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TECHNIQUE FOR WIRING CONNECTIONS OF ELECTRICAL
APPARATUS OR A MODULE OF CIRCUIT ELEMENTS

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5 The invention relates to a technique for
wiring terminals of electrical apparatus or a
module of circuit elements with the aid of
controlled mechanical wire-laying means, in
particular to wire-laying means adapted to carrying
out this technique, as defined by the preamble to
10 Claim 20, and a terminal configured for use in this
technique, as defined by the preamble to Claim 28.

In practical applications on electrical
apparatus or of a module of circuit elements,
"wiring" means connecting terminals to an electric
15 wire and making contact with this wire at the
respective terminal, in order to establish an
electrical connection, for example with the
associated circuit element. This kind of wiring is
required in the majority of electrical apparatuses
operating in the low-current range, including
20 electronic switching-controlling and regulating
instruments and in modules of circuit elements,
this latter overall term being understood to
include in particular such elements as printed
25 circuit boards, plug-in units, etc., which in the
commercially usual fashion are designed as units
and are intended to be inserted into electrical
apparatuses. For the wiring itself, as a rule
circuit wires, which are provided with a lacquer
30 coating or a sheath of insulating material, or
insulated flexible cables are used as the
conductors. The conductors, from which the
insulation is removed at their ends, are connected
in the zone of contact of the respective terminal
35 by employing various known connecting techniques
(such as screwing, plug-in connection, soldering,
piercing-clamping technique, crimping). The
operations required for the wiring are even today
carried out predominantly by hand. This is time-

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consuming and frequently requires trained workers; the resultant expenses are therefore considerable.

For the sake of more-rational production, particularly in the manufacture of larger series of identical electrical apparatuses, it is known to
5 prepare the conductors or to produce partial or complete cable harnesses, i.e., to produce a typical preassembled product, in a first region far from the electrical apparatus. After that, this
10 preassembled product is mounted in the respective apparatus or the final product. This final assembly includes basically establishing contact or connecting the various conductors of the preassembled product in the zones of contact of the
15 terminals and laying out and fastening the prepared conductors or cable harnesses inside the apparatus. Nowadays automated preparation systems are already used for preparing the conductors, whereas the ensuing processing of the prepared conductors for,
20 say, the production of partial or complete cable harnesses, like the operations at the proper site of wiring, are carried out almost exclusively by hand.

A number of techniques and systems have been
25 known for the automated production of cable harnesses (US Patent 4,677,734, German Published Patent Applications DE-OS 36 08 243, 36 11 805, 38 20 636, and 38 20 638; and Swiss Patent 598 740), all of which employ the so-called laying boards and the like. However all these techniques require
30 very high industrial investments which can be acceptable only for relatively large series of apparatuses. In any case, with this technique there remains the basic problem that the final
35 assembly of the prepared conductors or cable harnesses involves considerable expenses for labour so that the attainable degree of rationalization remains limited. Besides that, layout of the wires within the apparatus often must be chosen with

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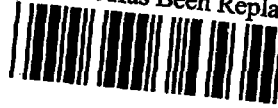
proper regard for the preparation of the conductors or cable harnesses, and this implies long layout lines, detours, branching, loops, and bi-directional movements of clamping means.

5 Therefore, the problem underlying the invention is to create a wiring technique for electrical apparatus and modules of circuit elements which makes it possible to substantially rationalize the wiring work in comparison with
10 known techniques, while at the same time high reliability of operation and a reduction of the chances for mistakes in the wiring are ensured.

 In order to solve this problem, the technique according to the invention has the characteristic
15 features recited in Claim 1.

 The new technique provides for rational complete automation of the wiring of electrical apparatus and modules of circuit elements. It makes it possible to do without prepared conductors
20 and partial or complete cable harnesses, because direct assembly of the conductors is carried out in the apparatus or the module of circuit elements proper. It is possible to make contact fully automatically with a conductor in the form of a
25 continuous wire at terminals provided with suitable, automation-fitting contact areas and to lay the conductor out in the wiring work in a well-defined fashion between the points of connection and to cut it finally. In this direct mounting of
30 the conductor, the requisite electrical connections are produced in series and fully automatically. Possible continuous wiring, i.e., connecting a conductor to a number of terminals, means an important advantage. It is in fact possible to do
35 without the plurality of conductors which in the past were needed for that purpose. This not only means savings in the number of conductors, but also avoids double connections at connection points and multiple laying out to the same connection points.

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Since the conductors are laid out directly and continuously and, since, as mentioned above, the production of preassembled products, i.e., the preparation of conductors, are redundant, a very high degree of rationalisation is obtained while, at the same time, fewer changes of directions are required in the laying operation proper. Branch points, loops, etc., which so far were required with a view to preassembly of conductors or the bundling of conductors in partial or complete cable harnesses, are to a great extent superfluous. But in comparison with the state of the art, there are fewer connection points, which implies increased reliability of the wiring and reduction of the chances for mistakes.

In the case of laying long lines of wire in dependence upon a structure, a support or retention point can be introduced within the working range of the wire-laying means and properly placed with respect to the same by means of a relative movement of the prepared apparatus or module of circuit elements, with the conductor being introduced by the wire-laying means into a wire holder at the support or retention point and affixed thereto. In the resumed direct wiring operation, the conductor is run from this support or retention point to the next connection point in the zone of contact of which contact is once more made with the wire which, if necessary, is then cut.

In the new technique, contact can be established with both the beginning and the end of the wire, as well as with a continuous wire, at the points of connection which are reached in successive controlled movements. Since the beginning of the wire is fixed when the wire laying operation is started, the strain relief required in direct laying of the wire can be obtained by simple forced synchronisation of length of wire paid out by the wire-laying means in a wire-laying operation

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between two terminals with the relative movement between the prepared apparatus or the module of circuit elements and its wire-laying means. The length of wire paid out by the wire-laying means may be dimensioned so that the wire laid out between the terminals is completely free of strain. If necessary, this wire may also be laid out with excess length, e.g., in sagging form. If it should be desirable in certain cases for the wire laid out between two terminals to be kept under a certain tensile strain, this may also be achieved by a simple appropriate tuning of the wire-laying means to the cited relative movement between the preassembled apparatus or the module of circuit elements.

