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(54) **Improvements in devices and methods for electrical and signal distribution, particularly in shipping environments**

(57) Improvements in devices and methods for electrical and signal distribution, particularly in shipping environments are described and relate to branching devices with contacts for perforating and/or cutting the insu-

lation, or with crimping and/or welding of the respective ends of the conductors, as well as electrical-conductor cables formed as flat ribbons. Apparatus and machines for producing the branching devices and/or the above-mentioned flat-ribbon cables are also described.

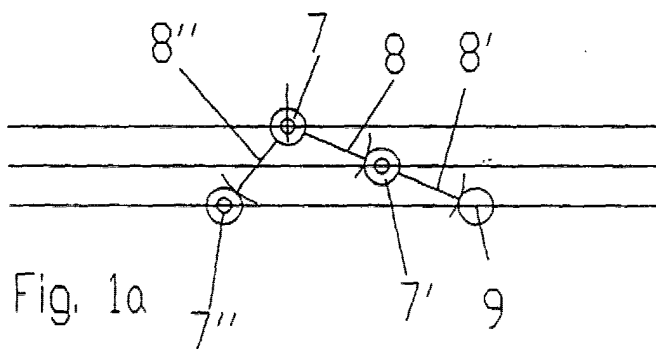


Fig. 1a

EP 1 178 571 A2

Description

[0001] The present invention relates to improvements in devices and methods for electrical and signal distribution, particularly in shipping environments. It is applicable particularly but not exclusively in the specific field of the branching of electrical or signal lines from a main line.

[0002] The branching of a cable of a line in an electrical or electronic system in order to connect a device to a cable of a main line generally involves cutting of the main cable, preparation of the two ends of the main cable and of the branch cable and then the reconnection of the two sections of the main cable with the insertion of the branch cable by known methods, typically by clamping, crimping or piercing. These methods have some principal disadvantages.

[0003] A first disadvantage is due to the fact that the protection introduced in the junction usually leads to problems of space occupied, of fixing, and of sealing against penetration of water and solid bodies. Moreover, the protection box sometimes has to be located in compulsory positions for various systems-engineering reasons.

[0004] A second disadvantage is that the preparation of the components of the junction is not reliable owing to their intrinsic nature or because the work is performed manually, since the compression force is not always correctly ensured in the connection of the parts.

[0005] A third disadvantage is that the security of the junction over time may be compromised, in dependence, basically on the chemical and physical characteristics of the conductor and particularly of its insulator.

[0006] In conclusion, the problems which result over time may weaken electrical conduction. As a result, the junctions necessarily have to be located in positions in which they are accessible and can be inspected, irrespective of their type. Where this is not straightforward, owing to the environment (for example, systems in panelling, under panelling, behind plaster), inspection is provided for by junction boxes, inspection hatches, and openable joints in positions with reasonable access for intervention at subsequent times for maintenance of the system. This results in problems of cost and sometimes of appearance, for example, in areas with particular atmospheres, in architecturally important areas, in areas where space is restricted, or in panelled areas and areas to which access may be difficult.

[0007] The technical problem underlying this invention consists of the provision of improvements in devices in electrical and electronic systems, particularly systems with widespread and repetitive small users, as well as in the fibre-optics field, the improvements being designed structurally and functionally to prevent all of the problems discussed with reference to the prior art mentioned.

[0008] This problem is solved by the invention by improvements in devices and methods for electrical and

signal distribution, achieved in accordance with the appended claims.

[0009] The characteristics and the advantages of the invention will become clearer from the following detailed description of some preferred embodiments thereof which are described by way of non-limiting example, with reference to the appended drawings, in which:

- Figure 1 is a schematic view of an electrical line in which a conventional junction of a pair of lines is shown,
- Figure 1a is a schematic view of an electrical line with a junction according to a first embodiment of the invention,
- Figure 2 is a schematic view of a multicore main line in which three conventional junctions of a corresponding number of lines are shown,
- Figure 3 is a schematic cross-section of a junction of electrical lines according to an embodiment of the invention,
- Figure 3a is a longitudinal schematic view of the junction of Figure 3,
- Figure 3b is a schematic plan view of the junction of Figures 3 and 3a,
- Figure 3c is a partial longitudinal schematic view of a junction of several branch lines and a main line according to the embodiment of Figures 3a-3c,
- Figure 4 is a view corresponding to that of Figure 3 in a further embodiment of the invention,
- Figures 4a and 4b are longitudinal schematic views of the junction of Figure 4,
- Figure 4c is a partial longitudinal schematic view of a further embodiment of a junction according to the invention,
- Figures 5, 5a and 5b are schematic cross-sections of a further embodiment of a junction of a branch line with a main line according to the invention,
- Figure 6a is a schematic cross-section of a junction of a branch from a main line with coaxial cable according to the invention,
- Figure 6b is a longitudinal schematic view of the junction of Figure 6a,
- Figure 6c is a view of a variant, corresponding to the view of Figure 6a,
- Figures 7a and 7b are a cross-section and a longitudinal elevational view, respectively, of a further embodiment of a junction,
- Figure 8 is a side elevational view of a detail applicable to the junction of Figures 7a and 7b,
- Figures 9, 10 and 11 are schematic plan views of flat multicore ribbon cables formed in accordance with the invention,
- Figure 12a is a schematic cross-section of a partially-screened flat cable according to the invention,
- Figure 12b is a view corresponding to that of Figure 12 in which the cable is enclosed in a cylindrical sheath, pre-cut in accordance with the invention,
- Figure 12c is a cross-section of a junction between

a pair of lines formed with flat cables in accordance with Figure 12a,

- Figure 12d is a view of a variant, corresponding to the view of Figure 12c,
- Figures 13a and 13b are schematic views showing a variant of the embodiment of Figures 12a-12c in cross-section and in longitudinal elevation, respectively,
- Figure 14a is a view of a variant of the junction on the branch line, corresponding to the view of Figure 3,
- Figure 14b is a view of a further variant of the junction on the branch line, corresponding to the view of Figure 14a,
- Figure 14c is a schematic cross-section of a device for aligning multicore flat cables according to the invention,
- Figure 14d is a schematic cross-section of a junction between flat cables performed by crimping in accordance with the invention,
- Figures 14e and 14f are cross-sections of junctions between cables in accordance with different geometrical crimping arrangements,
- Figure 14g is a cross-section of a device for the branching of a line by means of a junction by crimping according to the embodiments of Figures 14a-14f,
- Figure 15 is a schematic plan view of a stripping device for removing the insulation from a flat cable according to the invention,
- Figures 15a and 15b are a longitudinal elevational view and a cross-section, respectively, of a cable in which a variant of the stripping device with wedge-shaped blades is shown,
- Figure 16 is a view corresponding to Figure 15 of a variant of the stripping device for removing the insulation by vaporization,
- Figure 17 is a view corresponding to that of Figures 15 and 16 of a device for the relative positioning of branch and main lines and for their joining by welding in accordance with a further embodiment of the invention,
- Figures 17a and 17b are schematic views, in cross-section and in longitudinal elevation, respectively, of a device for joining a pair of main and branch lines by brazing in accordance with a further embodiment of the invention,
- Figure 18 is a schematic plan view of an embodiment of a junction between a main line and a branch line,
- Figure 18a is a schematic cross-section of a connector device for a branch line with an integrated electronic control device, according to a further embodiment of the invention,
- Figure 19 is a schematic plan view of a double-branch junction according to the invention,
- Figures 20 and 20a are a plan view and a cross-section, respectively, of a multicore ribbon cable

which incorporates cables with different configurations in accordance with the present invention,

- Figure 20b is a schematic view of a device according to the invention for the production of the multicore ribbon cable of Figures 20 and 20a,
- Figures 21, 22, 22a, 23 and 24 are schematic views of branches and junctions of branch lines with main lines in various examples of use,
- Figures 25a is a schematic view of a main line with respective branch lines for the services provided in a cabin system for ships according to the invention,
- Figures 25b and 25c are schematic views of details of branch connections for various applications in the cabin system of Figure 25a,
- Figure 26 is a schematic partial cross-section of a support for the integration of cables and junctions formed in accordance with the embodiments of the preceding drawings.

[0010] With reference to Figure 1, a generic electrical or signal line which is connected to apparatus 4 and to which devices schematically shown and indicated 6 and 6' are to be connected, has conductors indicated 1 and 2 and an earth conductor indicated 3. Electrical junctions 5 and 5' are provided for connecting these devices and, together with the lines and with the devices, and well as with the accessories, are formed in accordance with the improvements of the present invention.

[0011] Figure 1a shows a main line, preferably with a flat cable, as well as the positions of branch-line contacts in accordance with a configuration according to the invention. These positions are arranged in accordance with the shape of minimum distance from the closest contact. The conductor areas occupied by the contacts, with reference to the branches 5 of Figure 1, are indicated 7, 7' and 7"; for these areas, the respective contacts must be kept at a distance no less than that indicated 8 in Figure 1a, which constitutes the radius of minimum distance for the required insulation. Figure 1a shows that, if the three contacts are positioned in the triangular configuration 7, 7' and 7" with sides 8 and 8", the length of main cable affected by the branch is shorter than that which distinguishes an in-line positioning 7, 7', and 9 of the contacts, in accordance with known configurations. This triangular geometrical arrangement advantageously enables the space occupied by the branch to be reduced, permitting the use of shorter housing boxes for a given distance between the contacts.

[0012] Figure 2 shows a typical line with multicore cables 21, 22, 21' and 22', also constituting several lines, and with devices 26, 26' and 26" connected to the conductors 21, 22, 21' and 22' by respective electrical junctions 25, 25' and 25". The characteristics and the improvements explained below also extend to the above-mentioned junctions between lines, as well as to all of the junctions mentioned in the description which join together whole lines or only some conductors.

[0013] Figure 3 shows a junction schematically and in

section and Figure 3a is a longitudinal view of the junction. It shows the joining of two lines, one spinal line and one branch line, showing only one of the conductors; one of the spinal conductors is indicated 31 and one of the branch conductors, of the same cross-section or of different cross-section, is indicated 33. The insulators of each individual conductor are indicated 32 and 34 and the outer sheaths of the lines are indicated 35 and 36. A support 37 is provided for keeping respective contacts 38 positioned. The portions of the enclosing box which houses the junction are indicated 39 and 40. Figure 3c shows the offset insulation perforations which enable the distances between the contacts to be maintained so as to ensure the desired insulation characteristics of the line, where appropriate, with a smaller space occupied on the main line, as described and illustrated with reference to Figure 1a.

[0014] The conductors 31 shown in Figure 3 are insulated by the insulators 32 and 34 which are housed in a respective sheath 35, 36, preferably but in non-limiting manner, with a flat geometrical shape both for the line in the sheath 36 and for the line in the sheath 35. The dimensions and shape of the box portion 40 and of the contact-holder support 37 are selected so as to be suitable for the correct positioning of the cables, with the strength necessary for the support functions and for the forces for bringing about the penetration of the contacts 38 into the conductor. A projection on the portion 40 and a tooth on the portion 39 are indicated 40' and 39', respectively; the projection 40' and the tooth 39' can engage one another and their shape and size are selected appropriately to ensure resilience during fitting and restrained coupling after the box is closed. In the embodiment of Figure 3, the closure of the cover of the box is of the dovetail type.

[0015] The contacts 38 are blade contacts in order to perforate the insulation and to be introduced easily between the wires of the cable conductor and their dimensions are selected so as to be suitable on the basis of the current, the cross-section and shape of the conductors, and the geometrical shape and well as the physical and mechanical nature of the insulator. Figure 3a shows the contacts 38 in detail in a longitudinal view of the conductor, whereas in Figure 3b, they are shown in a view from above. The contacts 38 are double with respective tips 38' and 38'' having offset cutters produced by bending of the contact 38 along the line 38'''. They thus produce forces with action and reaction components on the conductors without affecting layers of insulation. With particular reference to Figure 3a, the contacts 38 enter the insulation by cutting and penetrate between the wires of the conductor. They compress the cross-section of the corresponding conductor 31 resiliently and in an offset manner and the conductor 31 reacts with a force of elastic-plastic deformation of the metal portion. This deformation in practice affects solely the cross-section of the conductor, producing an adequate force, irrespective of the plasticity of the insulation. The electri-

cal contact produced consequently has low resistance and is stable.

[0016] Figure 3c shows a detail of a connection formed in accordance with the above-mentioned configuration, offset and applied to a flat cable 36, shown schematically in a plan view from above, in which the tips 38' and 38'' of the contacts 38 are distinguished; the branch line 35 is not shown, purely for graphical clarity, and reference should be made to Figure 3 for details thereof.

[0017] In order to improve performance, each of the at least single contacts is repeated several times, for example, with two or more cutters and the conductor is coated with material suitable for maintaining low surface resistance over time, such as, for example, tin, silver, gold or nickel. The same is true of the surfaces of the contacts. To further improve performance, the contacts are made of resilient material, for example, bronze-beryllium. The multiple contacts deform along their respective planes, increasing the resilient compression (between the contact and the conductor) over time, independently of the insulating components of the cables and of the box, but purely in dependence on the metal conductors.

[0018] With reference to Figure 3, the box 39 - 40 and the contact-holder 37 inside it are shaped so as to enable the lines to be positioned easily with the necessary precision, and their strength and shape are selected so as to enable the lines to be compressed against the contacts 38, 38', 38''. The compression is performed in two ways. The first is by acting directly on the conductors 31-33 with a recess of a tool substantially reproducing the internal profile of the box and keeping the contact-holders 37 and the blades 38 in position. The second is by using the box 39 - 40 directly, the box acting externally as a bearer for a tool purely for compression and internally as a recess and a device for positioning the contact-holder 37. The typical installation steps are as follows:

- introduction of the spinal line into the half-box 40,
- introduction of the contact-holder unit 37 and contacts 38 into the box 40,
- introduction of the branch line into the half-box 40,
- introduction of the half-box 39,
- compression of the half boxes against one another by means of the compression tool (not shown).

[0019] Figure 4 shows, in section, a further example of joining and branching according to the invention in which the box 44 has the function of compressing the cables of the lines and causing them to slide on the cutting edges of the contacts 42 to facilitate the execution of the branching without tools. Figure 4a is a longitudinal diagram of the line. The box 44 is double-T-shaped and carries, in a central rib, the cutter contacts 42, already described above, of which only one is shown. It is particularly advantageous for cables the primary insulation

of which has a thickness or is of a nature such as to make other junctions, for example, of the fork type, inadvisable. The upper and lower ends 44 (visible in Figure 4a) of the box are inclined and act as sliding guides for the covers 45, 46 which are wedge-shaped. During their insertion, the covers 45, 46 compress the cables 41, 43 against the cutters 42 and contribute to their sliding, promoting the cutting of the cable and the penetration of the contact cutters 42. The compression component and the friction component of the covers 45, 46 on the cable 41, 43 arrange the contacts between the wires of the conductors 41, 43, or press/cut into the conductor if it is solid. A recess 47 and a projection 48 formed on the box 44 and on the covers 45, 46, respectively, serve to lock the whole in the final position by mutual engagement. To facilitate manipulation, the covers 45, 46 can be fitted from the opposite ends of the box 44. Figure 4a shows the closure of the box 44, in which the projection 48 and the recess 47 are formed without undercuts to facilitate production moulding.

