

METHOD AND DEVICE FOR PRODUCING A MULTICORE CABLE

The invention relates to a method and to a device for producing a multicore cable, in particular a ribbon cable, of the generic type defined in the preamble of claim 1 and claim 9 respectively.

Multicore cables are used to a large extent in computers and in control systems, for example for machine tools. They have a certain degree of flexibility, so that they can be laid largely as desired given sufficient installation space.

The objection of the invention is to specify a method and a device for producing a multicore cable, in particular a ribbon cable, with which a high-quality, highly flexible multicore cable, in particular ribbon cable, for universal cable guidance, even with restricted installation space, can be produced in a manner which is advantageous in terms of production.

According to the invention, the object is achieved by the features of claim 1 and claim 9.

The advantage of the inventive method and the inventive device is that the conductors can be oriented exactly in parallel before being encapsulated with the highly elastic plastic by clamping the conductor bundle and tautening the conductor sections which are located between the two clamping points, so that a high degree of insulation is ensured between the conductors too. Successive repetition of the method steps on successive length sections of the conductor bundle means length sections of the conductor bundle which are provided in

succession can be oriented and encapsulated, with the lined-up encapsulated lengths overlapping at the interfaces and being connected to one another in the casting process. Highly flexible, extremely high-quality multicore cables of any desired length can be produced in this way. In this case, the conductors may be in the form of individual cores, for example copper wires, or twisted wires or sheathed cores.

Expedient embodiments of the inventive method together with advantageous developments and refinements of the invention can be found in claims 2 to 8, and expedient embodiments of the inventive device together with advantageous developments and refinements of the invention can be found in claims 10 to 16.

The invention is described in greater detail below with reference to an exemplary embodiment which is illustrated in the drawing, in which

fig. 1 shows an exploded illustration of a device for producing a ribbon cable,

fig. 2 shows an enlarged illustration of detail II from fig. 1.

The device illustrated perspectively in fig. 1 is used to produce a highly flexible ribbon cable 10 as an exemplary embodiment for a general multicore cable. A ribbon cable 10 of this type has a plurality of electrical conductors 11 which run parallel to one another and are embedded in an insulating sheath 12. The electrical conductors 11 may be individual cores, for example copper wires, or twisted wires or sheathed wires.

The device has a mold 13 having two shaping parts 14, 15 which can be placed one on the other and can be releasably connected to one another with two mutually

facing shaping faces 141, 151. The two shaping parts 14, 15 are connected by screw bolts 16 which are passed through through-holes 17 in the upper shaping part 14 and are screwed into threaded holes 18 in the lower
5 shaping part 15.

A channel 19, which extends in the longitudinal direction of the shaping part 15 and is bounded at its ends, is made in the shaping face 151, and two
10 transverse filling channels 20, 21 issue into said channel 19. The mouths of the filling channels 20, 21 are situated close to a respective end of the channel 19. A guide region 22 or 23 for positioning sections of a conductor bundle 24 comprising a plurality of
15 electrical conductors 11 adjoins each end of the channel 19. Each guide region 22, 23 comprises an arrangement of parallel grooves 25 which each extend from the end of the channel to the end of the shaping part 15 and end freely at the end of the shaping face
20 151. The radius of the identical grooves 25 is somewhat larger than the radius of an electrical conductor 11, so that the conductors 11 which are placed into the grooves 25 are able to move axially in the grooves 25. The shaping face 141 (not visible in fig. 1) of the
25 shaping part 14 is formed in the same way as described for the shaping face 151. When the shaping faces 141, 151 of the two shaping parts 14, 15 are placed one on the other, the channels 19, the filling channels 20, 21 and the grooves 25 in the upper shaping face 141 and in
30 the lower shaping face 151 respectively rest congruently one on the other, so that the channels 19 form a casting space, the filling channels 20, 21 form two filling channels for pouring plastic into the casting space, and the grooves 25 form closed guide
35 ducts for the individual conductors 11.