It is advantageous for practising the novel wiring technique if by the relative movement between the preassembled apparatus or module of circuit elements and the wire-laying means, the wire-laying means are transferred only close to the respective terminal, whereupon the wire-laying means in a placing movement are transferred into the proper position relative to the terminal. It is achieved in this way that the movement of the wire-laying means along the preset path of wire laying does not have to satisfy excessive requirements in regard to accuracy, while, at the same time, precise initial placement of the terminals proper or of the components carrying the same in the electrical apparatus or the electrical module of circuit elements is unnecessary. The placement movement required for precise placement can be imparted to the wire-laying means, which were transferred close to the respective terminal, by direct cooperation between a laying tool of the wire-laying means and the appropriately configured terminal or guide means provided on the same, to mention a quite simple facility. But one may proceed also in such a way that with wire-laying

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means with position-filling means transferred close to the terminal, the deviation of the wire-laying means from the position of the terminal is determined and the deviation is thereafter automatically compensated. Any sensor means can be employed to determine the deviation. An image-processing system associated with the wire-laying means proved to be particularly convenient for this purpose, which for recording an image is moved close to the point of connection and which comprises image-evaluating means with which the compensation of the deviation is computed, whereupon there is outputted a corresponding control signal which is processed for controlling one direction of motion of the wire-laying means.

In principle, the relative motions between the preassembled apparatus or module of circuit elements and the wire-laying means, which motions are required when the novel wiring technique is practised in direct wiring, can be effected in various ways. For example, the wire-laying means may be controlled by a multiaxially movable manipulator or industrial robot whose movement is programmable along at least one axis. Before the wiring work is initiated, the preassembled apparatus or module of circuit elements is arranged in some stationary position within the working region of the manipulator or industrial robot. Assigned to the same is a suitable control unit in which the path coordinates required for the laying were programmed so that the wire-laying means perform the required travel and placement movements and carry out additional functions, such as, for example, the above-mentioned compensation for deviations, by means of appropriate system components (sensor system, etc.).

Alternatively, however, one may proceed by arranging the wire-laying means in stationary position or at placement means imparting only a

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positioning movement, and by moving the preassembled electrical apparatus or module of circuit elements by transporting means movable relative to the wire-laying means. The transporting means are likewise connected to a programmable control unit which makes it possible to fully automatically obtain the appropriate laying lines for the directly wired conductors. Therefore the result of the operations is the same. Which of these two kinds of procedures will be chosen in a particular case depends, inter alia, on the type of apparatus or module of circuit elements which is to be wired.

The relative movement between the preassembled apparatus or module of circuit elements, which is carried out in the manner described for direct wiring, basically can be chosen in some way in dependence upon local conditions within the apparatus or module of circuit elements, with curved lines of laying being possible too. But as a rule, this relative movement is at least over sections substantially rectilinear so that straight lines of laying are obtained at least over sections.

The zones of establishing contact at the various terminals must be configured to conform to automation, i.e., after their placement at the respective terminal, the wire-laying means must be able to introduce the wire fully automatically into the respective zone of contact and to establish contact within the same. It was recognised that this requirement can be met in a particularly simple way by employing zones of contact with contact means acting according to the principle of the piercing-clamping technique, with the wire being pressed by the wire-laying means into the contact means, establishing electrical contact. The piercing-clamping [IDC] technique renders a high-quality electrical connection of the electric

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conductor of the line to be connected with the contact means because it effects large-area, gas-tight contact establishment in the manner of a cold weld. Since contact with the wire is established immediately after cutting open the insulation, oxidation of the conductor surface cannot occur as would be the case when the insulation is removed from the ends of the conductors in a special operation prior to establishing contact. For the purpose of attachment, when the wire is pressed in, the wire is conveniently retained by clamping on at least one side of the IDC terminal means. Insertion by pressing-in is advantageously carried out by exerting a pressing force on the wire on both sides of the IDC means so that when the wire is pressed in, it remains perfectly aligned and contact is reliably established and the wire is kept clamped.

If there is no continuous wire laying at the point of connection, the wire is cut directly at the wire-laying means or, by appropriate configuration of the IDC means, directly at the same, whereby protection against accidental contact of the wire end with which contact was established is produced at the same time. Since removal of insulation is redundant, at each point of contact there is saved a small length of wire in comparison with other techniques of making connections, which implies significant savings in the total length of the continuous line required for the entire wiring.

As already mentioned at the beginning, the novel fully automated technique of direct wiring can be employed basically in all electrical apparatuses and modules of circuit elements without previous preparation of conductors etc. However, it was observed that a very interesting application involves the automated wiring of luminaires or their parts. As a matter of fact, such luminaires have a relatively large light box the dimensions of

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which are chosen with proper regard for luminous elements to be housed therein, such as gas discharge lamps, etc., and also contain some standardized associated circuit elements accommodated in the light box. Today, wiring of the connection points of these circuit elements is often done entirely manually; this is expensive and laborious.

The novel wiring technique is carried out with appropriately configured wire-laying means which make it possible to carry out the various functions required in the work. An especially suitable embodiment of such wire-laying means for this purpose is the object of claim 20 preamble of which starts from a state of the art as defined by the wire-laying tools known from German Published Patent Applications DE-OS 36 06 059, 36 11 805 and 38 20 636.

The stated problem is to create wire-laying means which ensure fully automated, perfect attachment of, and contact with, the wire at the respective point of connection.

In order to solve this problem, the laying tool included in the wire-laying means has the features according to the invention as recited in the characterising part of Claim 20.

By arranging a pressure-application member near the mouth of the guide conduit or guide tube of the wire for the wire emerging from the mouth one accomplishes that the wire can be pressed in the contact area of the point of connection in aligned and perfectly supported fashion. In this way high safety of the wiring can be ensured at the point of connection and, at the same time, any finishing work becomes superfluous. The zone of contact at the point of connection is usually formed in the aforementioned IDC technique, but, in principle, the new tool can be used for other connection techniques as well in which it is

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important to introduce, particularly to press in, the end of a wire or a piece of a wire with a predetermined orientation into a slit or a matching receptacle of clamping means existing at the
5 respective point of connection,

In an advantageous embodiment, the pressure-application member is a ram guided for longitudinal movement along the housing or along a part of the laying tool joined with the same, with the ram
10 usually arranged in parallel relationship to the laying tool's so-called laying finger configured likewise as a ram and spaced from the same so that when the conductor is pressed into the zone of contact, the conductor is supported at equidistant
15 points. The mouth of the guide conduit or guide tube of the laying tool is conveniently situated on the side of the laying finger's side facing the pressure-application member, wherein the pressure-application member and the laying finger may have
20 at least in some sections substantially equal width as measured across the longitudinal direction of the wire emerging from the mouth of the guide conduit or guide tube. In this way a very simple design of the point of connection can be obtained.