[0020] Figure 4b shows a type of box for branch lines which terminate or in any case are cut off in the box. The conductors of the line of conductors 43, which are cut and exposed at 43' and which are protected by means of a shoulder 49 projecting at right angles from the wedge-shaped cover 46, will be noted.

[0021] The function of the box is the mechanical protection and electrical insulation of the junction. This type of protection achieves the specifications necessary for the boxes shown to conform to IP 20.

[0022] In order to achieve a degree of protection against penetration of solid bodies and of liquids, the periphery of the box 39-40 is equipped with sealing rings, or soft shaped gaskets, or is filled with injectable, gelatinous or expanding fillers, or the box is provided with labyrinths and projections at the outlets such as to form leaktight seals against the lines.

[0023] A type of injectable filler used is silicone. The principal multi-part or single-part polymers already existing for fillings of this type are suitable for use.

[0024] A type of gelatinous filler is butyl rubber with a very low rheological coefficient. The principal gelatinous materials already existing for fillings of this type are suitable for use.

[0025] Fillers of a type which expand inside the box to ensure mechanical sealing are temperature-activated whereas, amongst the injectable and gelatinous filling techniques, the methods of external injection and/or injection with expanding blisters activated at the moment of closure of the box are used.

[0026] Both the fillers inside the body 39, 40 and, in particular, where fillers are absent, the offset between the contacts 38 along the line (visible in Figure 3c and in Figures 4c - 42', 42''), as well as the cutting of the end of the branch line in steps, in the manner of a Greek key design, or in the manner of the mouthpiece of a wind instrument, help to achieve an adequate degree of overall insulation between the various conductors of the line.

Figure 4c, which is a schematic view of the interrupted cable end from below, shows both the execution of the offset between the contacts and the cutting of the cable in the manner of a Greek key design, which thus offsets the exposed ends of the conductors 43' relative to the conductors 43'', increasing the degree of insulation. With reference to the requirement for the operator to perform the cutting in the manner of a Greek key design or of the mouthpiece of a wind instrument, with reference to Figure 4c, the shoulder 49 of the cover 46 is shaped to match the shape of the cut.

[0027] The reliability of each type of connection described herein is comparable with the reliability of the cable so that the same degree of use follows. This prevents the need for shells, inspectable boxes and the like, in applications.

[0028] Figure 5 shows a further embodiment of the invention relating to the "fork" branching technique, in which the fork is crimped rather than operating by resilience. This technique is advantageous on solid or relatively stiff conductors, particularly with thin insulator thicknesses, as well as with conductors of small diameter in which the execution and precision of the insertion of cutter contacts according to the preceding embodiments (Figure 3) is difficult to achieve.

[0029] Figure 5 shows a contact 51 which engages one of the insulated conductors, indicated 52, in which the tips (indicated 53' solely in Figure 5a for clarity) perforate the conductor 52 on the sides, deforming it and stripping the insulation. The conductor is pressed by the first portion 55 of a pressure element (which is shown raised for clarity in Figure 5a). The conductor 52' of the cable is deformed by plastic and elastic action of the fork contact 51. For further security of contact, the pressure portion 54 presses and deforms the tips 53' of the fork 51" (shown in Figure 5b) forming a firmly clamped contact the clamping of which depends, apart from marginal turning-back of the insulation, on the compression between the metals of the conductor 52" and of the crimped fork 51", also with edge portions 53' actually superimposed. The pressure element 54-55 is a recess of a separate tool, which fixes the individual forks to the cable 52; an extension of the technique provides for the shaping of the internal portion of the box (not shown in the drawing but similar to the box of Figure 3) in accordance with the surfaces of the pressure element or a portion thereof. The sharp slanted profiles of the forks for facilitating the superimposition of the edge portions 53' upon clamping of the contact by means of the pressure element 54" are indicated 56'.

[0030] Figures 6a and 6b show a further embodiment of the invention which relates to the piercing technique on screened cable. The technique is based entirely on conventional piercing techniques and on what has been described. What is indicated with reference in particular to Figure 4 and the relative description can be extended to conventional and flat screened cables with one conductor, with several conductors, screened either individ-

ually or together. The embodiment described for a single cable also extends to several screened cables in parallel.

[0031] Figure 6a shows a screened cable with an internal conductor 61, insulation 62, braided or film screening 63, and possibly an outer sheath 64. The junction box is indicated 68; in this embodiment, it is shown schematically for a single internal conductor for the general description of which reference is made to that given with reference to Figures 3 and 4. In the box, there is a contact 65 in the form of a cutter having a sheath or insulating layer 66. In the embodiment described, which is made of plastics reinforced with glass fibres, it is suitable to be inserted in the screening 63, for electrical signals, for voltages, and possibly for the impedance characteristic of the cable.

[0032] This example reflects the characteristics of plastics reinforced with glass fibres which is particularly versatile owing to its adhesiveness, cost, hardness, and dielectric properties, even in relation to frequency. The tip 69 is bare and either makes contact with the conductor or can be inserted in multi-strand conductors. The branch portion 68' is formed as appropriate for the junction, on another cable, on an active or passive circuit, for example, a data-transmission t/r with conventional, SMD, hybrid, or integrated solutions, a dimmer, a sensor, an actuator, or simply a switch, relay, or electrical device in general. Naturally contacts and branch portions 65, 66 as well as electronic/electrical componentry may, where suitable, additionally or alternatively be located on or in the box 68.

[0033] Figure 6c shows a variant of the previous embodiment in which the contact corresponding to the contact 65 of Figures 6a, 6b is indicated 65' and has the same function, although with a different configuration. Since the branch portion 68" (corresponding to the portion 68' of Figures 6a, 6b) is parallel to the axis of the main conductor, the contact 65' and its tip 69, the insulation 66' and the contacts of the screen 65' are produced from a single multi-layer printed-circuit structure with metal foil 65 inserted in the sandwich and projecting at the tip, and the insulating substrates 66' have the same function as the insulators 66, and the metallization or contact 65' formed on the insulation has the function of the contact 65' towards the screen of Figure 6b. For clear reasons of reliability and to extend its applications, this structure is multiple in parallel on the same conductor, with regard to the reliability of the contact, and on several conductors, with regard to the requirement for multiple services, for example, a device which requires supply and signal simultaneously from two or more parallel lines (in the same cable or in several cables). In this case, the contacts provided are suitable for the type of service, according to the embodiments of the invention.

[0034] For the insertion of the contact in the cable, if the cable has insulation and/or screening which are difficult to perforate, a perforation tool is used; the perforation tool advantageously copies the geometry of the

cable, being constituted by two jaws which grip the cable first of all and punch/es, which are usually made of material stronger than the material of the contact/s, and which penetrate the sheath, the screen, and the insulation. The tool thus prepares for the penetration of the final contact/s.

[0035] Figures 7a and 7b show an example of a connection suitable both for general uses and for branches perpendicular to the main line. The views are longitudinal and transverse views for a single conductor. The contact is formed by a shaped and bent ring 71 the inner edge of which cuts the insulation 73 and engages the conductor 72. The ring 71 itself or an auxiliary contact thereof performs the conduction. Clamping is by compression. The ends 71' of the ring are squeezed into closure. Where appropriate, the operation is assisted by tools for pre-cutting the sheath and the insulation of the cable, particularly if it has several conductors, by insulation boxes, and by squeezing tools. Components of the invention are shown singly and combined with one another in Figures 7a and 7b which show shaped and, where necessary, cutting wedges 74 and 74" which cut the insulation and press against the conductors, improving the contact and the contact stability between the conductors 72 and 72' of the two lines.

[0036] Also shown, as an alternative or in addition, is a solution with the use of cutter contacts 74' which solve the problem by the cutter contact technique. Naturally, the contacts can be inserted in the cable in accordance with the techniques described; in particular, this type of contact is used on cables with slots of the type which is described in greater detail below, in which the ring 71 is fitted astride the individual conductor.

[0037] Figure 8 shows a detail of a contact in the branch side of the conductor of the branch line applied to the devices of Figures 7a and 7b as an extension of the function of the components 74 or 74" with direct insertion of the conductors of the branch line. The contact, of suitable shape, for example, sharp, cylindrical, prismatic or pyramidal, is wedged in the ring 71, thus forming a junction either perpendicular or parallel to the main line.

[0038] The conductors of the branch line 82, of whatever nature, and not necessarily of the flat-cable type, carry the terminal 81, for example, to be crimped, which has the same properties as the component 74 or 74". The insulating covering 81' is used when the connection is not boxed, or when appropriate.

[0039] Figures 9, 10 and 11 show some examples of types of flat cables according to the invention. These cables can relate to all of the uses, accessories, and configurations of conductors, insulations, screens, and geometrical and mechanical arrangements mentioned in the present description.

[0040] The invention extends to the combination of the branching techniques described, in particular for crimping and welding, with the cables characterized by the arrangements described. Branching with crimped

junctions, for which the advantage of using high-flexibility polymers are mentioned as known, is facilitated when the flat cable has the arrangements described.

[0041] With reference to Figure 9, cable conductors, indicated 91, are joined together by ribbons 94 and 94'. Where appropriate, as for application in the field, the ribbons are of different widths both to constitute keys for preventing reversal upon installation and to achieve the necessary electrical characteristics. The ribbons have pre-incisions or preferential bend lines 92 which facilitate both longitudinal separation of the conductors, where this is useful during processing (for example, during the insertion of the cables in the clamps of a component which is not of the standard width of the flat cable, such as a generic user), and cutting when it is necessary to separate the conductors for staggered stripping, such as that indicated with the tool of Figure 15. In addition, pre-perforated, pre-cut, or pre-marked slots 93 and 93' are provided in the cable to facilitate the above-mentioned operations. Naturally, the pre-cut or pre-marked slots are opened as required. The pre-perforations advantageously reduce the weight and the fire load of the cable.

[0042] Figure 10 shows a flat cable of the same type, comprising ribbons 104 and 104' which carry a double longitudinal incision 102 and a single incision 102', respectively, but the ribbons can in any case be combined with respective incisions and slots according to specific requirements.

[0043] Figure 11 shows an example of a flat cable the conductors 111 of which are separated by ribbons with longitudinal incisions 113 and longitudinally offset slots 114, 114'.

[0044] Figures 12a, 12b and 12c show an embodiment of screened cable 121 according to the invention, comprising a screen 122. In Figure 12a, the flat cable 121 is of the type with three conductors with a screening metal foil or metallization 122. The screen is a metal weave or screen, for example, of the braided type, as required. The screen 122 is covered by an insulating barrier on the side facing the conductors 121, where appropriate. Figure 12b shows the same flat cable 121 with its screen 122 enveloped in an almost circular sheath 125. According to this structure, the screen or braid 122 surrounds the conductors on the outside with a screening function and the sheath 125 performs the restraint and protection. A recess in the sheath 125, indicated 124, has the function of indicating the generatrix for the incision of the cable and facilitating its opening in the manner of a flat cable 121 for a connection as shown in Figure 12c. This drawing shows a diagram of the connection between two cables of the above-mentioned type. The cable 121 of Figure 12b is cut along the recess 124 and opened out for the length necessary for the insertion of the connector. The branch line is indicated by the numerals 121', 122', 125'. For graphical clarity, the box and the shapes of the contacts are not shown and reference should be made to the embodiments de-

scribed above for their description. The connector also comprises a contact-holder support, possibly with restraining shoulders 123.

[0045] The contacts 128 perforate the insulation of the cable 121 without reaching the screen 122. One of the contacts of the support 123, indicated 127 in this configuration, or the contact 126 which is closable together with the box, performs the branching of the screen. A variant of the contact 126, shown schematically in Figure 12d, for cables in which the screen is accessible, comprises a metal plate 126' or metallization carrying a means for perforating the sheath 125' where there are either millings or projections for improving contact with the screen. Alternatively and/or in addition, the contact 126", which is of the same nature as the contact 126', can be used in order itself to become, with resilient, restrained-fixing or welding means, the connection circuit between the screens of the cables. When the screens 122, 122' carry control wires, they are connected by their appropriate contacts, for example, double-fork contacts.

[0046] It is also possible to branch a device or a cable of a different type from the main line 121, 122, 125. On the branch-circuit or line side, the contacts will have the appropriate connection, with reference to the embodiments described.

[0047] Figures 13a and 13b show a variant of the embodiments of Figures 12a, 12b, 12c, relating to cables which are not necessarily flat. Upon the assumption that a cable with braided conductors can be based on the case of cables with single conductors, an embodiment of the invention for a conventional cable, indicated 131 is shown. The cable 131, having conductors 132, is cut on its sheath 133. In Figure 13b, the sheath 133 is shown opened out and the conductors 132 are in a configuration in which the connection takes place in the same ways as in the embodiments of Figures 12c, 3 and 4. The box is indicated 134 and the contacts are indicated 135.

[0048] Figure 14a shows a further embodiment of the connection according to the invention, in which the contacts 142 on the main-line side 141 are formed in accordance with the embodiments described, whereas the solutions used for the branch line vary. The branch line, of which only one of the conductors 143 is shown, is prepared with an end with bare conductors and is engaged in rings or tubes 144 which can be welded, crimped, or connected in some way to the end of each individual conductor, and are usually housed in the box. For crimping, the ring 144 is connected to the ends of the branch conductors 143 by a single-recess or multi-recess tool, as appropriate; for welding on the other hand, it is welded by appropriate methods and techniques of the types described, or of conventional type. If appropriate, the ring 144 is of flat or U-shaped plate and is fixed to the conductor 143 by the techniques described, or by conventional techniques, such as ultrasound or spot welding or by compression.

[0049] Figure 14b shows a detail of a variant of the

contact, indicated 142', carrying a housing 145 with a resilient funnel 145' or spike in which, once the male element 146 of the conductor 146' has been inserted, it is squeezed to a shape such as to prevent its removal, even by pulling. The surface of the housing 145 in contact with the male element 146 is milled and shaped as a half-cap, and is coated with materials which improve contact. The male element 146 constitutes the male portion of a connector fitted on the end of the branch conductor 146'. This solution extends to the insertion of the end of the conductor 146' directly in the housing 145, when the conductor is sufficiently stiff and of suitable dimensions. In this case, the connections are advantageously perpendicular and are usually offset along the main line, but other configurations are not excluded. In the embodiment described, the box is formed in two parts which can be combined perpendicular or parallel to the main line for an outlet of the branch line at an angle or perpendicular to the main line. It should be noted that the branch line is not necessarily of cable with a flat geometrical shape or of the same standard.

[0050] Figure 14c shows a tool according to the invention for keeping the individual conductors 141' of the main line, as well as the conductors 143' of the branch line, aligned. It comprises jaws 149, 149' and 149", 149''' which are shaped so as to keep the lines in position and, when appropriate, also taut, during the stages of the processing of the junction, in particular during the stages of the penetration of the branching contacts into the insulation and into the conductors. The jaws form part of the tool (not included in the drawing) for closing the box. Alternatively, jaws with the same function forming part of the box, such as its lower portion, are provided. The jaws 149, 149' and 149", 149''' are located on the lines at the ends of the regions of the lines which are involved in the branching.