A pair 26 or 27 of clamping pieces which is formed by two clamping pieces 261, 262 or 271, 272 is arranged at each end of the mold 13. The pairs 26, 27 of clamping

pieces are used to clamp the conductor bundle 24 in front of and behind a guide region 22, 23. The pair 26 of clamping pieces at the rear in fig. 1 is fixed to the mold 13, whereas the front pair 27 of clamping pieces is movably arranged in the longitudinal direction of the mold 13. In the exemplary embodiment of fig. 1, the lower clamping piece 262 of the rear pair 26 of clamping pieces is integrally formed with the lower shaping part 15 of the mold 13, but it may also be separate from the shaping part 14, so that the two shaping parts 14, 15 can be identical. The upper clamping piece 261 of the rear pair 26 of clamping pieces is guided on two guide pins 28 in an axially movable manner, with the guide pins 28 being pressed into receiving holes 34 in the lower clamping piece 262 and protruding beyond the shaping face 151 at right angles to the latter. The upper clamping piece 261 can be braced on the lower clamping piece 262 by means of screw bolts 29 which are passed through through-holes 30 in the upper clamping piece 261 and are screwed into threaded holes 31 in the lower clamping piece 262.

The lower clamping piece 272 of the front pair 27 of clamping pieces in fig. 1 is guided on guide pins 32 such that it can move in the longitudinal direction of the shaping part 15. The guide pins 32 are pressed into corresponding receiving holes 33 which are made in the lower shaping part 15 of the mold 13 starting from its end face 152. A through-hole 35 which runs parallel to the guide pins 32 and has an internal thread section (not visible here) is made in the lower clamping piece 272. A screw bolt 36 having an external thread section 361 (fig. 2) can be screwed into this internal thread section, with the end of the bolt being supported on the end face 152 of the lower shaping part 15. The distance between the lower clamping piece 272 and the end face 152 of the lower shaping part 15 can be increased or decreased by increasing or decreasing the depth to which the screw bolt 36 is screwed in the

through-hole 35. The upper clamping piece 271 is movably guided on guide pins 40, which are pressed into receiving holes 41 in the lower clamping piece 272, in the same way as the clamping piece 261 of the rear pair
5 26 of clamping pieces, with the guide pins 40 being oriented at right angles to the shaping face 151. The upper clamping piece 271 can be braced on the lower clamping piece 272 by means of screw bolts 37 which are passed through through-holes 38 in the upper clamping
10 piece 271 and can be screwed into threaded holes 39 in the lower clamping piece 272.

In order to reliably clamp the conductor bundle 24 between the mutually facing clamping faces of the pair
15 26, 27 of clamping pieces, with only the clamping faces 262a and 272a of the lower clamping pieces 262, 272 being shown in fig. 1 and only the clamping face 272a of the lower clamping piece 272 being shown in fig. 2, a groove arrangement 42 comprising parallel grooves
20 (fig. 2), which are made in the clamping faces 262a, 272a, is provided on each clamping face 262a, 272a, said grooves being aligned with the grooves (25) in the guide regions 22, 23 and each extending over the entire clamping face 262a, 272a. The radii of the grooves 43
25 are smaller than those of the grooves 25 in the guide regions 22, 23, so that the conductor sections situated in the grooves 43 are clamped in a force-fitting and interlocking manner when clamping pieces 261, 262 and 271, 272 rest one on the other.

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The highly flexible ribbon cable 10 is produced using the above-described device as follows:

A conductor bundle 24, which has any desired number of
35 conductors 11 which is restricted only by the number of grooves 25 in the guide regions 22, 23 of the shaping faces 141, 151 or groove arrangements 42 on the clamping faces of the clamping pieces 261, 262, 271, 272, is placed between the two shaping parts 14, 15

after the conductors 11 are degreased and dried when the mold 13 is opened, with, in a rear bundle region, one conductor section of the conductors 11 being placed into the grooves 25 in the rear guide region 22 and
5 into the grooves 43 of the groove arrangement 42 on the lower clamping piece 262a of the rear pair 26 of clamping pieces. The upper clamping piece 261 of the rear pair 26 of clamping pieces is then placed on the bundle region and braced on the lower clamping piece
10 262 by means of the screw bolts 29. A conductor section of the conductors 11 is then placed into the grooves 25 of the front guide region 23 on the shaping face 151 of the lower shaping part 15 in a front bundle region and into the grooves 43 of the groove arrangement 42 on the
15 clamping face 272a of the lower clamping piece 272 of the front pair 27 of clamping pieces. The upper clamping piece 271 of the front pair 27 of clamping pieces is then fixed on the lower clamping piece 272 by means of the screw bolts 37. The lower clamping piece
20 272 is now increasingly pressed away from the end face 152 of the lower shaping part 15 by turning the screw bolt 36, as a result of which the sections of conductors 11 between the two pairs 26, 27 of clamping pieces are tautened and thus aligned exactly parallel
25 in the region of the channel 19. The mold 13 is closed by the upper shaping part 14 being placed on the lower shaping part 15 and being braced on the lower shaping part 15 by means of the screw bolts 16. A highly elastic plastic which can be processed in a casting
30 method is now poured in via the two filling ducts which are formed by the filling channels 20, 21 in the upper and in the lower shaping face 141, 151. The plastic used is preferably a two-component silicone elastomer. This plastic fills up the casting space which is formed
35 by the two channels 19, which rest congruently one on the other, in the shaping faces 141 and 151 of the two shaping parts 14, 15 which rest one on the other, and surrounds each of the conductor sections of the conductors 11 which are oriented in parallel in the