In order to cut the wire at the point of
25 connection, one can use, for example, an IDC terminal having a cutting edge which acts when the wire is urged into the zone of contact. It suffices in this case to provide the aforementioned
30 pressure-application member on the laying tool. If such a cutting edge at the terminal is omitted, it is advantageous to provide on the laying tool controlled cutting means for the wire, which have at least one movable cutting blade arranged in the
35 area between the mouth of the guide channel and the pressure-application member. This cutting blade may be supported to act directly at the laying finger, with the edge of the mouth of the guide conduit being formed as a counterblade. The

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conductor can be cut near the zone of contact or directly in the zone of contact.

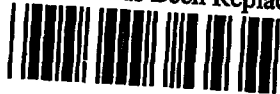
Finally, the laying finger of the laying tool is usually affixed to its housing or to a part joined with the same; but it may also be supported to be movable and may be coupled to proper setting means.

As mentioned above, the novel technique of direct wiring can be practised in a particularly simple fashion by using terminals the zones of contact of which are configured to conform to the so-called piercing-clamping [IDC] technique. This technique has been described, for example, in the journal "Messen + Prüfen/Automatik" [Measurement + Testing/Automatic Systems], July/August 1982, pp. 491, 492; as to the design of corresponding IDCs or IDC terminals, reference is made, for example, to German Model-of-Utility Patent DE-GM 88 04 388, to published French Patent Application 2 330 159 and to US Patent 2,501,187. Based on this prior art, the stated problem is to create a terminal [point of connection] to be used in the aforementioned technique and with application of the above-mentioned wire-laying means, which terminal is designed so that operationally safe contact establishment and fixation of the connected wire is ensured in a simple, efficient way and that, at the same time, automated execution of the technique is not impeded.

In order to solve this problem, the terminal according to the invention has the features recited in the characterising part of Claim 28.

The slit-like or groove-like indentation provided at the housing of the clamping terminal means ensures protected, all-insulated enclosure of the cut end of the wire, on the one hand, without need for additional operations or measures. On the other hand, if necessary, it may form centering means for the laying finger and/or the pressure-

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application member of the laying tool when the wire is introduced into the zone of establishing contact. When the wire is introduced, the IDC terminal itself causes some automatic height compensation because it is only important that the wire be firmly held in the piercing-clamping seat within a certain range of height variations.

The housing's insertion slit at the point of connection may have a width resulting in attachment of a pressed-in wire by clamping so that the wire is fixed independently of the zone of contact proper. The indentation in the housing may also be arranged to be confined on both sides by IDC terminals or on one or both sides of an IDC terminal.

The technique according to the invention is described below by way of an embodiment with reference to the drawing. In the drawing, there show:

Fig. 1, a perspective schematic view of a preassembled light box to be wired according to the technique of the invention;

Fig. 2, a partial perspective view of the terminals designed according to the invention, for a ballast unit of the light box of Fig. 1, on a different scale;

Fig. 3, a partial plan view of a terminal of the arrangement of Fig. 2, on a different scale;

Fig. 4, a plan view corresponding to Fig. 3 of a terminal of the arrangement of Fig. 2, in a modified embodiment;

Figs. 5-7, side views of a clamp of a terminal of the arrangement of Fig. 2, taken along the line V-V of Fig. 3 or of line VI-VI and line VII-VII of Fig. 5;

Fig. 8, a schematic perspective view of the terminals designed according to the invention, of the clamping block of the light box of Fig. 1, on a different scale;



Fig. 9, a perspective view of the terminals according to the invention, of a lamp socket of the light box of Fig. 1, on a different scale;

Fig. 10, a schematic side view of a system for practising the technique according to the invention with the aid of an industrial robot;

Fig. 11, a plan view of the system of Fig. 10;

Fig. 12, a schematic side view of a system for practising the technique according to the invention with the aid of a portal-type manipulator;

Fig. 13, a schematic side view of a further embodiment of a system for practising the technique according to the invention, using a manipulator with a movable transport table;

Figs. 14 - 20, a schematic sectional representation of the laying tool of the system according to Figs. 10 and 11, in its placement relative to the point of connection of a ballast unit of the light box of Fig. 1, illustrating various chronologically successive phases of the technique according to the invention when the continuously supplied wire is connected to the first terminal;

Figs. 21 - 29, each as a corresponding representation of the arrangement of Figs. 14-20, chronologically successive steps of the technique after attachment of the wire end, during laying of the wire to the next terminal, while making contact, and the subsequent cutting of the wire at this point of connection;

Fig. 30, a schematic plan view of the light box of Fig. 1 in the state of wiring after conclusion of the part of the wiring illustrated by way of Fig. 14-29, on a different scale;

Figs. 31 - 33, in a representation similar to that of Fig. 14 to 19, the wire-laying means of the system according to Figs. 10 and 11, placed relative to an other ballast unit of the light box according to Fig. 1, with chronologically

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successive steps in practising the technique according to the invention, when the next section of wiring is being completed; and

5 Fig. 34, the light box of Fig. 30 in its state after completion of the wiring section made with the technique according to Fig. 31 to 33.

The technique for direct wiring of electrical apparatuses and modules of circuit elements will be described below by way of the wiring of a
10 rectangular light box 1, shown in Fig. 1, for two rod-shaped gas discharge tubes, not shown in further detail. For operation the light box is covered with a transparent acrylic glass hood or reflector, which is clamped in holder means 2 and
15 not shown in further detail.

The light box has already been preassembled insofar as the electrical circuit elements required for accommodating and operating the gas discharge lamps were firmly affixed to, or screwed onto, the
20 box bottom 3 in their proper positions according to a predetermined plan of the layout. As to details, four lamp sockets 4 of known design are provided in pairwise facing relationship near the front walls of the box, and two magnetic ballast units 5 are
25 associated with each pair and situated approximately along the centre line of the box bottom 3, on either side of the wire-inlet openings in equal distances from the front faces of the box. A socket of insulating material, which supports a
30 capacitor 8, is fixed near the wire-inlet openings 6 likewise on the centre line of the box bottom 3. On the lamp sockets 4, the ballast units 5, and the socket 7 of insulating material there are provided points of connection for electrical wires which are
35 denoted by 9 at the lamp socket 4, by 10 at the ballast units, and by 11 at the socket 7 of insulating material. All these points of connection 9, 10, 11 have a zone of contact conforming to the IDC technique following the same

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basic principle. Details of the design can be recognised in Figures 2 to 9; they will be explained specifically by way of the terminal 10 of a ballast unit 5 with reference to Fig. 2 to Fig. 7.