[0051] Figures 14d, 14e, 14f show an example of crimping both of the branch line and of the main line. Figure 14d shows the box with a crimping recess 147, 147'. Figures 14e, 14f show crimpings with square upset or rounded geometrical arrangements, respectively, according to requirements owing to the dimensions and the other parameters of the solution. Figure 14g shows a device for branching by crimping at the two ends of the contact, both on the main-line side and on the branch-line side. In particular, the open, "U"-shaped portion of the contact 142" is fitted on the stripped main line 141' and is then crimped by a tool with a suitable recess which clamps the U-shaped portion around the conductor. This operation is typical for cables with single or, in any case, separate conductors. For a flat cable, stripper elements suitable for the cable, for which reference should be made to Figure 15 and the relative description, are used for the preparation of the main line, in particular, for crimping. Where appropriate, the main line in particular is formed of cut or slotted flat cable of the type described in the embodiments of Figures 9, 10 and 11.

[0052] The invention also relates to solutions with me-

chanical joints with perforation of the insulation. When the branch has to be made in inaccessible positions and its reliability has to be unchanged over time, the stability of the junction is a determining factor. In this case, the technique of crimping around the bare conductor, which is not broken, is recognized as adequate or, alternatively, the technique of welding the branch to the main line is recognized as comparable to the intact cable.

[0053] Prior to the crimping and welding techniques, bare-conductor preparation techniques and tools, of which some examples according to the invention are described below, are used where appropriate.

[0054] Figure 15 is a diagram of a mechanical device for stripping a flat cable 153', which operates without having to break the cable. For the details of the cables referred to below, reference should be made to the examples of Figures 9, 10 and 11. The same tool, apart from modifications where necessary, is used for the stripping of conventional twisted cables, with and without sheaths. Blades, indicated 151 and 152 cut the insulation of the cable longitudinally, separating the conductors 153 from one another physically. Naturally, if the cable is prepared with slots (for example, 93, 93') and, for multi-ribbon cables (Figure 20; slots 205, or pre-incisions 204), the blades 151 and 152 are unnecessary or are limited to tools which can force the pre-incision 204, penetrate the slots, and remove the bridges joining the slots. The shaped or non-shaped stripper blades 154 cut and strip the insulation along the cable, exposing a portion of each conductor 153 suitable for crimping or welding. The same principle, with the necessary simplifications, is used for stripping on a single transverse line where voltages and insulation characteristics of the junction permit (for example, for long distances, with insulating filling of the junction box, and in systems with very low insulation voltage). To assist the stripping blades 154, jaws 155 and 156 are used for assisting the sliding of the insulation along the conductors. The jaws and the blades are shown schematically in Figure 15, for graphical clarity. Where appropriate, the jaws 155 and 156 engage the cable, additionally or alternatively, in the region cut by the blades 151 and 152, and are shaped so as to be offset or in the manner of a Greek key design, according to the positions of the individual stripping blades. The stripping blades adopt positions designed, for example, to achieve the geometrical arrangement of Figure 1a. Naturally, the blades and the jaws are mounted on suitable movement mechanisms. Moreover, longitudinal blades, indicated 159, 159', cut the sheath and the insulation of the cable longitudinally to facilitate the detachment of the separated piece of insulation.

[0055] Figures 15a and 15b show, schematically, in longitudinal elevation and in cross-section with respect to the line to be stripped, a wedge-shaped variant of the stripping blades. A wedge-shaped blade 154' is engaged on each of the conductors 153 by means of a slot 154". For lines the insulation of which require it, two

pairs of pulling jaws 155' are provided. The insulation of the cable is cut and opened out by compression, exposing a portion of the conductor. The tips of the wedge-shaped blade 154' assist the cutting of the insulation.

[0056] In addition to the mechanical device, for cables with temperature-sensitive insulations and sheaths, a heating device, shown schematically in the drawing, is added to the tool and comprises a duct 157 for air heated and moved by the heating unit, as well as a blower 158.

[0057] To facilitate cleaning or to complete the stripping down to the insulating layers adhering to the conductor 153 (which are not shown in the drawing), a brush device 159 shown schematically in the drawing, is provided for insertion in the stripping of the cable. Alternatively, a device for circulating abrasive particles, or fluids containing sandblasting particles, or energy beams (laser, plasma, etc.) are provided, with respective means for cleaning and removal of the insulation waste, with dimensions and adjustments suitable for removing the above-mentioned insulating layers with minimal damage to the conductors, to the tool, and to the subsequent process.

[0058] Solutions according to the invention for the removal of the insulation by high temperatures, which are advantageous, in particular, for branching by welding, are described below.

[0059] In general, it is advantageous to weld copper by brazing, ultrasound, TIG, or contact resistance, in accordance with conventionally known techniques and processes and with conventional materials.

[0060] The stripping system described with reference to Figure 15 is effective but is subject to stress in the conductors, to limitations of the types of insulation used, and to use preferably in bench and manual apparatus. For apparatus, machines, and methods in which their use is suitable, Figure 16 shows a detail of apparatus for vaporizing the insulation by thermal energy.

[0061] The thermal energy is generated either independently or, for use in hot-joining or welding apparatus, by the same source which then heats the conductors 161 for welding. The portion, indicated 161, of a conductor of a flat or conventional cable 161' is inserted in the apparatus, which has a cooling mass 162 composed of several parts in order to form a chamber 162' which can be opened for the insertion of the cable 161', where required by the application.

[0062] An energy beam 164 is delivered by a laser system comprising optics, devices 163 for aiming and focusing/defocusing the beam 164', as well as an optional scanner. The laser system is preferably of the diode or CO₂ type (since this technique is advantageous as an initiator of the combustion of combustible insulations, possibly in an oxygen-enriched atmosphere, with minimal damage to the tool). The above-mentioned beam is applied to the insulation 161" which reaches a temperature such as to burn, incinerate and vaporize. The apparatus shown schematically also comprises a fluid-supply nozzle 165 supplied by a pipe 165' for the

supply, initially of oxygen to promote the chemical insulation-removal reaction, and then of a known fluid, in the case in question, argon, for preventing oxidation of the metal of the conductor 161. As an alternative to, or before the argon, and in the presence of an ejector for protecting the laser optics, there is provision for the supply of a fluid containing abrasive material to minimize residues on the conductor. The cooling mass 162 limits the stripping effect to the treatment region of the cable in the chamber 162' and protects its insulation from damage. A suction duct 166, complete with an exhaust fan, generally indicated 167, keeps the chamber 162' at reduced pressure and helps to optimize the flows and to remove the gases and the soot produced. A further function of the fan/duct 166, 167 is to produce a flow of gas which is practically independent of the ventilation conditions of the location, where appropriate, for example, for on-site joining.

[0063] The laser system shown schematically in Figure 16 may be replaced, where necessary, by a plasma gun, by TIG (or MIG) electrodes, by an electrical resistor, or by a combustion flame, which energy sources may also be combined with one another for the same purpose, with respective tooling configurations based on each source. The operative configuration is preselected in dependence on the apparatus for connecting between the lines.

[0064] As already mentioned, with welded and brazed connections, reliability equal to that of the intact conductors can be achieved so that, with suitable protection and suitable insulation in accordance with the embodiments of the invention described, these connections can even be installed in inaccessible places, in the same manner as intact cable.

[0065] After stripping, the welding between the conductors takes place by one of the techniques mentioned, usually with the use of hot-stripping apparatus combined with welding apparatus. Figure 17 shows partially apparatus for the positioning and welding of the main and branch lines.

[0066] The laser-welding apparatus generates a beam 171 focused at 171' with characteristics suitable for increasing the temperature of the welding metal, that is, the wires 172 of the main line and 173 of the branch line, or the added material 178, with or without flux, (if brazing is to be performed, the protection gases or the flux in the vapour form 175). The apparatus is completed by a positioner for the branch cable 173 which may or may not form part of the nozzle unit 176 and which has degrees of freedom suitable for bringing the partially-stripped end of the branch conductor 173 towards the conductor 172. The apparatus portion 176 forming the chamber and the portion 179 for positioning the branch cable also has the function of absorbing heat of the welding energy in order not to damage the insulation, in accordance with the same criteria described with reference to Figure 16. The apparatus is indicated schematically by a single conductor but may be multiple for the

number of conductors which form the junction. The welding head may optionally be single, for reasons of economy, and movable from one conductor to another, with nodes and translators, whereas its formation with multiple heads (one for each conductor) or with multi-beam focusing achieves a parallel process. As an alternative to the cleaning and laser brazing described, ultrasound welding, Microtig welding, Micromig welding, and resistance welding by conventional techniques are provided for. The process is similar, but resistance welding is less flexible in use, ultrasound welding is more awkward if impurities are present in the welding area, and Microtig and Micromig welding are suitable for high-speed processes, whether they are automated in a workshop, or on the bench, either for prefabrication, or in situ. Cooling jackets, gas exhausters and accessories suitable for the correct use of each individual technique are of conventional type and are therefore not described in detail.

[0067] Figures 17a and 17b show schematically, in longitudinal elevation and in cross-section, respectively, a device for joining by brazing. The example is based on tinning but may be extended to other techniques. A wedge-shaped, or alternatively dish-shaped, device with a hollow interior, indicated 180, is made of high-melting metal, for example, copper, alloys thereof, steel, or with metallized insulating walls 180, 180', for example, of copper-coated vetronite. The same insulation may form part of the box 176' or of parts thereof which are covered by an adequate layer of metallic material and brazing flux 180". A slot, indicated 179', which houses the two conductors, may, additionally or alternatively, be shaped for the stripping at least of the line 172'. The line 173' is the branch line which is inserted, preferably already pre-stripped at its end. Once the device is arranged as in Figures 17a, 17b, it is heated by conduction, by flame, or by another heat-supply means, until the brazing material 180" melts on the walls and the conductors are then brazed to one another and/or also to the conductive surface 180'.

[0068] The same configuration and method are suitable for the use of pastes or conductive varnishes that can be hardened, such as to create the electrical connection by chemical reaction, and for amalgams in the widest sense.

[0069] The joint according to Figures 17a and 17b is repeated for each conductor of the lines located in a box 176' having the characteristics of the examples already described. Where appropriate, for example, when the system requires a fire-resistant box 176', the above-mentioned junction is formed directly by the box 176'. The brazing material 180" is usually high-melting. The properties of the "fire resistant" junction are thus ensured without further measures. The heat for melting the welding material is supplied directly or through the box 176', as appropriate.

[0070] Figure 18 shows a completed junction between a branch line and a main line, for example, lines

formed by several individual conductors and installed in cable ducts or similar constructions, that is, with cables of the type shown in Figure 13a, or of another appropriate type. In Figure 18, a line 181 extends in a cable duct 183 of appropriate cross-section, in the embodiment shown, with a circular cross-section. The cable duct is interrupted at 183 and 183' for the insertion of a T-shaped openable joint of which the lower half-shell 185, which carries engagement recesses 185', 185", 185''' for the cable ducts 183, 183', 184 and an engagement recess 186' for a perforated-insulation or welded junction, indicated 186, are shown. The junction 186 and the recess 186' are formed integrally in the same component (T-joint as junction box with insulation perforation) or with the recess 186' as the container of the junction 186. The upper half-shell of the junction of Figure 18 and its closure devices, which are formed, purely by way of example, by hooks, not shown, perform the closure function. This junction solution as a whole is particularly advantageous in junctions in which considerable protection of the cable and of the protection, mechanical protection, anti-explosive protection, or watertightness is required.

[0071] Figure 18a shows a junction similar to the solution of Figure 18 to which the same details relate, and the box 187 of which is formed so as to carry the line 181' shown with three wires in the drawing, and, where appropriate, with more wires, with the addition, for example, of the control wires of an electronic, or electrical device 188, possibly controlled optically by means of a sensor 190 or by radio. The main line contacts 181', for example, the power contacts, are shown, including any signal contacts and the contacts 189 relating to the branch line 182'. The box is designed to carry both the input contacts and the output contacts, in accordance with an appropriate standard, and to provide housing in accordance with an appropriate standard for the devices 188, for example, on an electronic board.

[0072] Figure 19 shows a junction in which a line 192 branches from a main line 191 and in turn branches in two directions. This solution can relate to all of the junction examples according to the invention already described above and has the purpose of enabling double junctions to be formed by a single branching device 193.

[0073] The embodiments described above can be extended to double-T-shaped devices or to devices with double branch-line outputs which can be related to Figures 18 and 18a.

[0074] The joints are also formed, according to the appropriate geometry, for parallel, inclined, or perpendicular lines, according to the specific requirement.

[0075] The shape of the box and of the contacts is such that the solutions described also extend to devices which are not junction devices but which in any case are disposed on main lines and branch lines, even in the vicinity of or on apparatus, users, etc., also including internal active and passive processing, protection, safety devices etc., such as jumpers, fuses, switches, relays,

and line, branch or user sensors, actuators, amplifiers, decoders, or regulators.

[0076] In the field to which the invention relates, there is often a need to lay several cables, one or more cables for each service, each of the cables extending along practically parallel paths. The conventional technique provides for the laying of several cables in parallel or the incorporation of several cables in the same sheath and several functions or services are thus incorporated in the same physical object, or the signals are converted and then, with encoding, modulation, and multiplexing, are exchanged between devices, in which they are re-converted. Moreover, some services are characterized by several cables; a device, or several distributed devices which require supply and signal connection, or in any case multiple connection, are mentioned by way of example.

[0077] In particular, there are systems which necessarily have to be spaced apart for ordinary reasons or because of standards. There are systems in which the cables extend in parallel for some portions and have junctions on their paths. They are physically separate, and each has a separate junction and they are therefore laid and processed separately.

[0078] Figure 20 shows a cable 201 composed, by way of example, of two flat cables 202, 202', and a coaxial cable or optical cable 202" the structure of which may or may not be suitable for junctions such as those described above. The lines 202, 202', 202" carry electrical (and optical) quantities in a broad sense, such as power and signals. The lines are fixed together by means of ribbon bridges 203, 203', 203" the distance apart and structures of which are constructed suitably on the basis of the services, of the EMIs, of the requirements of the standards, and of design suitability. The individual components of the lines 202, 202', 202", the conductors, the insulations, the sheaths, the fibres, and the tensile elements, are formed in accordance with the most suitable techniques and for the demands required. For the lines of Figure 20 which require screening, two solutions are proposed: the solution of partial screening with ribbon, with or without control wire (in the earth plane), or the solution of complete screening. For the detail of these solutions, reference is made to Figures 12 and 16 and to the descriptions thereof. For the pre-incision 204, reference is made to Figures 9, 10 and 11. It is performed with the function of facilitating the physical separation between the lines 202, either at the level of each individual cable or of both, at the moment at which they have to be separated either in order to follow separate paths, where appropriate, or in order to be inserted in different apparatus, to be inserted in different apparatus connections, by stripping or other processes. Each line 202 is either of conventional construction or of ribbon construction, that is, a flat cable, as appropriate, since each line is viewed as an individual subject which in turn is incorporated in a parallel arrangement. The cable 201 as a whole is suitable either to be laid by

conventional means or to be placed, flat, bent, or enveloped in a cable duct, individually or in groups. Its lines 202 can be bent to angles, as appropriate. Partial or total connections and junctions may be made by conventional methods and those according to the invention. Solutions with slots 205 of the type described with reference to Figures 9, 10 and 11 are provided for. One application is that provided in circuits which have to have redundancy. When two or more lines serve, in parallel or in loops, circuits or devices (for example, in the case of security loudspeaker systems) which are offset or have multiple terminals with several inputs that are independent or are to be combined internally, the lines, each of which is not necessarily of flat cable, are arranged in the generic configuration of Figure 20, at the distances and with the devices provided for by the techniques, by the standards, by the system, etc.

