. A cable termination as claimed in Claim 1
15 substantially as herein described with reference to the
accompanying drawings.