Each terminal 10 has a housing 12 of substantially rectangular cross section, made of insulating material, mounted on a base 13, likewise made from insulating material, so that there is obtained a unitary connection clamp or terminal which at 14 is attached to a stamped, upward-bent tab of a baseplate 15 of the ballast unit 5. The two side walls 16 of the housing 12, which is open on top, have on their inside two moulded facing ribs 17 which are situated approximately in the middle between the two faces 18 of the housing 12 and delimit inbetween a slightly wedge-shaped insertion slit 19 or an insertion slit with parallel sides (Fig. 6) which flares toward the top in the form of insertion ramps 20. The lower part of the insertion slit is locally somewhat broadened at 21 in a partially circular region.

Two narrow facing grooves 22 extend from below approximately to the level of the insertion ramps 20, to accommodate the two legs of an IDC terminal 25 made from spring steel or spring bronze, with the legs confining an IDC slit 23 which is open at the edges. The narrow, plate-shaped, substantially U-shaped IDC terminal 25 is embedded on all sides in the insulating material of the housing 12 except for the cutting sections formed on the legs 24 and facing the IDC slit 23, with the two legs 24 adapted to be guided for limited movement within the grooves 22. In a manner not shown in further detail, one end of the winding of the ballast unit 5 is connected to it. Together with the IDC slit 23, it forms the zone of making contact of the point of connection 20.

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As can be seen particularly from Figs. 3 to 7, the housing 12 has one groove-like indentation 26 of rectangular cross section on either side of the ribs 17 and, hence, near the insertion slit 19, with each indentation opening toward the top of the housing 12. The two groove-like indentations 26 are aligned with each other and with the insertion slit 19. On top they are likewise delimited by an insertion ramp 27. Figures 5, 7 show that the depth of the groove-like indentations 26 exceeds that of the insertion slit 19 and that also their width 28 substantially exceeds the width of the insertion slit 19.

The dimensions of the various parts are chosen so that for an insulated conductor pressed in through the insertion slit 19, the insulation is cut open in the IDC slit 23 by the legs 24 of the IDC terminal 25 and that, at the same time, gas-tight contact is established between the IDC terminal 25 and the conductor which is being deformed at the point of clamping. The pressed-in conductor is at the same time retained clamped in the insertion slit 19 between the two ribs 17, and the flaring section at 21 serves to ensure locking of the wire by its insulation upon pressing into the insertion slit 19. The connected wire which was fixed in this way runs through one of the groove-like indentations 26, whereas its cut end is situated within the other groove-like indentation 26, as will be described in detail hereinafter. The width and depth of the groove-like indentations 26 and their axial length are dimensioned so that protection against accidental contact results automatically for the cut end of the wire. This means that, in a test for shock protection, the standardized sensing finger cannot penetrate to the bare cut end at the depth of the respective groove-like indentation 26.

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In the above-described embodiment of the housing 12, two groove-like aligned indentations 26 are provided on both sides of the insertion slit 19 the widths and depths of which considerably exceed the diameter of the wire to be accommodated. One can also contemplate omitting one of the groove-like indentations 26, and this is of interest particularly if the wire is only run through the terminal, as will be explained below. In certain cases, the two groove-like indentations 26 may even be omitted.

Fig. 4 shows a plan view of an other embodiment of housing 12: In this embodiment, there is only one groove-like indentation 26 which is confined in the housing 12a on both sides by one pair 17 of ribs each with an insertion slit 19 inbetween and by a contact element 25 protruding with its legs 24 into the same. The ends of each of the pair of ribs are moulded to be flush with the side walls 16a in the housing 12a and have their insertion slits 19 aligned with the longitudinal axis of the groove-like indentation 26.

While in the embodiment of Figs. 2 and 3 a cut end of a wire is situated near the zone of contact formed by the IDC element 25 (see, for example, Figs. 27-29), in the embodiment of Fig. 4 it is ensured that the cut end will be within the zone of contact defined by the two IDC terminals 25, i.e., within the housing 12a which is closed on all sides except for the insertion slit.

The terminals 11 which are arranged on the base 7 of insulating material are basically of the same design as the terminals 10, as can be inferred from Fig. 8. Reference is therefore made to the description pertaining to Fig. 2 to 7. Identical parts have the same reference numbers.

A total of three terminals 11 are arranged on the base 7 of insulating material; two of them are combined to form a connection-clamp unit which is

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denoted by 28 and has a unitary housing 12b. Clamps for internal connection to the terminals of the capacitor 8 are indicated at 29.

5 The design of the terminals 9 of the lamp sockets 4 is basically identical with the design of the terminals according to Fig. 2, 3. Therefore, in Fig. 9 identical parts are characterised by the same reference numbers and reference is made to the description pertaining to Fig. 2, 3.

10 While the housings 12, 12b at the points 10, 11 of contact (Fig. 2, 8) point with their insertion slits 19 and the groove-like indentations 26 in the longitudinal direction of the ballast unit 5 or of the starter 6 and, hence, of the
15 bottom 3 of the light box (Fig. 1), the arrangement of the lamp sockets 4 is such that the housings 12 are mounted on a fastening base 30 of the respective lamp socket 4, with insertion slits 19 and groove-like indentations 26 extending
20 perpendicular to the longitudinal extent of the gas discharge lamps to be inserted and, hence, of the bottom 3 of the lamp box. Therefore, wires to be connected must be pressed into the insertion slit 19 at the lamp sockets 4 at right angles to the
25 longitudinal extent of the lamp box 3.