[0079] In addition to the solution of cables slotted at the production stage, the inventive concept extends to flat cable produced without slots, holes, pre-incision, etc., these being formed at the moment of use, in the most convenient manner with regard to position and shape, for example, loops of the junction box, by punches or other tools.

[0080] Figure 20 shows how, as well as being constructed in conventional manner for flat cables, the ribbon of lines may also be constructed by the joining of two secondary insulation films 203, possibly multi-layered films, and possibly metallized for screening functions, so as also to carry lines of different kinds. Slots 205 and the incisions 204, as in the embodiment of Figure 20, are produced by punching at the time of the production of the ribbon or at the time of its processing.

[0081] Figure 20b shows schematically apparatus for producing the ribbon of cables shown in Figure 20a, even in short lengths. Machines of small dimensions are also produced for short lengths of ribbon, according to Figure 20b. The line is removed in predefined ribbon regions, where appropriate, for example, because the service is not necessary, with advantages of weight, costs, etc.

[0082] Reels, indicated 2001 and 2001' carry respective ribbons 2004 and 2004' in which the face 2014 is insulating and the face 2013 is adhesive, for example, owing to heating or owing to the addition of glue, activator, etc. The ribbon and adhesive are selected from fully-insulated or metallized multi-layered structures with adhesive on the outer reeling face (or as provided for by the machine). Reels, indicated 2002, with grooved rollers and locating templates 2003, carry the cables and the lines to be insulated. A suitable number of rollers 2005, also grooved, perform the shaping of the ribbon on the lines unwound from the reels 2002. A suitable number of activators (in the embodiment in question heaters) 2007 increase the plasticity of the ribbons and cause the glue to react. A rotary punching machine 2006, 2006' performs longitudinal punchings and pre-incisions in the ribbon for the advantages described in

the text. The punching machine 2006, 2006' has tools which can be opened upon command so as to form the slots and the incisions where appropriate.

[0083] The cables inserted in the ribbons may be changed during processing, for example, by means of an additional reel 2002' for the addition or removal of conductors and lines or for the formation of cables of preselected length.

[0084] From the dimensional point of view, the cross-sections of the line conductors is preferably between the minimum sections which can technically be achieved, in practice, of 0.01 sq.mm. and a cross-section of 50 sq. mm. with main-line cross-sections of up to 120 sq. mm. According to the types and cross-sections of the line, the primary insulations of the conductors are included, from simple lacquering to a thickness of 1.6 mm or, in any case such as to be suitable in accordance with applications and standards. The materials used are copper, possibly tinned and annealed, or aluminium, also nickel-plated and tinned, for the conductors, and typical elastomers such as G5 rubber XLPE, silicones, PVC, vetronites with or without copper coating, polyesters, electro-glass, mineral insulations such as mica, and mica-coated ribbons, for the insulators.

[0085] Similarly, the junctions, the branches, the accessories, etc. have dimensions suitable for currents of up to 25 amperes, extending to main line capacities of up to 150 A.

[0086] The typical working voltages for alternating current, direct current, and signals are up to 220V, extending to 1000V for distances and insulations of suitable quality and dimensions.

[0087] For "special" cables in which there are impedance, frequency-response or pulse requirements, etc., for optical fibres, and for the resulting branches, reference should be made to the quantities which are typical for the respective systems.

[0088] The typical width of the flat cable is from 2 to 200 mm, the width of the multi-cable ribbons of Figure 20 is from 3 to 300 mm.

[0089] The number of lines in parallel is defined exclusively by geometrical and service convenience.

[0090] The apparatus is formed by manual, bench or automated production techniques, in accordance with suitable productivity, as appropriate.

[0091] Figures 21 to 24 show non-limiting examples of the application of the above-mentioned components, the devices, and the methods according to the invention.

[0092] Figure 21 shows, schematically, a portion of a system with two junctions 212 and 213 from a line 214, contained in a cable-duct 215 to which respective cable ducts 216 and 217 are fixed. The branch lines supply users 218 and 219 located on respective panels 211, 211'. In particular, the lines and the branches are located in positions which will be inaccessible once the electrical and general installation work is completed.

[0093] The cables 216, 217 are mounted, either independently or in the cable ducts 216' and 217', possibly

on the rear of the panels or enclosed therein, or possibly boxed. The only parts which are accessible, and purely for the period of the execution of the branching, are constituted by the regions of the junctions and by any space required for the apparatus around the junctions 212 and 213. Where this solution is offered, the prefabricated main and branch lines are mounted, irrespective of whether access to the joints is possible, clamped or glued to the walls. Implementation is thus not constrained by the final location, by subsequent processing, or by the testing of the system, since the techniques described in most cases form junctions with reliability equal to that of the intact cable. Implementation takes the form either of pre-wiring in the factory, or of wiring with bench apparatus at the stage of the preparation of the product which, for example, is prefabricated, for example, *in situ*, or at a subsequent stage when the product is complete and the system is complete, during repairs, modifications, or extension, and requires the minimum space purely at the operative moment and for the operative time. Further junctions can be formed, irrespective to the state of advance of the system or of the closure of the structures, since dismantling, pulling and joining of the main line are not necessary. Use in transport means and, in particular, in ships is mentioned by way of non-limiting example, in particular for panelled regions, public areas, stairs, corridors, cabins and similar and adjoining areas. Use in transport means and in particular in ships, particularly for distributed systems, in alarm systems, sound broadcasting, fire-detection systems, cabin supply, lighting, low-voltage, security lighting, signal systems for sensors, automation, and the like, and industrial, civil and safety signal systems are mentioned by way of non-limiting example.

[0094] Figure 22 shows an equipped junction 221, that is, a junction which can perform at least one passive function, in the specific case, that of connecting the main-line 222, the user branch line 223, and the branch line 223' to the switch 226 with a single connection device 221. Purely by extension, a case with a further branch 221' towards two lamps 224, 224' is given by way of example. It should be noted that, where convenient, the branch 221 may be a branch line geometrically in parallel with or geometrically perpendicular to the line, with the appropriate contacts and jumpers.

[0095] Figure 22a shows a solution with a double branch line, where appropriate, with the use of two lengths of cable 223", one for the switch and one for the user, possibly of different kinds, for optimization purposes. In the example shown, the cable 223" has no earth conductor. In addition, a jumper device 229 is shown inside the junction, with contacts formed in accordance with the embodiments described.

[0096] Figure 23 is a diagram of two user branches on the same line but under one switch 236. A line 232 with four conductors is provided, in which the conductor 239 is cut at 239' and 239" to connect the lamps 233, 233'. The switch 236 is disposed between the branches

231', 231" so as to be separated from other possible users upstream and downstream of the circuit shown. Other circuits and junctions formed on the main line 232 are independent.

[0097] Figure 24 shows a branching solution with operating, control and regulation devices. The purpose of this solution is selective control along device signal and power buses. In addition to systems with several lamps which are controlled either with regard to luminous intensity (dimmers) or for light effects, control on buses constituted by cables and groups of cables such as those mentioned above, of generic actuators supplied and operated individually and in groups, in accordance with addresses, codes, frequencies, and signal levels, and hence electrical and optical quantities however they may be expressed, is mentioned. On one line 242, 242' in which the conductors 242 are power conductors and the conductors 242' are control conductors, junctions 241 and 241' contain complete devices 245, 245' for the transmission of signals in a broad sense from controls 246, 246' connected at any convenient point of the main line by the branch lines 243'. The junctions 241' and 241" contain the receivers/actuators 245 and 245' which are addressed, tuned, or in any case respond to signals expressing quantities and addressed to them.

[0098] With similar branch configurations which in any case may be based on the above-mentioned solution and also formed by conventional and standard techniques, it is possible to form sensor networks and buses of sensors, and intelligent, active, passive, and supply devices, all of which, however, are formed with the use of cables and devices as described above according to the invention.

[0099] Figure 25a shows an application of a main line from which locally or remotely controlled devices are branched with a complex distribution. In practice, standard ships' cabins or, in particular those with a high proportion of prefabrication are referred to. These extend to all similar systems, in particular for areas of ships with corridors, stairs, saloons, crew areas, technical areas, navigation, propulsion and control areas in a broad sense, open areas, closed areas, and covered areas in general. Normal, emergency, and external lighting systems, low-power electrical distribution, distributed signal and security systems such as telephones, fire alarms, loudspeakers, bells, supply and control of air-conditioning devices are mentioned by way of non-limiting example. Also mentioned by way of non-limiting example are use in security systems such as the operation and control of doors, fireproof doors, watertight doors, control, supply and piloting of machinery and instruments, communication with and between active and passive means including concentrated, distributed and remote intelligent controllers, active and passive anti-intrusion systems, entertainment, information and security and broadcasting systems, visual remote-control systems with video cameras, monitors, and the like.

[0100] In Figure 25a, cabins, or possibly other loca-

tions, in which there are electrical and signal devices in a broad sense, are indicated 252, 252', respectively. A location or container suitable for the supply and control of the area is indicated 253. Power supplies 253', controls 253", also interconnected with other system branches, controls or signal sources 253'" for security and/or broadcasting systems or in any case distributed systems, are also shown schematically. The main line 251 of suitable cable, multiple where appropriate, of the type described above, conducts both power and signals necessary for the systems of the area concerned. In the case shown, the line 251' represents the conduction of security signals either as several cables in parallel or as a cable bus with decoding and addressing, the line 251" represents the conduction of either normal or emergency energy or both, the line 251'" represents the conduction of the control and services distribution signals. Boxes 254, 254' and 254" with their internal and connected control, branch and user devices, shown schematically and graphically in Figure 25a, are branched from the line by junctions according to the invention. The example extends to generic areas, for example, to public areas, corridors, stairs and to conventional, panelled or prefabricated repetitive areas such as, for example, cabins and the relative control and security devices with their branches 256 and also remote and isolated apparatus/controls with their branches 257. Naturally, the remote-control devices connected in the users or in the branches or in any case provided as boxes, are also installed in positions to which access is difficult since they are devices which are not operated directly but are operated/controlled remotely, requiring access only in exceptional situations. The system as a whole is provided with redundancy by repetition of the strategic apparatus and the distribution or splitting-up of the devices, the users, and the supply systems.

[0101] With reference to Figure 25a, the invention can be used in an electrical and signal bus to replace bus ducts and/or power circuits and sound-broadcasting signal circuits (better described with reference to Figure 25c), alarms and fire detectors, or other users on shipping constructions in cabin areas, corridors and public areas, with flat cables carrying the quantities for controlling the cabins, direct branching of the users, distribution boards of the individual final systems, down to, in some cases, where appropriate, single devices. Specifically, this refers to signal branches for standard, constant-voltage loudspeakers, light and low-voltage up to 220/110V, both alternating and direct emergency supplies, fire alarm signals on low-voltage supply and encoding, where the main line has the configuration described above for a current of the order of 100A for the power conductor and a number of current branches of the order of 16A per individual service, for a number of services and/or of users up to the order of tens and, where appropriate, hundreds. The system for controlling and implementing the functions is based on baseband, frequency, standard open coding (for example, Profi-

bus; Ethernet) or is dedicated. The control system can be extended to several groups of lines supplied either by the supply 253 or by other devices.

[0102] According to the connections in accordance with Figure 25c, and with the provision of devices, boxes, control units, and branches according to Figure 25a, the solutions according to the invention are implemented in accordance with the specific requirements and are either applied to conventional devices or are formed by the same structure, for example, formed by moulding of plastics reinforced with glass fibres, the formation of recesses, etc. of suitable shape. They are connected either by direct junctions included in the box (for example, 254, 257) or by branching and branch lines, where appropriate, for example, for accessibility of controls.

[0103] Figure 25b shows a solution for the connection of a security system. An example of application to a sound broadcasting and alarm system, as well as emergency lighting and control and automation devices, video cameras, multiple viewers, and duplicated devices, is shown. The duplicated main lines 250 and 250' carry the quantity, supply, signal, etc., according to need, in a multi-line, screened or non-screened, ribbon cable. The characteristics of the cable are selected according to the service and the standards with regard to dimensions, distances, materials, and laying, relating to the lines 250, 250' of which it is composed.

[0104] Each of the junctions with branch lines, indicated 255 and 255', respectively, or junctions direct to users, such as 255", involves a single line. This system configuration conforms to the redundancy or duplication of function with the use of a single multiple line instead of several disconnected individual lines. Redundancy is increased by the line-protection device 259 which is either automatic, remote-controlled or controlled on the spot, and can switch the lines in the event of breakdown.

[0105] The device 269 has a switch for switching the lines 250, 250' in the section downstream of the device. When the sensor 259' detects a breakdown, for example, an anomalous load, a short-circuit, an interruption on the downstream section of the line, it switches the lines until it detects a situation recognized as a non-breakdown situation. If the non-breakdown situation is not achievable, the device switches the short-circuit or open circuit condition to the most suitable configuration on the basis of the requirements and characteristics of the service. The faulty service is thus limited to the minimum which can be provided for.

[0106] Figure 25c shows a detail of Figure 25a showing how the box 254 is also connected directly to the main line 251 as well as being branched with a secondary line, whilst being reasonably remote from the main line 251. In Figure 25c, the box 254 is installed, in particular, mounted in or forms an integral part of an area 252 such as a cabin, an electrical device, or a product in general. Since the main line 251 is not rigid, for example, as a bus duct, it is shaped, for example, in a loop or possibly with suitable guides, to reach the junction

258 forming part of the box 254. An additional advantage of this solution is that, in comparison with a rigid line, the absence of the branch line, which is usually of smaller cross-section, protected by devices at the output of the main line, eliminates the need for specific protection.

[0107] The use of lines, junctions, and devices in general as mentioned in the description leads to the advantage of using supports equipped for the orderly and rational support of the lines and of their junctions as well as other devices where appropriate, for example, a bracket, or a rider suitably shaped for supporting the line and for supporting the junction or the lamp connected thereto. The advantage of arranging the cables in an unambiguous and orderly manner and reducing the number of components, weights, dimensions etc., is achieved.