casting space. Curing the plastic produces a highly flexible plastic encapsulation 44 which reliably insulates the individual conductors 11 from one another and from the outside.

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Following curing of the plastic encapsulation 44, the mold 13 is opened again and the conductor bundle 24 together with the plastic encapsulation 44 is removed from the mold 13, as illustrated in fig. 1. In order to
10 obtain any desired length of ribbon cable with an insulating sheath 12, the conductor bundle 24 is now moved in the direction of arrow 45 until the end, which is at the front in fig. 1, of the plastic encapsulation 44 protrudes into the channel 19 slightly beyond the
15 rear end of the channel 19. The conductor bundle 24 is then clamped in the region of the plastic encapsulation 44 by the rear pair 26 of clamping pieces. The conductor bundle 24 is placed together with conductor sections of the individual free conductors 11 into the
20 grooves 25 in the front guide region 23 on the shaping face 151 of the lower shaping part 15, with the conductor sections continuing in the grooves 43 of the groove arrangement 42 on the clamping face 272a of the lower clamping piece 272 of the front pair 27 of
25 clamping pieces. The front pair 27 of clamping pieces is closed and pulled away from the mold 13 until the individual conductors 11 which run in the channel 19 are tautened and thus run parallel to one another. The mold 13 is then closed and the plastic is poured in.
30 This produces a further plastic encapsulation 44 which seamlessly adjoins the previously cast plastic encapsulation 44 and overlaps the latter at the joint, with the edges of the two plastic encapsulations 44 merging with one another in the second casting process.

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If the plastic encapsulation 44 is cured, the mold 13 is opened again and the above-described method steps are performed again on a conductor bundle 24 which is moved in the direction of arrow 45 by the length of the

new plastic encapsulation 40. The individual method steps are repeated with the sheathed part of the conductor bundle 24 being successively moved until a prespecified length of ribbon cable 10 is produced.

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In order to obtain a different arrangement of the parallel conductors 11, the guide regions 22, 23 are not formed directly in the shaping faces 141, 151 of the shaping parts 14, 15 but on exchangeable adapters
10 which can be inserted flush into the shaping faces 141, 151 in the same positions. It is also possible to change the clamping faces 262a and 272a on the pairs 26, 27 of clamping faces by exchanging the clamping
15 pieces 261, 262 and 271, 272. It is therefore not only possible for the ribbon cable 10 to be of elongate design, but also to form curves between cable sections, with the parallel conductors 11 running in the plane of the cable, as before.

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PATENT CLAIMS

1. A method for producing a multicore cable, in particular a ribbon cable (10), which has a conductor bundle (24) which is situated in an insulating sheath (12) and comprises electrical conductors (11) which run parallel to one another, characterized by the following method steps:

- the conductors (11) of the conductor bundle (24) are clamped in two bundle regions which are spaced apart from one another with the conductor sections situated in the bundle regions being oriented in parallel,
- the conductor sections of the conductor bundle which are located between the clamping points are tautened by increasing the distance between the clamping points, and
- the tautened conductor sections are encapsulated with a highly elastic plastic which can be processed in a casting method.

2. The method as claimed in claim 1, characterized in that the conductor sections are each placed into a groove arrangement comprising parallel grooves (25) in order to achieve parallel orientation of the conductor sections in the two bundle regions.