The wiring of the light box 1 described in connection with its circuit elements 4, 5, 7 and their terminals 9, 10, 11 is effected with the aid of an industrial robot as shown in Fig. 10, 11 or a
30 manipulator as shown in Figs. 12, 13 moving the wire-laying means, as will be described below by way of Figs. 13 et seq.:

35 The wire-laying means, generally denoted by 31, in the system according to Fig. 10, 11 are mounted on the two-component arm 32 of an industrial robot 33 which has a column 36 rotatable about a first stationary vertical axis 34, for

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instance by a stepper motor drive 35, which column supports a first arm member 37 connected at its free extremity with a second arm member 40 through pivotable bearing means 39 forming a second vertical axis 38 parallel with the first axis 34 of rotation and incremental drive means, with the outer extremity of the second arm member supporting the wire-laying means 31. The two drives 35, 39 can move the second axis 38 of rotation on a circle 41 around the first axis 34 of rotation and, with the arm 32 extended, can move the wire-laying means 31 on a substantially circular path 42; lifting drive means 43 associated with the drive column 36 enable a controlled vertical raising and lowering movement of the arm 32 and, hence, of the wire-laying means 31. The industrial robot 33 cooperates with a stationary work table 44 with an integrated conveying mechanism (indicated by the arrow 45 in Fig. 10) which facilitates transferring in succession preassembled light boxes 1 of Fig. 1 on the horizontal working surface of the work table 44 from a remote standby position at 46 (Fig. 10) into the working range of wire-laying means 31 confined by the substantially circular path 42, as indicated by the working position of the light box 1 at 47 shown in Fig. 10, 11. In this position 47, the light box 1 is clamped to the work table 44 in the proper position. The appropriate clamping means are of a known type; they are not shown in detail in Figs. 10, 11. Within its operating range, the wire-laying means 31 can be moved by the programmable industrial robot 33 to any point within the light box 1 and can be moved along any preprogrammed, well-defined path inside the light box 1.

Basically the same is at hand when one uses the portal manipulator 48 shown in Fig. 12 in which the preassembled light box 1 is clamped in its proper position on a light box receptacle 50 on a

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stationary work table 49 and the wire-laying means 31 are arranged on a carriage 51 which is mounted at a portal 52 in such a way that it can be freely programmably moved both in an X direction indicated by a double arrow in the longitudinal direction of the light box and in a transverse Y direction, likewise indicated by a double arrow. Moreover, the wire-laying means 31 are mounted on the carriage 51 and adapted to rotate around a vertical axis 53 of rotation (c axis). Each of the axes X, Y, c of motion, as well as the axis of lifting (z axis) have associated stepper drive means which, controlled by a freely programmable control unit, can transfer the wire-laying means 31 to any point inside the clamped, preassembled light box 31 on the respective preprogrammed path.

Finally, the relative motion which is required between the wire-laying means 31 and the preassembled light box 1 for laying out the wires, i.e., for wiring the points 9, 10, 11 of connection of the preassembled light box 1, can also be obtained with the system of Fig. 13. There the preassembled light box 1 is clamped to an XY table 54 by means of the light box receptacle 50 and each of the axes of its X and Y movements is indicated by double arrows. The wire-laying means 31 are held by a placement system 56 mounted above the XY table 54 on a stationary support 55, with the placement system adapted to impart to the wire-laying means a lifting movement in the Z direction (indicated by a double arrow) and a rotational movement around the vertical axis 53 (c axis). Also in this case, incremental drive means for movement along the XY axis and the zc axis act upon the XY table 54 and the placement system 56 and are controlled by a freely programmable control unit in such a manner that the wire-laying means can be moved to any point within the light box 1 along the respective programmed path.

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The wire-laying means 31, in turn, basically comprise a so-called wire-laying tool 57, if necessary with a multi-component housing 58, which is mounted on the arm 32 of the industrial robot 33 (Fig. 10) or the carriage 51 (Fig. 12) or at the placement system 56 (Fig. 13). A vertical laying finger 59 of substantially rectangular cross section is arranged on the underside of the housing 58 and includes an L-shaped curved wire-guiding channel 62 which opens near a side wall at 60 a short distance from the flat bottom surface 61 of the laying finger 59. The wire-guiding conduit 62 (Fig. 14) contained in the laying finger 59 is continued in housing 57 in the form of a guide tube 65 preceded by a belt drive for a wire indicated at 68 and comprising two pairs 66 of belt rollers (Figs. 12, 13) and endless drive belts 67 wrapped around them.

The belts 67 are guided as parallel lengths of belt with a small spacing and are coupled via the belt rollers 66 with an incremental drive imparting them a controlled driving motion synchronised with the relative orbital movement between the preassembled light box 1 and the wire-laying means 31, which movement can be obtained by the systems according to Figures 10 to 13 when producing the wiring.

A measurement system preceding the belt drive means for the wire 68 and comprising a measuring wheel 70 and a drive roller 71 elastically prestressed into the position of engagement makes it possible to measure the exact advance of the wire 68 without any dependence upon the slip developing between the endless belts 67 of the belt drive so that perfect synchronization of the advance of the wire with the travel of the robot 33, the manipulator 48, or the XY table 54 is ensured.

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The laying finger 59 is usually nonmovably mounted on the housing 57 but it may also be mounted to move up and down along the vertical Z axis and may be provided with appropriately controllable setting means within the housing 58. This is indicated by a double arrow 72 in Fig. 12.

As can be inferred from, say, Fig. 14, at a lateral distance from the laying finger's vertical flat side face 60 enclosing the mouth 74 of the wire-guiding channel 62, or on the housing proper, as per Fig. 12, 13, there is arranged a pressure-application member in the form of a vertically movable ram 76 adapted to be moved up and down via associated drive means mounted inside the housing 58. The movement of the ram 76 is controlled by the control unit according to a program and in dependence upon the travel of the wire-laying means 31. A sensor 77 (Fig. 14) coupled with the ram 76 outputs a feedback signal indicating the respective position reached by the ram's 76 bottom face, which acts as a pressure-application surface, to the control unit so that an accurate setting of the level of the bottom face 78 of the ram 76 relative to the mouth 74 of the wire-guiding conduit 62 is possible.

On the vertical side face 60 of the laying finger 59 there is mounted a knife 79 adapted to move up and down, the drive mechanism of which is accommodated in the housing 58 and is not shown in detail. Its knife blade 80 (Fig. 16) mounted at the lower extremity can be advanced from the standby position illustrated in Fig. 14, 16, 17 into an operational position shown in Fig. 27 in which the wire's 68 end protruding from the mouth 74 of the wire-guiding channel 62 is perfectly cut. For this purpose, the knife blade 80 has transversed the mouth 74, with the underside 81 of the edge of the mouth of the wire-guiding channel

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62 acting as a counterpiece, as can be directly inferred from Fig. 27.

In principle, one can contemplate embodiments in which the knife 79 has a separate associated counterblade which is detached from the laying finger 59.