[0108] Figure 26 shows a support of synthetic material and/or of metal which supports one or more cables, not necessarily of flat configuration. The support comprises a bracket which encloses and fixes the cables. The bracket, its parts, and its accessories are appropriately formed. It carries the boxes of the line junctions or the junctions directed to the users or the devices, as appropriate. With combinations of components in accordance with the examples described, distributions by several cables and by several lines in parallel are also achieved. The types of cables and hence the solutions are also applied to cables which are not necessarily flat, according to specific requirements. A bracket 261, shown by way of example, is preferably stiff but may be made formed with another shape and of flexible, adaptable, material, for example, of plastics material. The bracket 261 fixed to the structure 260 is of the open type to facilitate laying of the lines at appropriate moments during installation. The movable closure 261' is formed in accordance with suitable techniques, for example, by the slot technique, by the buckle, bayonet, or screw, technique, or by resilient clips of suitable shape and strength. A crosspiece 262 grips the lines which do not have junctions with surfaces and pins or bending of sheet-metal or projections which clamp the cable, in order to eliminate the use of metal strips. Slotted seats or a single seat 264 and 264' formed in the cross-members 261 and 262 hold any junctions which may be present. The drawing shows a lamp junction 263, a junction for clamping a through line 265, and a line junction 266 to another line. It will be noted that when the bracket 261 is made of metal and is securely connected to earth, as in the case of secure fixing to a metallic structure by screw contact or by resilient pressure against the metal body of the user 263, it forms the earth connection, eliminating the need to distribute the earth by protection conductors. Moreover, a recess for the fixing of conventional multiple cables is indicated 264. The housing is widened by the removal of the rear and front sides of the seat for the junction. Generic cables 267 are laid as required. A clip 268 clamps the bundle of cables at appro-

priate spacing. The cables are fixed to the brackets by fixing the clip to the bracket, for example, by a pin or by means of holes and slots. In an alternative embodiment, not shown in the drawing, the cables are fixed by shaped or non-shaped plugs of suitable flexibility and shape, made of rubber or in any case soft material. The plugs have the advantage of being releasable, replaceable, or reusable should a modification of the route of the cables be required.

[0109] The examples described do not limit the geometrical arrangement, the electrical quantities, or the solutions having the purposes of the invention. The apparatus described is suitable for possible variations with the most appropriate modifications.

[0110] Naturally, shapes of contacts or welds which are repeated to form several contacts in parallel, forming part of the same contact or separate from one another, should be considered to be included within the inventive concept referred to in the embodiments described, in particular, to increase the contact conductance.

[0111] Moreover, the application of different contacts and solutions, provided that they are suitable from the point of view of reliability and appropriateness, fitted in places which are inaccessible or to which access is difficult, can in any case be based on the embodiments described.

[0112] With regard to the applications referred to, those on transport means in general and ships in particular, with single junctions, including connectors or other passive branching devices, active devices such as amplifiers, decoders, etc. for use in screened, coaxial, duplex, or multicore cables in particular, on analog and digital TV signal-distribution, passive antennae or amplifiers fitted on a single cable, sensors, actuators, automation and data-transmission devices are mentioned.

[0113] The junctions also have hermaphrodite components for the most appropriate situations, for example, of a supply to a contact with a female protection solution (for example, supply cable insulated as far as its intersection with the male branching contact and a male contact on the signal line to which the branch cable is to be connected end-to-end).

[0114] The invention thus achieves the aims proposed, overcoming the disadvantages discussed and achieving the advantages mentioned over known solutions.

Claims

1. A device for the branching of power and/or signal lines in the electrical and/or electronics field, particularly in shipping environments, comprising at least three contacts between respective conductors (1, 2, 3) of a main line and a branch line, in which the branching contacts are positioned in a triangular configuration (7, 7', 7'') of which they constitute the vertices, the sides (8, 8'') of the triangular configu-

ration being of a length equal to or greater than a preselected minimum distance between conductors required for their insulation.

2. A device according to Claim 1 in which the conductors of each of the lines have a flat-cable or ribbon configuration and the branching contacts are positioned in non-aligned positions in which each contact is at the minimum distance from the nearest contact, the minimum distance being preselected for the insulation required between the conductors.

3. A device for the branching of power and/or signal lines in the electrical and/or electronic field, particularly in shipping environments, comprising contacts (38) between the conductors of respective main lines (31) and branch lines (33), each of the contacts comprising at least one cutter element for cutting and/or perforating the insulation (35, 36) of each corresponding pair of main and branch conductors for the electrical connection between the conductors, the cutter comprising at least one pair of blades with an offset configuration so as to give rise to a resilient compression torque of the blades on the cross-section of the conductor to ensure improved electrical contact over time.

4. A device according to Claim 3 in which the conductors of the main line (31) and of the branch line (33) have a flat-cable or ribbon configuration.

5. A device according to Claim 3 or Claim 4, comprising a contact-holder support (37) and a junction box for housing the support, opposed pluralities of adjacent recesses being formed on the support and having profiles and relative positions such as to permit a positioning of the cables of the lines with the main conductors (31) arranged in parallel positions, and spaced from the respective branch conductors (33).

6. A device according to Claim 5 in which the junction box comprises at least two half-boxes (39, 40) which can be closed onto one another, each of the half-boxes comprising recesses corresponding to and in positions facing the recesses of the contact-holder support (37).

7. A device according to Claim 6 in which respective pairs of main conductors (31) and branch conductors (33) are perforated by the cutter elements (38) by compression of the half-boxes (39, 40) against one another.

8. A device according to Claim 5 in which the contact-holder support is double-T-shaped in cross-section with opposed ends (44) joined by a central rib, the cutters being supported in the rib, each of the ends

carrying a pair of opposed projections constituting sliding guides for a respective cover (45, 46), the projections and the covers having inclined relative sliding surfaces for a wedge-shaped coupling engagement of the covers in the junction box, the insertion of the covers in the box giving rise to a compression component which can press the cutters (42) against the respective conductors in order to perforate or cut the respective insulation.

9. A device according to Claim 8, comprising means for locking the covers (45, 46) relative to the contact-holder support in the condition in which it is fitted in the junction box.

10. A device according to Claim 9 in which the locking means comprise respective mutually-engageable projections (48) and recesses (47) formed on each of the ends (44) and on each of the covers (45, 46), respectively.

11. A device for the branching of power and/or signal lines in the electrical and/or electronics field, particularly in shipping environments, comprising at least one fork-shaped branching contact (51) with a pair of juxtaposed prongs having respective tips (53') at their free ends, the tips being arranged for cutting the insulating material of the conductor housed between the prongs and being capable of being clinched further towards the conductor in order to clamp the branching contact onto the conductor.

12. A device for the branching of power and/or signal lines in the electrical and/or electronics field, in particular in shipping environments, comprising at least one branching contact between a main line with a screened cable and a corresponding branch line, the cable comprising an inner conductor (61), a screen (63), and an outer sheath (64), the device further comprising a contact-holder support (68') housed in a respective branch box (68), the contact comprising a cutter (65) carrying a tip (69) at its free end and a covering insulating sheath, the cutter being able to perforate the outer sheath (64) and the screen (63) of the cable for contact of the tip (69) with the section of the inner conductor and to insulate the cutter (65) electrically from the screen (63) by contact of the screen with the insulating sheath of the cutter.

13. A device according to Claim 12 in which the cutter (65) is formed with a multi-layered printed-circuit structure with a metal foil core inserted in the sandwich structure and projecting at a tip as well as with insulating layers superimposed on the core.

14. A device according to Claim 12 or Claim 13 in which the branching between the main and branch lines

is achieved by the closure of the contact-holder support by compression against a casing constituting part of the junction box.

5 15. A cable with electrical conductors (91) in a flat configuration, particularly for use in shipping environments, in which the conductors (91) are joined together and incorporated in a ribbon (94, 94') comprising preferential bending and separation lines (92) extending parallel to the conductors for the separation of individual conductors in the cable.

10 16. A cable according to Claim 15, comprising, in the ribbon, slotted openings (93, 93') formed along the preferential separation lines (92) for facilitating the separation of the flat cable into individual conductors.

15 17. A cable according to Claim 15 or Claim 16 in which the slotted openings (93, 93') are offset longitudinally along the length of the ribbon.

20 18. A cable according to Claim 16 or Claim 17 in which the slotted openings (93, 93') are pre-perforated, pre-cut, or pre-marked in the ribbon of the cable.

25 19. A cable, particularly for uses in a shipping environment, with electrical conductors in a flat configuration in which a pair of opposed main faces are identified, the cable comprising a screen (122) associated with the conductors for the screening thereof on at least one of the said faces.

30 20. A cable according to Claim 19 in which the screen (122) has a configuration with a substantially closed profile in cross-section, with a screening and protective effect on the conductors.

35 21. A cable according to Claim 20 in which the metal screen (122) is of the braided type.

40 22. A cable according to one or more of Claims 15 to 21 in which the screen, together with the flat cable, is enveloped in a sheath (125) of approximately circular cross-section, having a cylindrical surface with a recess (124) extending along one of its generatrices for facilitating its opening out in order to adopt the flat-cable configuration.

45 23. A device for the branching of power and/or signal lines in the electrical and/or electronics field, particularly in shipping environments, comprising contacts for branching between main and branch lines, which are formed with cables having a flat configuration according to one or more of Claims 15 to 22.

50 24. A device for the branching of power and/or signal lines in the electrical and/or electronics field, partic-

- ularly in shipping environments, comprising branching contacts (142) between conductors (141) of a main line and conductors (143) of a branch line, the contacts including at least one cutter with an end which can perforate or cut the insulation of the main conductor and an opposite end carrying a ring-shaped element (144) which can be engaged by an end of the branch line with a bare conductor.
25. A device according to Claim 24 in which the ring-shaped element (144) is crimped onto the end of the branch conductor.
26. A device according to Claim 24 in which the ring-shaped element (144) is welded to the end of the branch conductor.
27. A device according to one or more of Claims 24 to 26 in which the ring-shaped element is made of flat plate with a U-shaped configuration.
28. A device according to Claim 24 in which the ring-shaped element is formed with a housing (145) with a resilient funnel or spike for opposing removal of the end of the branch conductor.
29. Apparatus for stripping electrical-conductor cables by removal of the insulating material, particularly for uses in shipping environments, comprising a pair of blades (154') converging in a wedge-shaped arrangement, each blade having a slot (154'') with an at least partially sharp profile, for being engaged by the section of the conductor, the engagement of the blades on the conductor leading to the cutting and opening-out of the insulation, exposing a portion of conductor.
30. Apparatus according to Claim 29, comprising a heating device including a duct (157) for directing air onto the portion subjected to stripping, as well as a blower device (158) associated with the duct.
31. Apparatus for the removal of the insulation of sheaths of electrical-conductor cables, particularly for uses in shipping environments, comprising a vaporization device including a laser system for generating an energy beam (164), means (162) for aiming and focusing the beam onto a portion of insulation to be removed, nozzle means (165) associated with the portion for supplying operative fluids for promoting the chemical insulation-removal reaction and opposing oxidation of the conductor metal, cooling means (162) for limiting the stripping effect to the portion subject to removal, and suction means (166) arranged for removing the reaction gases produced.
32. Apparatus for implementing power and/or signal lines in the electrical and/or electronics field, particularly in shipping environments, comprising welding means for generating a beam (171) of energy to promote the welded joining of an end of a branch conductor (173) to a portion of a main conductor, means for positioning the end relative to the portion, possibly after stripping of the end, as well as means for supplying the material to be added in the welding process.
33. Apparatus according to Claim 32 in which the welding means are of the laser type.
34. A cable with multi-service electrical conductors, comprising cables with a flat configuration, coaxial cables and optical cables and having a ribbon configuration, according to one or more of Claims 15 to 22.
35. A support for branching devices of one or more lines branched from a main line, particularly for shipping environments, comprising at least one bracket (261) which can be closed releasably on a cross-piece (262), as well as seats (264, 264') for housing branching devices (263, 265, 266) formed in accordance with the preceding claims, the seats being formed partly on the bracket (261) and partly on the crosspiece (262), the seats being accessible after opening of the bracket (261).
36. A ship structure such as a cabin (252, 252') or the like, comprising at least one pre-wired connection line for internal installations, the line being capable of being connected to a main electrical distribution and signal line (251), in which optional pre-wiring and/or the connection between branch and main line are performed by branching devices and/or by flat or ribbon cables formed in accordance with one or more of Claims 1 to 35.
37. A machine for the production of flat ribbon cables according to one or more of Claims 15 to 22, comprising reels (2002) for the supply of respective conductors arranged parallel and spaced apart in a flat configuration, and at least one pair of further reels (2001, 2001') for supplying respective films (2004, 2004') which can be fixed together, in which the conductors are compressed in a sandwich between the films.
38. A machine according to Claim 37, comprising means for punching the flat ribbon cables.
39. A junction for the connection of a branch line (182) to a main electrical distribution and signal line (181) particularly in shipping environments, in which the main line (181) is installed in a cable duct (183) and the junction is T-shaped and is integrated with a

branching device formed in accordance with one or more of Claims 1 to 14 and 23 to 29.

- 40.** A branching device according to one or more of Claims 1 to 14 and 23 to 29 further comprising at least one electrical/electronic control device (188), incorporated therein.