3. The method as claimed in claim 1, characterized in that parallel orientation of the conductors (11) in one bundle region is produced by the previously cast plastic encapsulation (44), and in that the conductors (11) of the conductor bundle (24), which conductors emerge from the plastic encapsulation (44), are placed into a groove arrangement comprising parallel grooves

(25) in order to achieve parallel orientation of the conductors (11) in the other bundle region.

4. The method as claimed in claim 3, characterized in that the plastic encapsulation (44) is cast such that it overlaps the conductor bundle (24) at the point at which the said conductor bundle (24) exits the previously cast plastic encapsulation (44).

5. The method as claimed in one of claims 1-4, characterized in that orientation and clamping in the two bundle regions are performed on the same conductor sections or on immediately successive conductor sections of the conductors (11).

6. The method as claimed in one of claims 1-5, characterized in that the plastic used is a two-component silicone elastomer.

7. The method as claimed in one of claims 1-6, characterized in that the electrical conductors (11) used are blank or sheathed individual cores or preferably twisted wires comprising a plurality of individual cores.

8. The method as claimed in one of claims 1-7, characterized in that the electrical conductors (11) are degreased before the casting process and are dried after being degreased.

9. A device for carrying out the method as claimed in one of claims 1-8, characterized by the following features:

- a mold (13) has two shaping parts (14, 15) which can be placed one on the other and can be releasably connected to one another with mutually facing shaping faces (141, 151),
- an elongate channel (19), which runs in the longitudinal direction of the shaping part (14,

- 15) and is bounded at its ends, is made in each shaping face (141, 151),
- at least one plastic-filling channel (20, 21) issues into the channel (19),
 - 5 - a guide region (22, 23), which reaches as far as the end of the shaping part and comprises parallel grooves (25) which extend in the longitudinal direction of the shaping part (14, 15) and serve for positioning the conductors (11), adjoins the end of each channel (19),
 - 10 - the channels (19), guide regions (22, 23) and filling channels (20, 21) in the two shaping faces (141, 151) are identical and congruent,
 - a pair (26, 27) of clamping pieces having two clamping pieces (261, 262, 271, 272) is arranged at each end of the mold (13), it being possible to press mutually facing clamping faces (262a, 272a) of said clamping pieces against one another,
 - 15 - one pair (26) of clamping pieces is firmly fixed to the mold (13), and
 - 20 - one pair (27) of clamping pieces is designed such that it can be moved in the longitudinal direction of the mold (13).
- 25 10. The device as claimed in claim 9, characterized in that one clamping piece (262) of the pair of the clamping pieces (26) which is fixed to the mold (13) is integrally formed with a shaping part (15), and the other clamping piece (261) can be clamped on this
- 30 clamping piece (262).
11. The device as claimed in claim 9 or 10, characterized in that one clamping piece (272) of the movable pair (27) of clamping pieces is movably guided
- 35 on guide pins (32) which extend in the longitudinal direction of the shaping part (15), are secured in the shaping part (15) and protrude at right angles from its end face (152), and in that the other clamping piece

(271) can be clamped on the movably guided clamping piece (272).

12. The device as claimed in claim 11, characterized
5 in that there is a through-hole (35), which is provided with a thread section, in the movably guided clamping piece (271); and a screw bolt (36) which is supported on the end face (152) of the shaping part (15) and has an external thread section (361) can be threaded into
10 said through-hole (35).

13. The device as claimed in one of claims 9-12, characterized in that a groove arrangement (42) comprising parallel grooves (43) is formed on each
15 clamping face (262a, 272a) of the pair (26, 27) of clamping pieces, these grooves in each case continuing from the grooves (25) of a guide region (22, 23) and having a clear cross section which is smaller than that of the grooves (25) in the guide regions (22, 23).

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14. The device as claimed in one of claims 9-13, characterized in that the two elongate channels (19) in the shaping faces (141, 151) of the two shaping parts (14, 15) have such a channel shape that they enclose a
25 casting space which specifies the contour of the insulating sheath (12) of the ribbon cable (10) when they rest one on the other in a congruent manner.

15. The device as claimed in one of claims 9-14,
30 characterized in that at least one guide region (22, 23) with grooves (25) is arranged on an adapter which is inserted into the shaping part in an exchangeable manner.

35 16. The device as claimed in one of claims 9-15, characterized in that the grooves (43) on the clamping faces (262a, 272a) of the clamping pieces (261, 262, 271, 272) of at least one pair (26, 27) of clamping

pieces are designed such that their orientation and/or profile can be changed.