With the aid of the above-described wire-laying means 31 moved, for example, by the industrial robot 33 (Fig. 10, 11) according to a program along predetermined paths, a preassembled light box 1, which is provided at predetermined points of the light box bottom 3 with the terminals 9, 10, 11 of the above-described form, is automatically wired in the following way, with reference being made to Fig. 14 to 34:

An insulated wire 68 drawn, for instance, continuously from a coil 82 (Fig. 10) is threaded into the laying tool of the wire-laying means 31. It runs between the measuring wheel 70 and the roller 71 and between the two looped belts 67 of the belt drive and is fed by the same through the guide tube 65 into the L-shaped wire-guiding conduit 62. The belt drive has advanced the forward end of the wire 68 so far in the manner recognisable from Fig. 12 to 17 that a section 84 (Fig. 17) protrudes from the mouth 74 of the wire-laying channel 62 and extends under the pressure-application surface 78 of the ram 76.

A preassembled light box 1 was moved into the operational position 47 of Fig. 10 and into the operating range of the industrial robot 33 and clamped there in the correct position on the work table 44 (Fig. 11). The ram 76 is in its raised standby position as per Fig. 16; also the knife 79 is in its standby position above the mouth 74. The belt drive 66, 67 is not moving.

The appropriately program-controlled industrial robot 33 transfers the wire-laying means 31 with the laying finger 59 from a remote standby

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position to the vicinity of the first point of
connection which, in this case, is a terminal 10 of
the left ballast unit 5 as per Fig. 1. On this
occasion, the laying finger 59 reaches about the
5 position of Fig. 14 in which it is situated above,
and laterally offset from, the terminal 10.

In this position of the laying finger 59,
position-sensing means in the form of an image-
processing system 85 with its image-recording unit
10 86 arranged on the housing 58 are situated above
the terminal 10. The image-processing system 85
includes means for image evaluation with the aid of
which the deviation of the laying prong's 59 place
from the terminal 10 is computed and a
15 corresponding compensating control signal is
generated. This signal is processed in the control
unit in such a way that the industrial robot 33 -
or a placement system arranged between the same and
the wire-laying means 31 in analogy to the
20 placement system 56 of Fig. 13 - carries out the
requisite compensation of position variations and
sets the laying finger 59 into the proper place
relative to the point 10 of connection. Once this
has been achieved, the laying finger 59 assumes the
25 position of Fig. 16 in which it is accurately
aligned above the housing 12 and its groove-like
indentations 26.

Then the ram 76 moves into its lower
operational position of Fig. 17 in which it rests
30 with its pressure-application surface 78 (provided
on the bottom of a longitudinal groove) on the
wire's end section 84, which was appropriately
advanced out of the mouth 74 of the wire-guiding
channel 92, and puts the same exactly horizontally.
35 If necessary, the end section 84 of the wire can be
moved forward to the end of the pressure-
application surface 78.

The laying tool of the wire-laying means 31
and particularly their laying finger 59 and the ram

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76 are simultaneously lowered along the vertical Z axis. In doing so, the horizontal end section 84 of the wire is pressed through the insertion slit 19 of the housing 12 at the terminal 10 into the IDC slit 23 of the IDC terminal 25 until the wire section 84 locks itself in the wide part 21 of the slit (Fig. 6). In this pressing-in motion, an equally large, uniform pressing force is exerted from the upper side of the wire-guiding channel 62 and the pressure-application surface 78 on both sides of the insertion slit 19 upon the horizontally retained end section 84 of the wire so that the same cannot deviate and perfect introduction into the zone of making contact at the terminal 10 is ensured.

In this insertion and pressing-in motion, the insulation is cut open by the cutting edges on the legs 24 of the IDC element and perfect contact is established. The end section 84 of the wire is at the same time fixed in its position - with slight deformation of its insulation - by the two ribs 17 on both sides of the IDC terminal 25.

At their forward extremity, the ram 76 and the laying finger 59 are basically of the same width perpendicular to the plane of the drawing (Fig. 19), with the width matching the width of the groove-like indentations 26 so that perfect three-dimensional placement of the housing 12 relative to the laying finger 59 and the ram 76 is ensured when the wire section 84 is pressed in. Then the components are in the position as per Fig. 18.

Now the ram 76 rises into its end position or standby position and releases the end of the wire section. This situation is shown in Fig. 19.

Since the end of the wire section 84 is accommodated in the groove-like indentation 26 very close to the guide groove 19 and since the same has a length, width and height such that the free front end of the conductor cannot be touched from the

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outside, and since the IDC terminal 25 is embedded in the insulating material of the housing 12 and is likewise shut off from the outside in all-insulated fashion, perfect protection against accidental
5 contact is obtained in this way at the point 10 of connection.

The control unit now controls the motion of the industrial robot 33 according to a program in such a way that the laying finger 59 moves from the
10 terminal 10 at which contact was made to the next terminal - terminal 11 - on the base 7 of insulating material along the rectilinear path of laying which can be inferred from Fig. 30. This is illustrated in Fig. 20, 21.

15 During this, the belt drive 66, 67, controlled by the control unit, is actuated in synchronism with this travel of the laying finger 59 so that laying of the wire without stress is obtained. If necessary, in this travel, also a vertical movement
20 along the Z axis may be imparted to the laying finger 59, for instance, in order to place the laid wire on the bottom 3 (Fig. 1) or to compensate for a difference in the levels of the terminals 10, 11, as indicated in Fig. 22.

25 In the course of this travel, the laying finger 59 is at first transferred only into the vicinity of the terminal 11, into the position shown in Fig. 21 or 22 in which the image-processing system 85 is above the terminal 11 and
30 can sense its place in space which certainly may be influenced by unavoidable tolerances in mounting the components.

As before at terminal 10, the image-processing system 85 now determines the deviation of the
35 laying finger 59 from the terminal 11 and, via the control unit of the industrial robot 33, compensates for the variation to obtain the accurate placement of the laying finger 59 relative to the terminal 11. As soon as this has been



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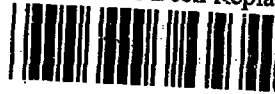
accomplished, the components have assumed the position according to Fig. 23 or Fig. 24.

Now the ram 76 is lowered from its end position or standby position into the operational position in which it bears with its pressure-application surface 78 on the wire's 68 part which is there horizontally guided and emerges from the mouth 74 of the wire-guiding channel 62 - see Fig. 25.

After that, the laying finger 59 and the ram 76 are lowered simultaneously in a fixed relationship with respect to each other and to the housing 12 of the terminal 11, while the wire section 84a extending between the pressure-application surface 78 and the top of the mouth's 74 edge is supported at two points on both sides of the zone of contact and pressed into the insertion slit 19 and the IDC slit 23 until the position of locking (described by way of Fig. 18, 19) has been reached. In this way contact with the wire 68 has been properly made at the wire section 84a and the wire 68 is clamped and fixed in the guide slit 19 near the point of connection on both sides at its insulation.