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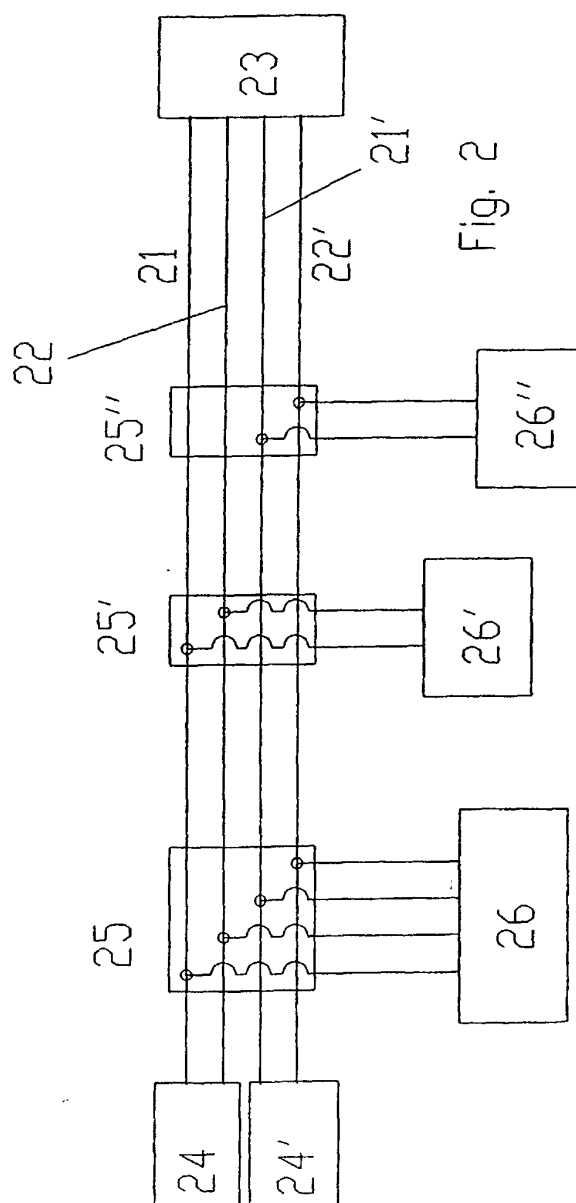
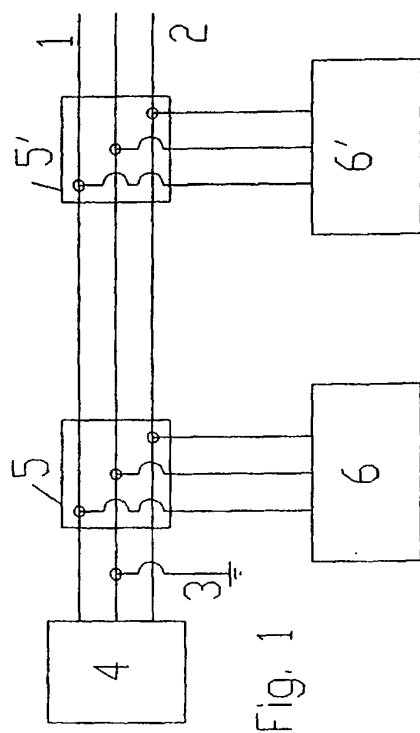
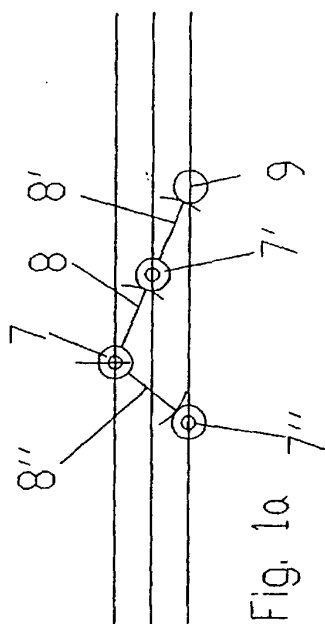
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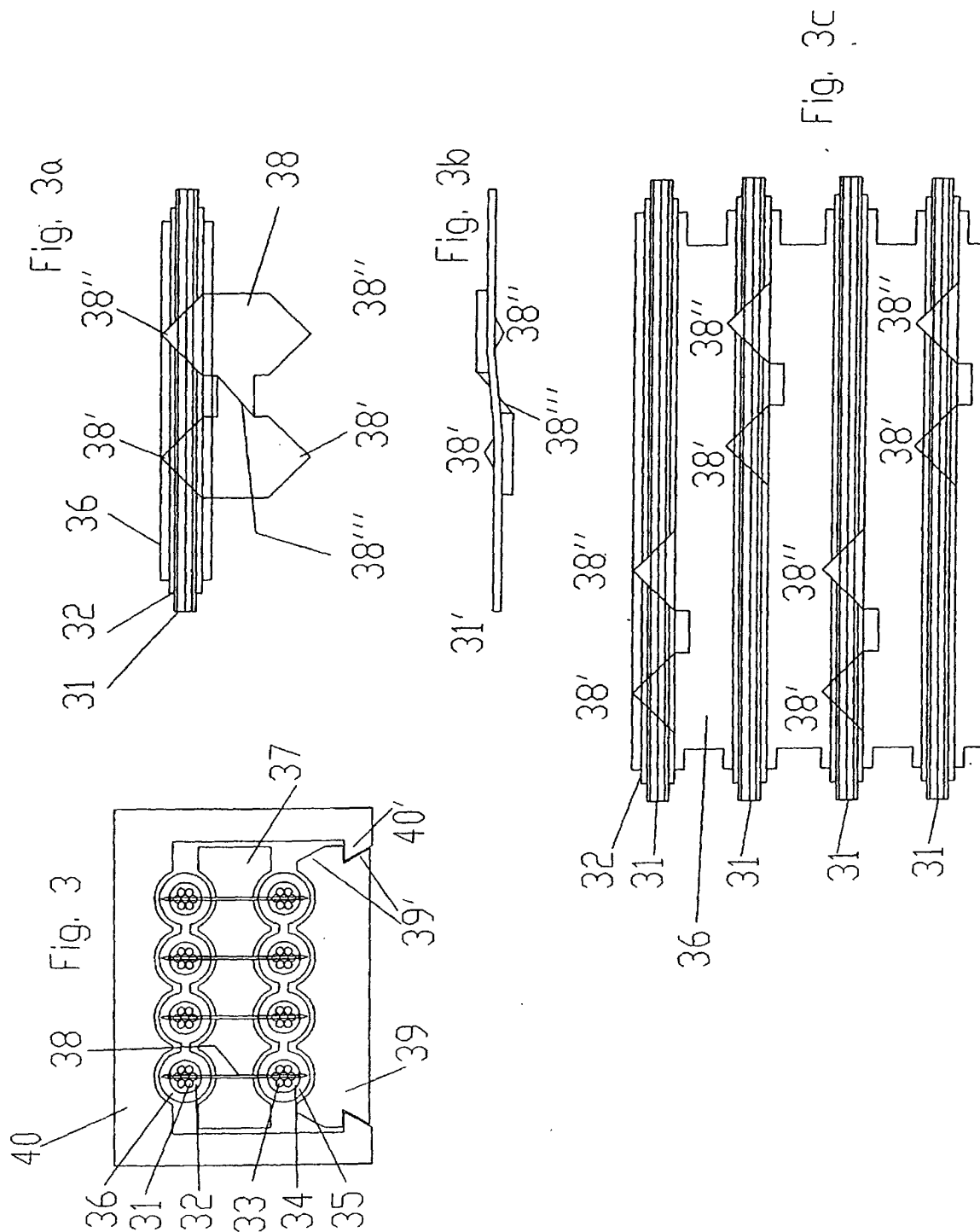
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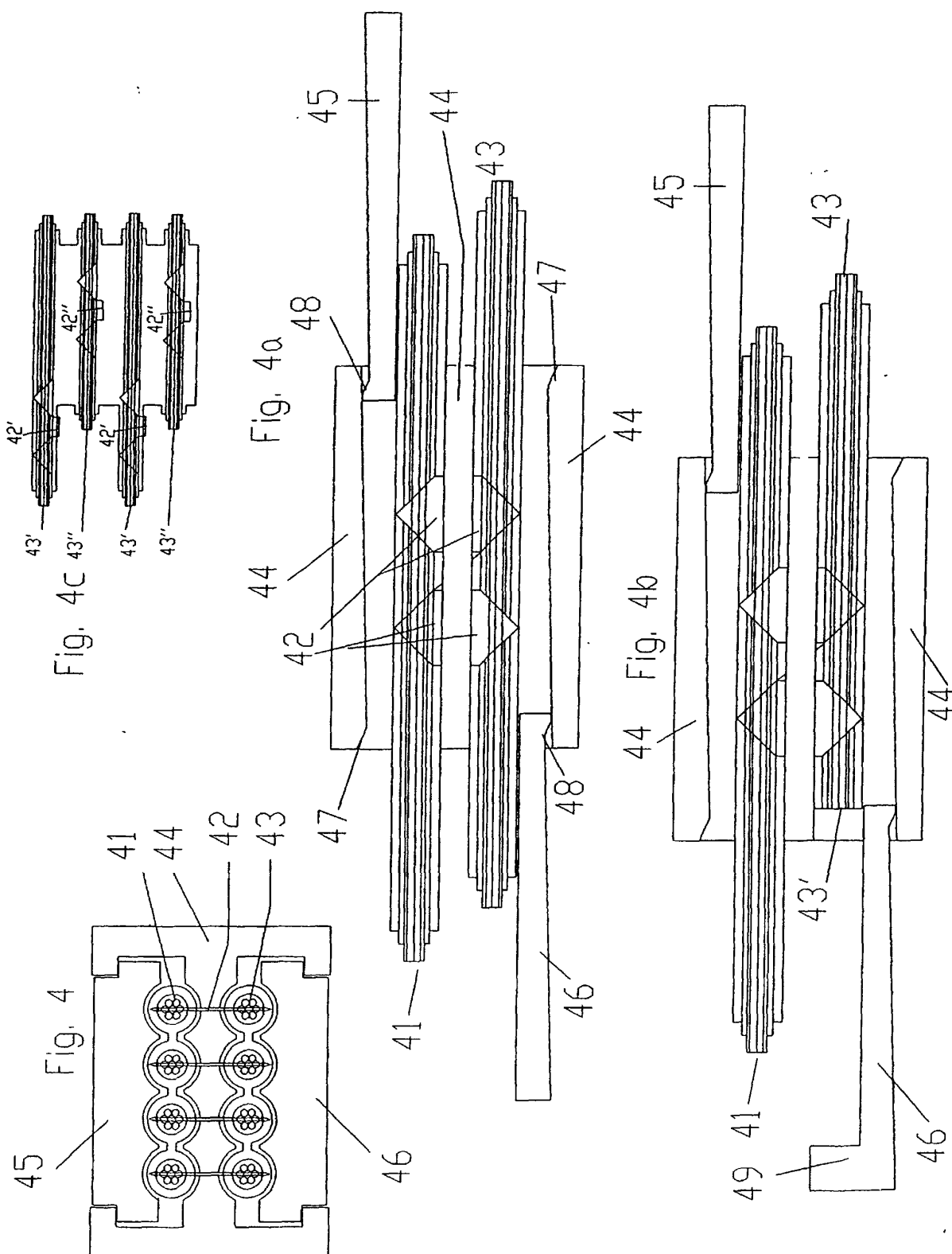
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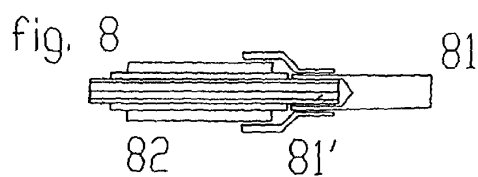
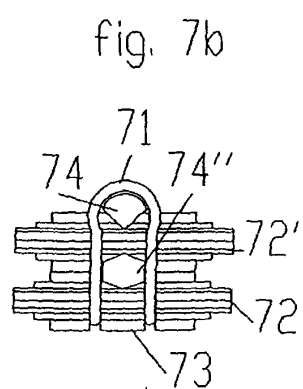
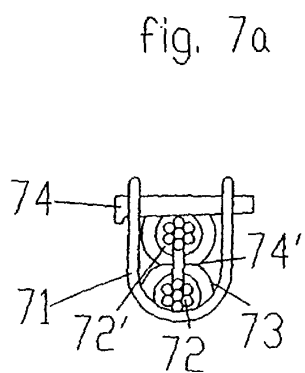
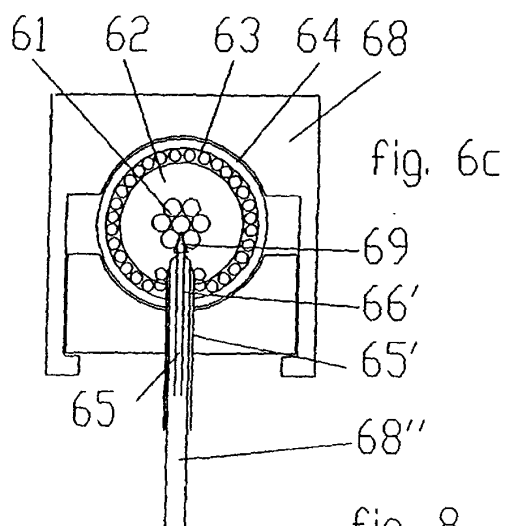
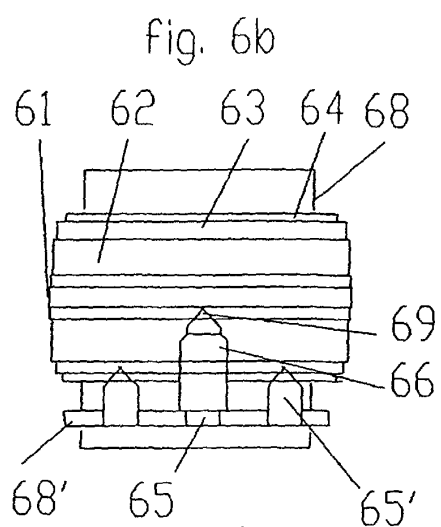
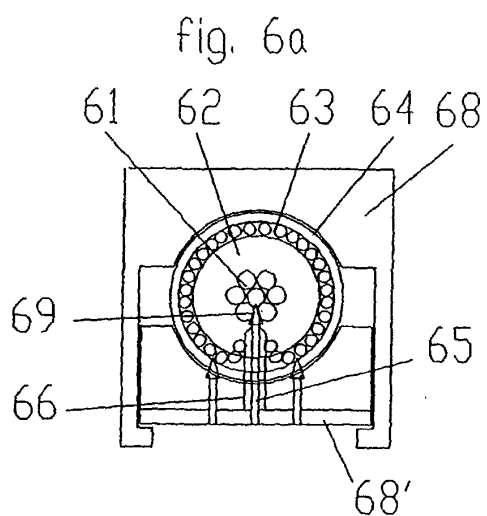
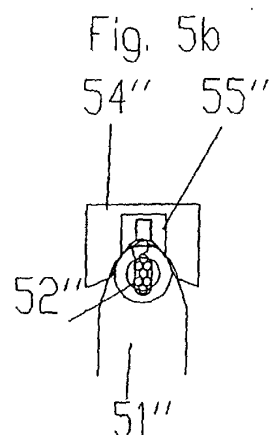
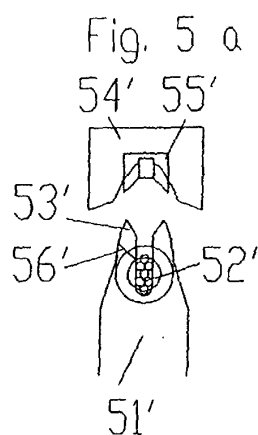
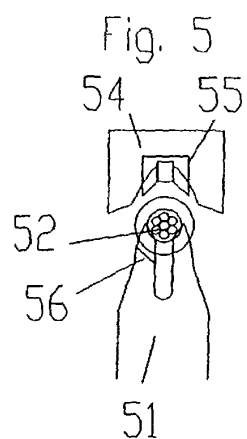
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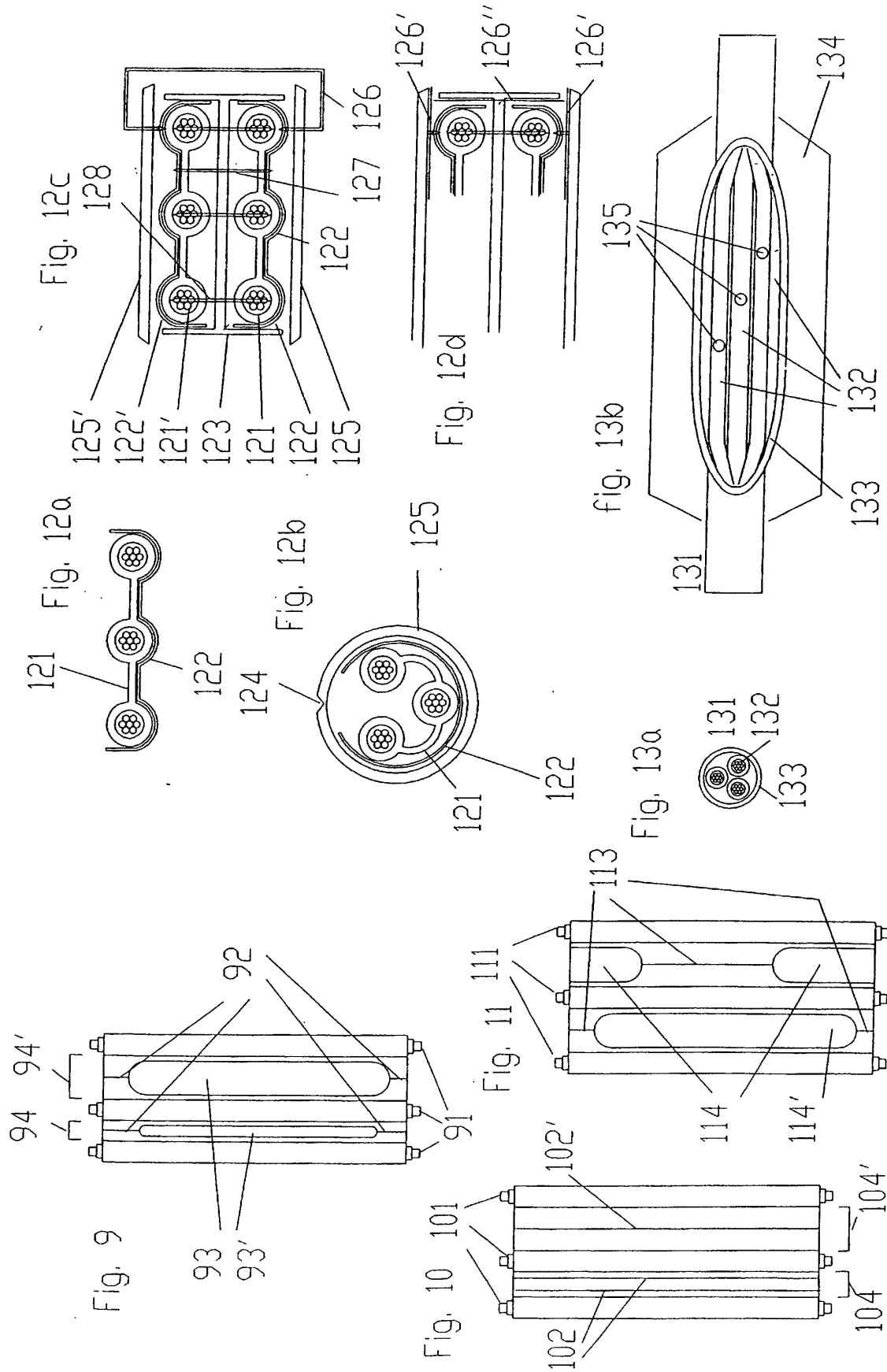
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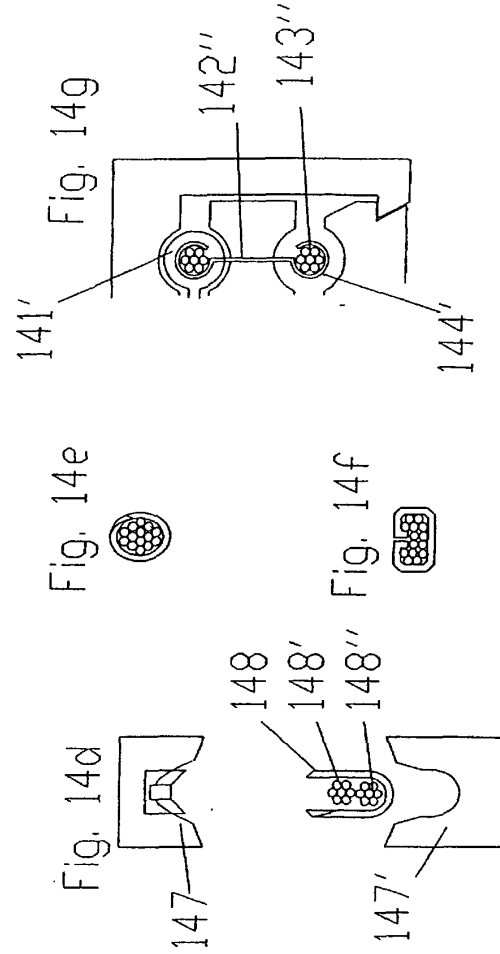
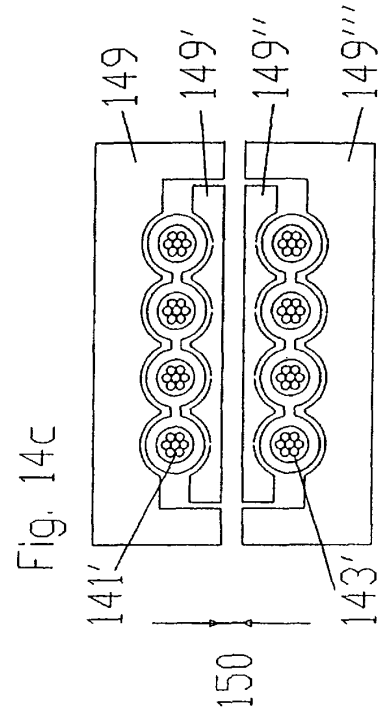
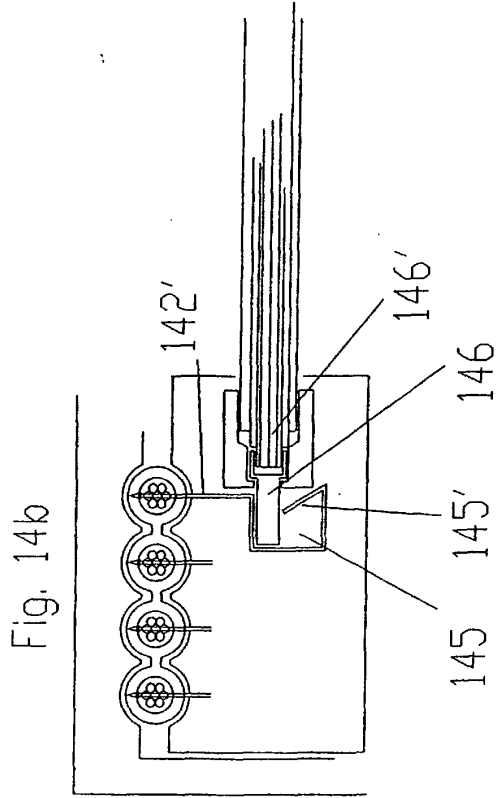
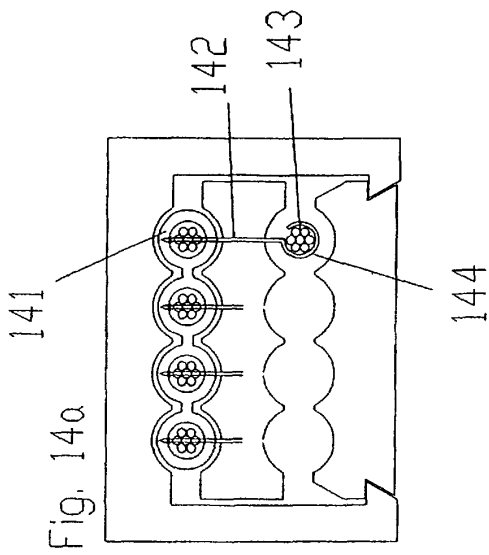