In the wiring work under consideration, the wire laid in the above-described manner is cut at the terminal 11. This is done with the knife 79 which moves downwards and severs the wire 68 directly at the wire-guiding channel's 62 mouth 74 which with its edge acts as a counterblade.

As shown in Fig. 27, when the wire 68 is severed, the laid wire section's end held in the guide slit 19 of the terminal 11 is bent downwards by the inclined surface 86 adjacent the blade 80 of the knife 79. This means that the bare front surface of the wire is directed toward the bottom of the enclosing groove-like indentation 26 and, as a consequence, that the protection against



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accidental contact is greatly increased. This bending causes at the same time additional mechanical attachment of the wire's end at the terminal 11.

5 Thus, the wiring between the two terminals 10 and 11 has been completed. The knife 79 returns to its end position or standby position as per Fig. 28.

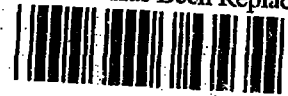
10 After that, the ram 76 is returned to its end position or standby position and the laying finger 59 is raised by the industrial robot 33, whereby the initial position for the next step of wiring work in in the light box 1 has been reached. This initial position is shown in Fig. 29.

15 Depending upon the wiring which has to be made, the wire 68 can be run through, for example, the terminal 11. In this case, severing the wire as per Fig. 27, 28 is not necessary; subsequently to the state as per Fig. 26, the ram 76 is rather
20 returned to its end position or standby position (see Fig. 19, 20), whereafter the control unit according to the program makes the industrial robot 33 move the wire-laying means 31 and, hence, the
25 laying finger 59 along a programmed, well-defined path to the next point of connection. This will be briefly explained with reference to Fig. 31 to 33:

The next terminal is once more a terminal 10, but now it is the one of the right ballast 5 of Fig. 1. The wire must be run past the ballast 5.
30 As can be inferred particularly from Fig. 2, the ballast 5 is at its two ends on top provided with two retaining elements 870 for wires 68. Each of the comb-like retaining elements 870 is provided with a row of parallel, continuous locking grooves
35 88 of semicircular cross section into each of which one wire 68 can be pressed through an insertion slit 89.

When wire is laid out between the terminals 10, 11 (Fig. 26 and 31), the industrial robot 33

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therefore first transfers the laying finger 59 along a programmed path to the vicinity of the respective retaining element 870. Once the laying finger 59 has been placed in the previously described manner with the aid of the image-processing system 85, the ram 76 sinks and presses, either alone or together with the laying finger 59, the wire into one of the locking grooves 88. After that, the ram 76 is transferred into its end position or standby position; the laying finger 59 rises and is moved to the next retaining element 870 where the same operation is repeated.

After that, the laying finger 59 is moved into the vicinity of the terminal 10 and placed above the same in the previously described manner, whereafter the ram 76 is advanced until its pressure-application surface 78 rests on the wire section 84a emerging from the mouth 74. The components assume the position shown in Fig. 32.

In the ensuing lowering motion of the laying finger 49 of the ram 76, the wire section 84a is horizontally aligned and perfectly supported to be fixed in the above-described manner in the insertion slit 19, with contact established in the IDC slit 23, and, at the same time, the wire 68 is bent downward to the level of the IDC terminal 25. Once contact has been made, the components assume the position according to Fig. 33.

As the next step, the wire 68 either can be cut (as per Fig. 27) or passed through to the next point of connection, e.g., a terminal 9 of a lamp base 4.

Since in the case of the lamp base 4, the insertion slits 19 at the points 9 of connection extend across the longitudinal direction of the light box, the industrial robot 33 must rotate over 90° the wire-laying means 31 and, more specifically, the housing 58 of the laying tool 57 with the laying finger 59 and the ram 76, around

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the vertical axis (c axis) before the wire section, which is bent in this operation, is introduced into the insertion slit 19 in the above-described manner.

5 The direct wiring work carried out with the above-described steps of the technique on the preassembled light box 1 is illustrated in Fig. 33, 34 for two cases, namely that the wire 68 is cut after having reached the point 11 of connection
10 (Fig. 27) or that the wire is passed on beyond this terminal (Fig. 31).

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CLAIMS:

1. A technique for wiring the points of connection of electrical apparatus or modules of circuit elements with the aid of controlled mechanical wire-laying means, wherein the following operations are carried out:

- a preassembled electrical apparatus or module of circuit elements is prepared to have terminals permanently arranged therein,

- by means of a relative motion between the preassembled apparatus or module of circuit elements and the wire-laying means, a first point of connection is moved into the working area of the wire-laying means and placed in the proper place relative to the same,

- by means of the wire-laying means, the end of a continuously supplied wire is introduced into a zone of establishing contact with the first terminal and fixed at that point of connection, with electrical contact being made,

- by means of an other relative motion each on a predetermined path between the preassembled electrical apparatus or module of circuit elements and the wire-laying means, each additional terminal is in succession moved into the working area of the wire-laying means while the wire is laid out and put into the proper place relative to the same, wherein, during each of these relative motions, the wire-laying means pay out at least a length of continuously supplied wire corresponding to the path of wire laying between the two respective points of connection,

- by means of the wire-laying means, the wire which is continuously fed to the same, is introduced at each point of connection into a zone of contact of that terminal and, while establishing an electrical contact, is fixed at this point of connection, and



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- the wire which was laid out in this way is thereafter severed at the end of the path of wire laying near the respective point of connection.

5 2. The technique according to Claim 1, characterized in that by a relative motion between the preassembled electrical apparatus or module of circuit elements, a point of support or retention is transferred into the operating range of the
10 wire-laying means and placed properly relative to the same and that by means of the wire-laying means, the wire is introduced into wire-holding means at the point of support or retention and fixed there.

15 3. The technique according to Claim 1 or 2, characterized in that the wire-laying means are moved by a multiaxially movable manipulator or industrial robot the motions of which are
20 programmable for at least one axis and that the preassembled electrical apparatus or module of circuit elements is placed in a stationary position prior to commencement of the wiring work.

25 4. The technique according to Claim 1 or 2, characterized in that the wire-laying means are stationary or are arranged at a placement system imparting a placement motion and that the preassembled electrical apparatus or module of
30 circuit elements is moved by transport means adapted to move relative to the wire-laying means.