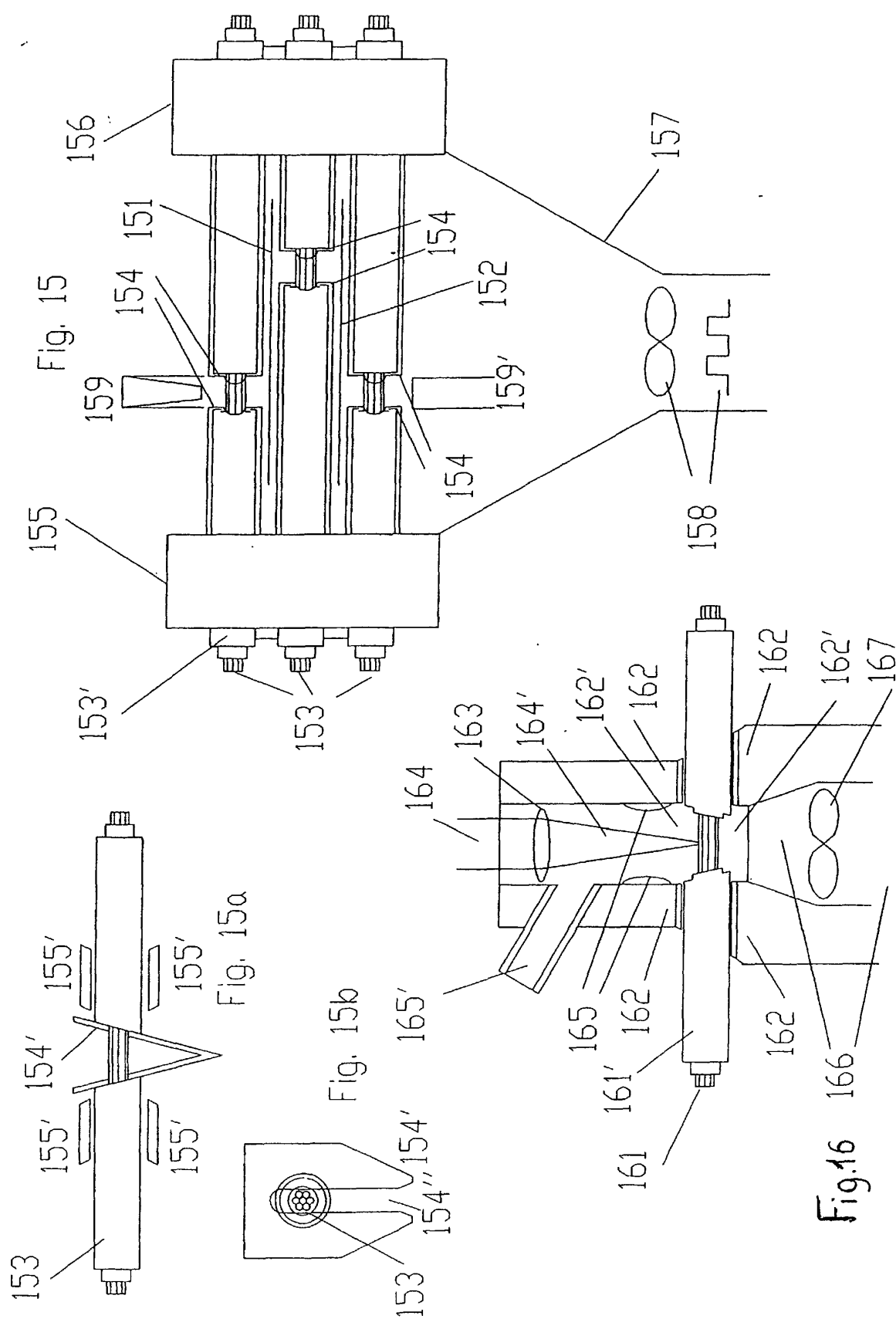


Fig. 17

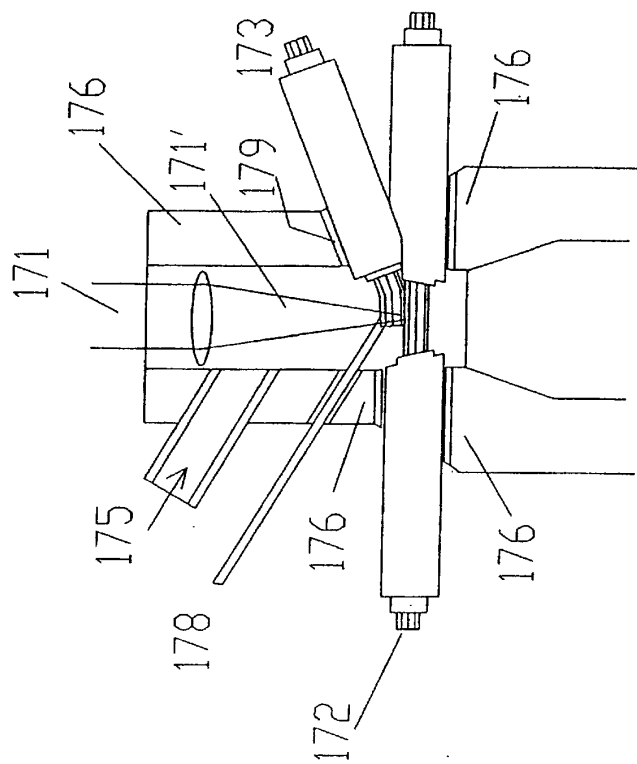


Fig. 17a

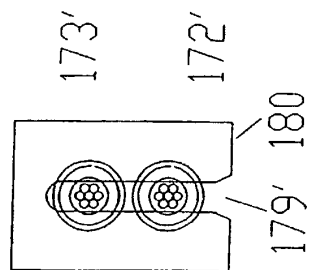


Fig. 17b

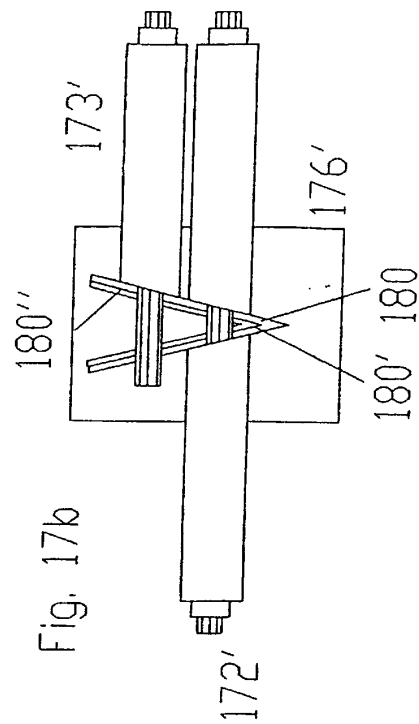


Fig. 18a

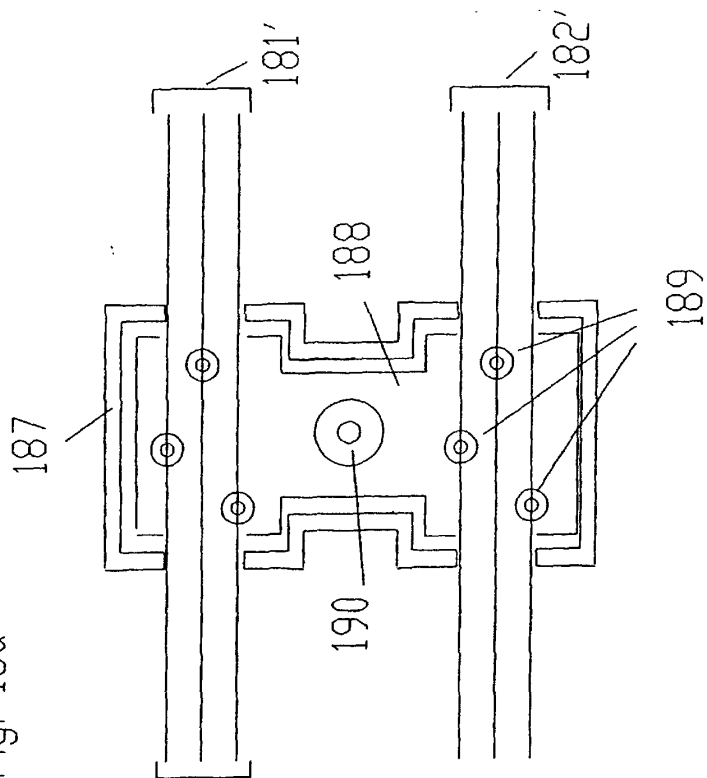


Fig. 18

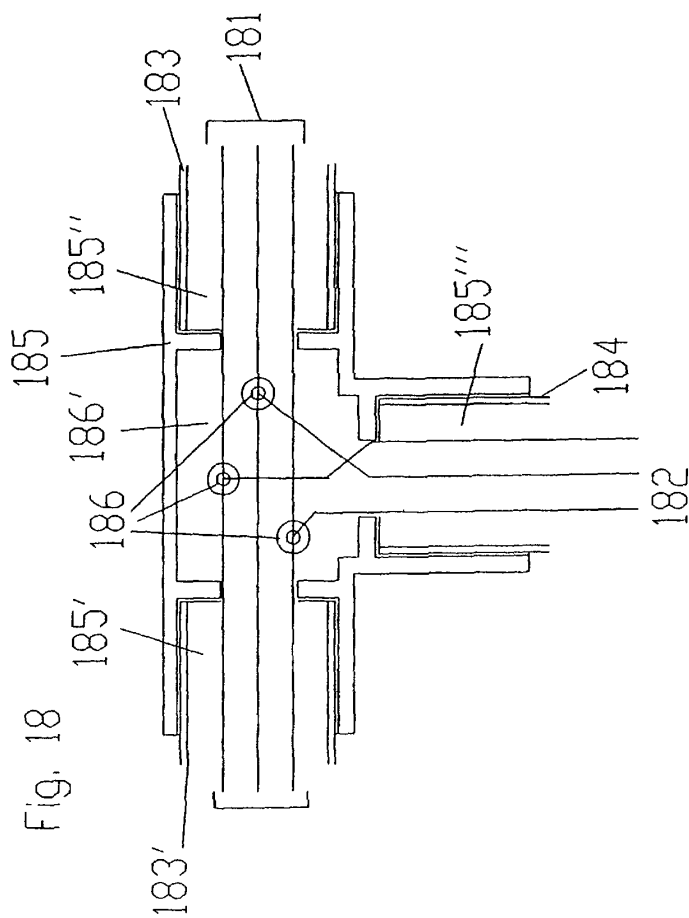
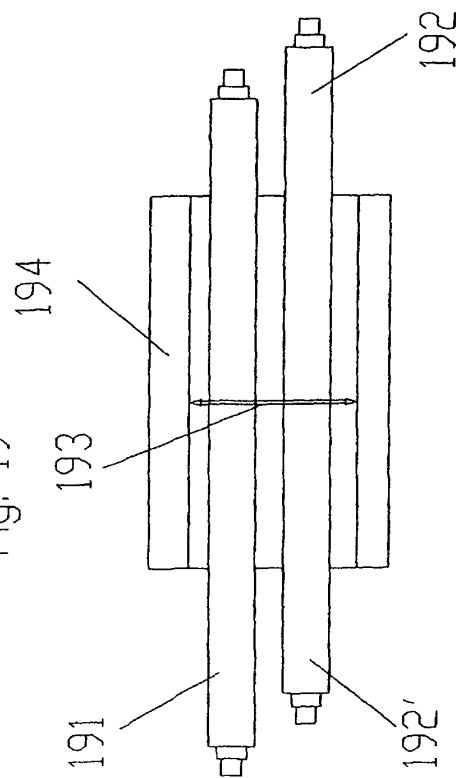


Fig. 19



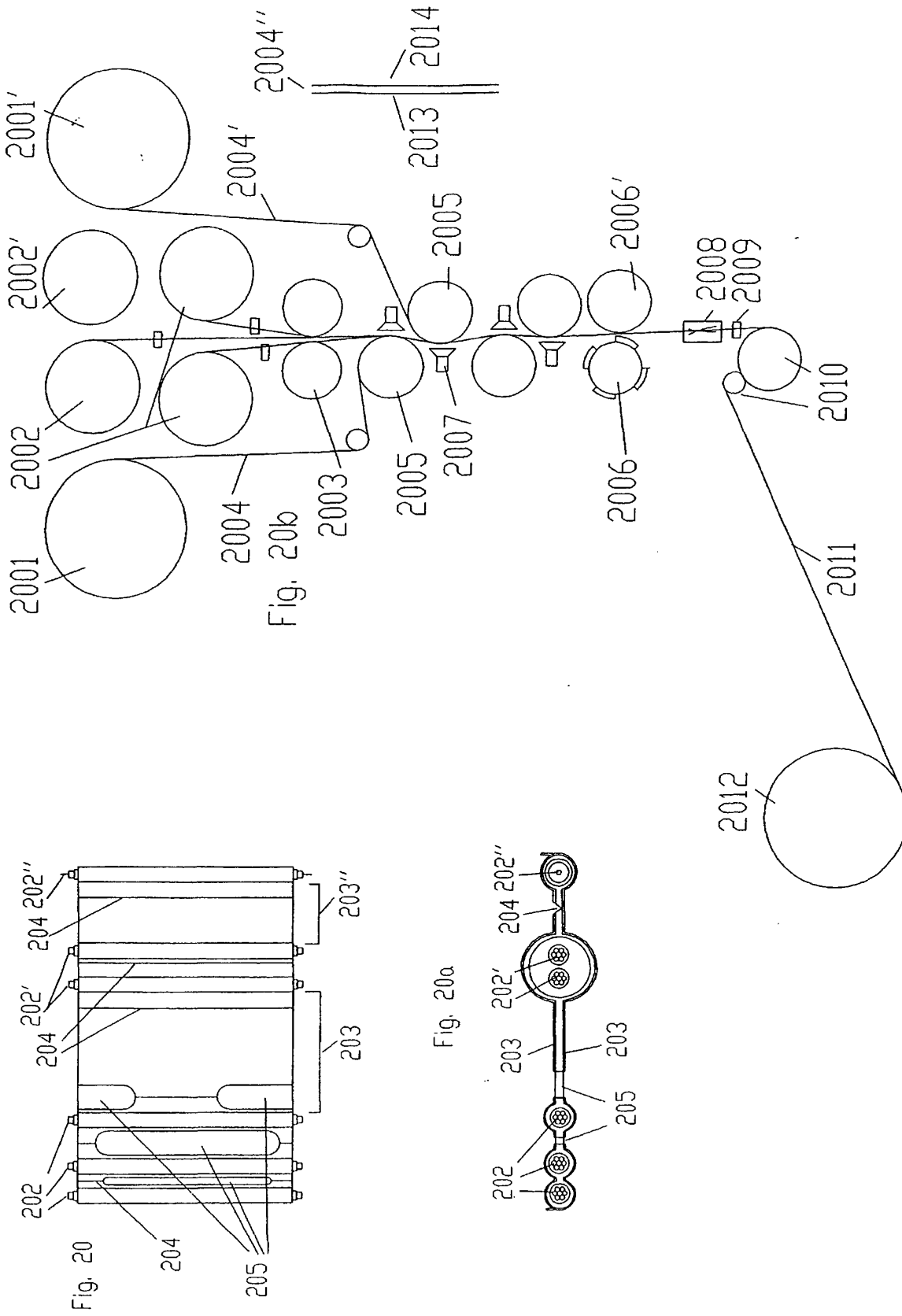


Fig. 21

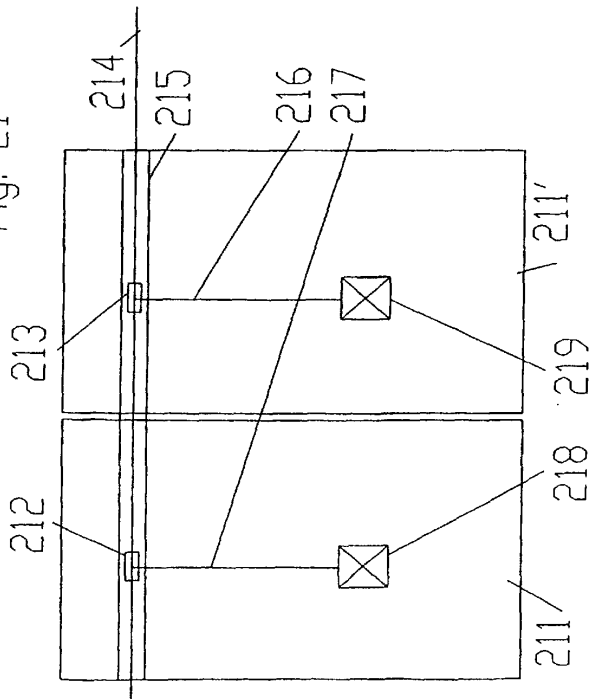


Fig. 22

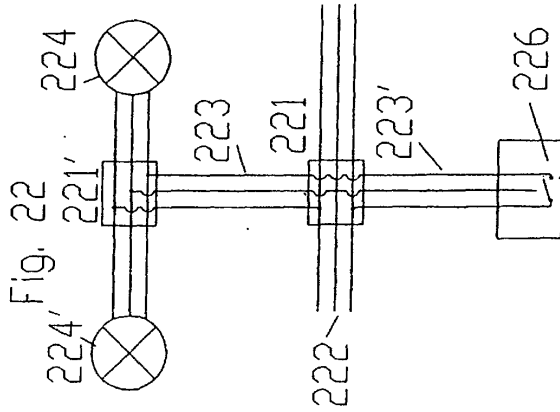


Fig. 22a

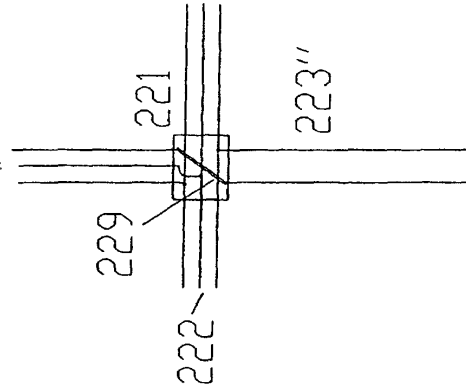


Fig. 23

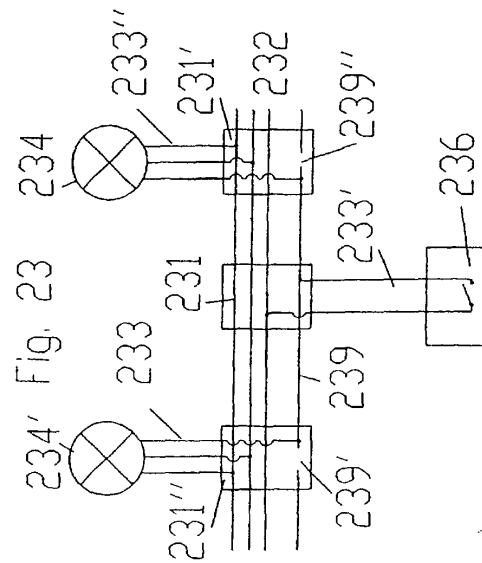


Fig. 24

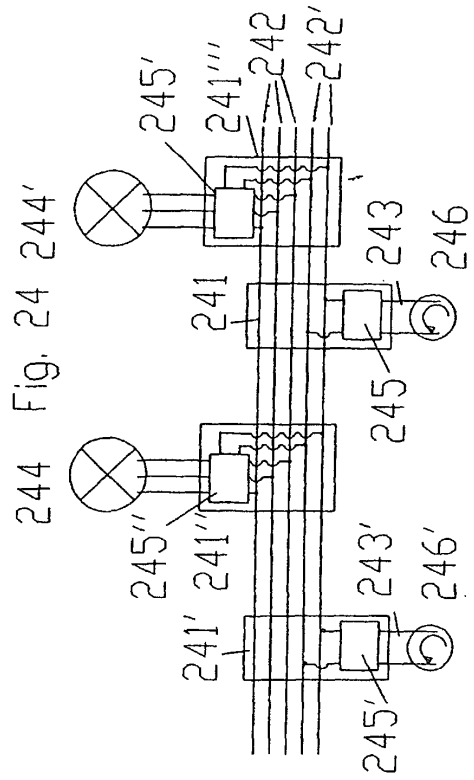


Fig. 25a

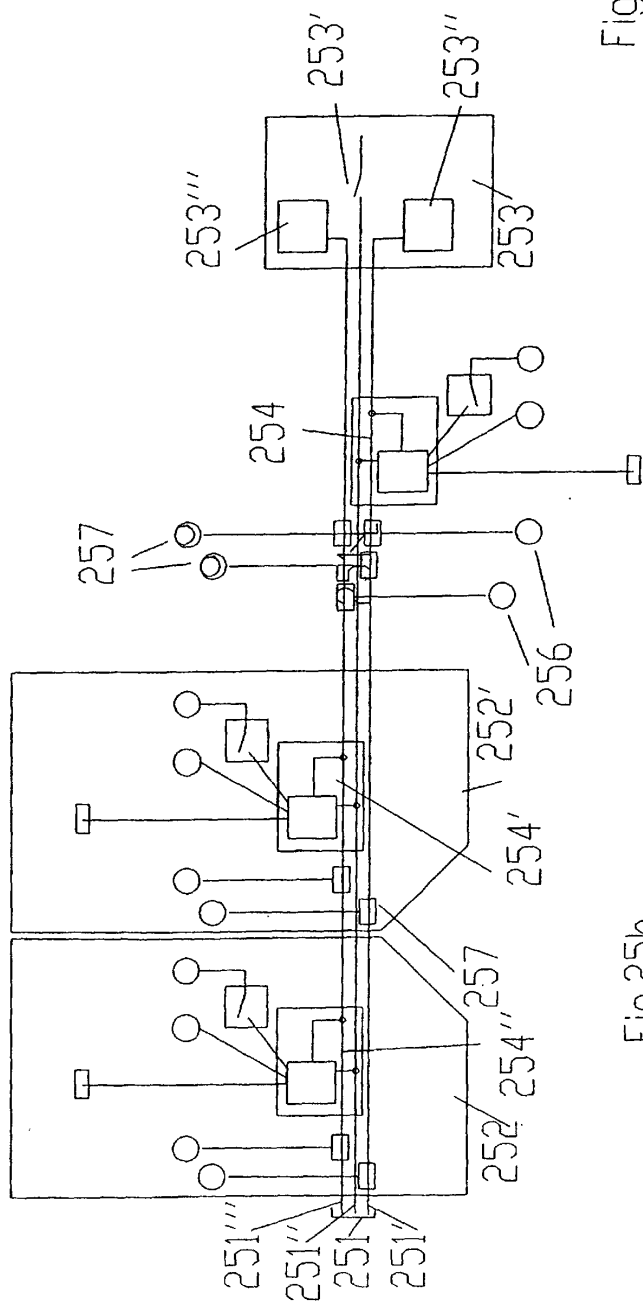


Fig. 25c

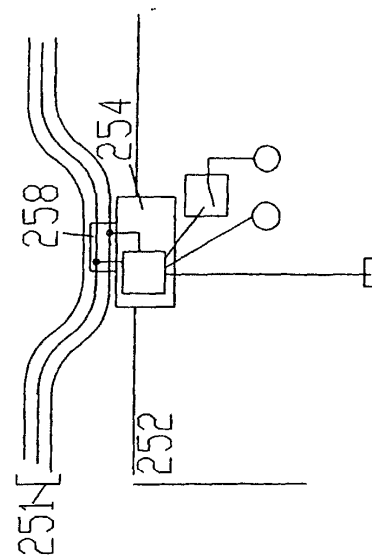


Fig. 25b