5. The technique according to any one of the preceding claims, characterized in that the length
35 of wire, which is paid out by the wire-laying means between two points of connection during a wire-laying operation, is necessarily synchronised with the relative movement between the preassembled



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electrical apparatus or module of circuit elements and the wire-laying means.

6. The technique according to Claim 5, characterized in that the length of the wire paid out is chosen so that the wire laid out between the terminals is substantially free of tensile stress.

7. The technique according to any one of the preceding claims, characterized in that in the relative movement between the preassembled electrical apparatus or module of circuit elements and the wire-laying means, the wire-laying means come close to the respective point of connection and that the wire-laying means are subsequently placed in a placement motion into the proper position relative to the point of connection.

8. The technique according to Claim 7, characterized in that once the wire-laying means have been moved into the vicinity of the terminal, the deviation of the wire-laying means from the place of the terminal is determined with position-sensing means and the deviation is thereafter automatically compensated.

9. The technique according to Claim 8, characterized in that for the purpose of determining the deviation there is used an image-processing system cooperating with the wire-laying means, which system - for recording images - is moved close to the point of connection and which comprises image-processing means computing the compensation for the deviation and outputting an appropriate control signal.

10. The technique according to any one of the preceding claims, characterized in that after placing the wire-laying means, an insertion

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movement of a well-defined length is imparted to the wire near the terminal, by which movement the wire is transferred into the zone of contact of the point of connection.

5

11. The technique according to any one of the preceding claims, characterized in that the relative movement between the preassembled electrical apparatus or module of circuit elements and the wire-laying means is substantially rectilinear at least over path sections.

10

12. The technique according to any one of the preceding claims, characterized in that zones of contact with IDC contact means acting according to the principle of the insulation-piercing/clamping (IDC) technique are used and that the wire is pressed by the wire-laying means into these contact means, while making electrical contact.

15

20

13. The technique according to Claim 12, characterized in that the wire upon being pressed in is subjected to a pressing-in force on both sides of the IDC contact means.

25

14. The technique according to Claim 12, characterized in that the wire is held clamped on at least one side of the IDC contact means.

30

15. The technique according to any one of the preceding claims, characterized in that the wire is cut at the wire-laying means proper.

35

16. The technique according to any one of Claims 12 to 14, characterized in that the wire is severed at the IDC contact means.

17. The technique according to any one of Claims 12 to 15, characterized in that the wire is

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cut between IDC contact means in the zone of contact.

18. The technique according to any one of the preceding claims, characterized in that the ends of the wire are automatically protected in an all-insulated fashion at the respective terminals.

19. The technique according to any one of the preceding claims, characterized in that it is employed for the automatic wiring of luminaires or parts thereof.

20. Wire-laying means, particularly for carrying out the technique according to any one of the preceding claims, comprising a laying tool with a housing provided with fastening means, a guide channel for a wire fed into a laying finger on one working side of the housing, and controlled wire-advancing means, characterized in that the laying tool has at least one pressure-application member (76) arranged near the mouth (74) of the guide channel (62) for the wire (68) emerging from the mouth (74), which member is supported to move substantially across the axial direction of the guide channel (62) in the mouth region and is coupled with proper setting means by which it is adjustable between a standby position far from the mouth (74) and an operational position in which it projects on one side beyond the edge of the mouth of the guide channel (62) with a pressure-application surface (78) aligned with the wire (84) protruding from the mouth (74) or in which it is substantially flush with the upper side of the edge of the mouth.

21. The wire-laying means according to Claim 20, characterized in that the pressure-application member is a ram (76) which is adapted to move in



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guided fashion along the housing (58) or a part joined with the same.

22. The wire-laying means according to Claim 5 21, characterized in that the ram (76) is mounted parallel to, and spaced from, the laying finger (59) which is likewise configured as a ram.

23. The wire-laying means according to any 10 one of Claims 20 to 22, characterized in that the mouth (74) of the guide conduit (62) is arranged laterally on the laying finger (50) on the side facing the pressure-application member (76).

24. The wire-laying means according to any 15 one of Claims 20 to 23, characterized in that the pressure-application member (76) and the laying finger (59) have at least over sections basically the same width measured across the longitudinal 20 direction of the conductor emerging from the mouth (74) of the guide channel (62).

25. The wire-laying means according to any 25 one of Claims 20 to 24, characterized in that controlled means (79) for severing the wire are provided on the laying tool and have at least one cutting blade (79) arranged to move within the region between the mouth (74) of the guide channel (72) and the pressure-application member (76).

26. The wire-laying means according to Claims 30 23 and 25, characterized in that the cutting blade (79) is supported to act directly at the laying finger (59) and that the edge of the mouth of the wire-guiding channel (62) is configured as a 35 counterblade.

27. The wire-laying means according to any one of claims 19 to 26, characterized in that the

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laying finger (59) is supported on the housing (57) for movement and is coupled with proper setting means.

5 28. Terminal, particular for use in the technique according to any one of Claims 1 to 19 and making use of the wire-laying means according to any one of Claims 20 to 27, with clamping
10 terminal means containing the zone of contact, which means comprise a housing of insulating material with at least one insertion slit, open at the edge, for a wire and at least one IDC terminal mounted inside the housing with an IDC slit open at the edge toward the side of insertion and aligned
15 with the insertion slit, characterized in that in the preassembled electrical apparatus or module of circuit elements, the housing (12, 12a) of the terminal clamping means is arranged with an insertion slit (19) accessible for the wire-laying
20 means (31); that the housing (12, 12a) on at least one side near the insertion slit (19) has a slit-like or groove-like wire-accommodating indentation (26) the width of which exceeds the width of the insertion slit (19); and that the dimensions of the
25 slit-like or groove-like indentation (26) are chosen so that near the IDC terminal (25), a free end of a wire with which contact is made in the IDC terminal (25) is accommodated in protected all-insulated fashion within the slit-like or groove-like indentation (26); and that the slit-like or
30 groove-like indentation (26) and the housing (12) match the dimensions of the laying finger (59) and of the pressure-application member (76) of the laying tool of the wire-laying means (31).

35

29. The terminal according to Claim 28, characterized in that the insertion slit (19) has a width which fixes a pressed-in wire by clamping it.



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30. The terminal according to Claim 28 or 29, characterized in that the slit-like or groove-like indentation in the housing (12) is arranged for confinement on both sides by IDC terminals (25).

5

31. The terminal according to any one of Claims 28 to 30, characterized in that the slit-like or groove-like indentation (26) is deeper than the insertion slit (19).

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