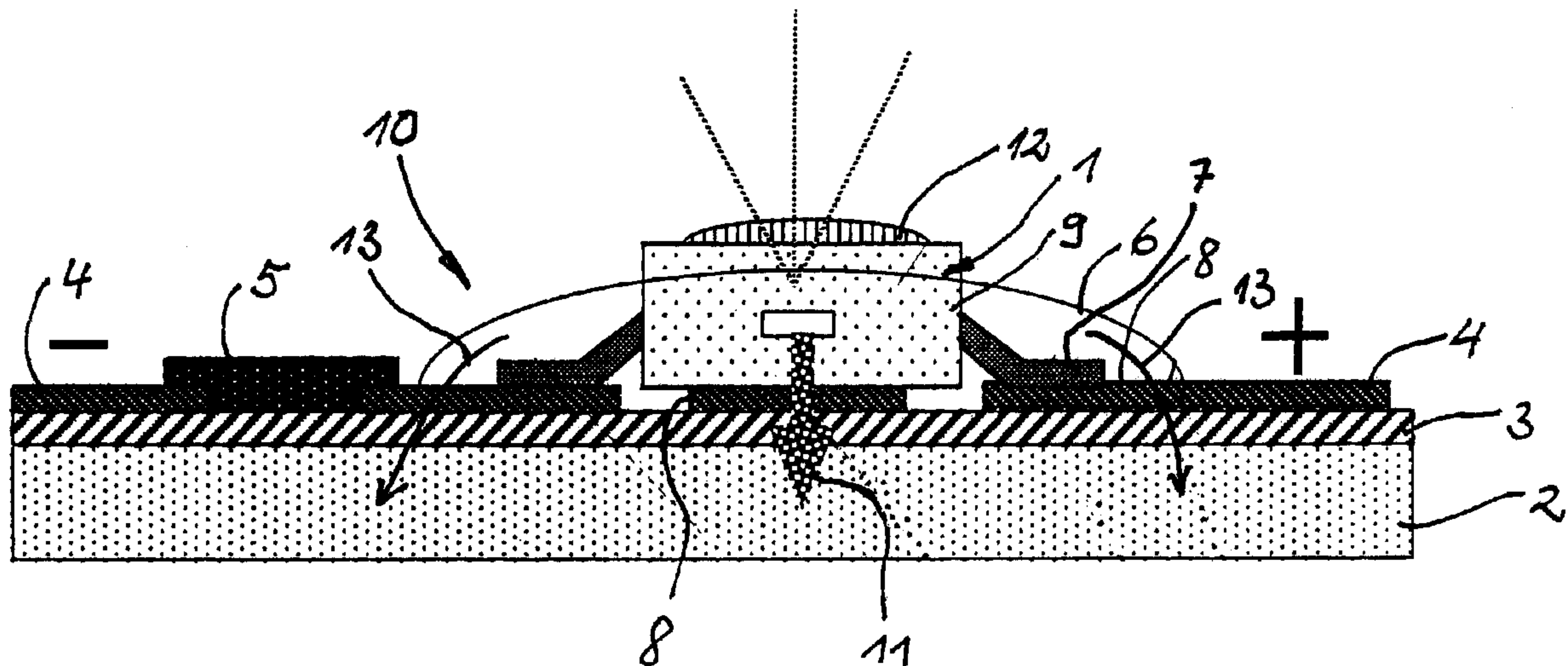




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(54) Title: FLAT ILLUMINATING DEVICE



(57) **Abrégé/Abstract:**

The invention relates to a flat illuminating device (10, 10') which comprises light-emitting illuminating elements (1) which are arranged on a carrier and which are connected to the current supply lines and current discharge lines (4') for supplying current. Said support is shaped as a metallic film (2) which is covered with an insulating layer (3), whereon series circuits consisting of an illuminating element (1) and a series resistor surface (5) are arranged, respectively between the current supply lines and the current discharge lines (4'). An illuminating element (1) and a series resistor surface (5) of a series circuit and series circuits and current supply lines and current discharge lines (4') are connected together via conductor paths (4). The invention also relates to a method for producing said type of illuminating devices.



Abstract

The invention relates to a flat lighting device (10, 10') comprising light-emitting lighting elements (1) arranged on a carrier, which are connected to current supply and current discharge lines (4') to supply current. The carrier has the form of a metallic sheet (2), which is covered with an insulating layer (3), on which in each case series connections of a lighting element (1) and a surface series resistor (5) in each case are arranged between the current supply and current discharge lines (4'). One lighting element (1) and one surface series resistor (5) of a series connection and the series connections and the current supply and current discharge lines (4') are in each case connected to one another by conductor paths (4). The invention also relates to a method for producing lighting devices of this type.

15 (Fig. 1)

Flat lighting device

The invention relates to a flat lighting device and a method for the production thereof.

5

Optoelectronic modules are known, in which a plurality of lighting elements are arranged on a substrate. In this case, there is a problem in that the lighting elements can only be operated with a relatively low current of about 10 to 50 mA because of heating. The quantity of light emitted by the lighting elements is
10 therefore small.

An optoelectronic module emerges from DE 100 33 502 A1, in which light-emitting semiconductor components are fastened to a substrate which is a good conductor of heat. The underneath of the substrate is fastened to a metallic carrier body,
15 which has a high heat capacity and good heat conductivity. The component fastening between the semiconductor components and the substrate, as well as the substrate fastening between the substrate and the carrier body, is implemented with good heat conductivity. The substrate may consist of silicon, which is a lighter and relatively economically available material and has excellent
20 heat conductivity. The entire module is covered by a glass body, which has a recess exposing the substrate surface, in which recess the semiconductor components are arranged.

The object of the present invention is to disclose a lighting device, which has a
25 relatively high efficiency and a long service life and, in addition, is constructed relatively simply, and a method for the production thereof.

This object is achieved by a lighting device with the features of claim 1 and by a method with the features of claim 31.

30

The substantial advantage of the present lighting device, which preferably has the form of a wall covering of light or a panel of light, consists in that it is particularly simply constructed and can be handled and installed like a large-area wall

covering or like individual panels. The method for producing the lighting device according to the invention is also relatively simple and economical to carry out. This is to be attributed to the special structure of the lighting device according to the invention.

5

As the individual lighting elements, or light-emitting diodes, are arranged in such a way that excellent heat transmission or dissipation takes place into the metallic carrier sheet which is being used as a carrier, the individual lighting elements can be operated, depending on their number, with an operating voltage of, for
10 example, 20 V. The operating voltage is therefore in the range of small voltages according to the VDE standards. The outlay for insulation is therefore advantageously kept small.

The hard-rolled aluminium sheets being used as a carrier sheet are particularly
15 simply and advantageously provided in a flat manner with an insulating layer, in particular with an outer layer of varnish, as an insulator, and printed by the gravure printing method in several layers with a conductive dye, preferably a silver conductive dye, to produce the various conductor paths and the connection contact faces, and also with a further conductive dye, preferably a graphite
20 conductive dye, to produce the series resistors. This method is also particularly simple to carry out and economical. In this case, both the conductor paths being used for current supply and current removal and for current distribution in the face of the lighting device, and also the connection faces for the light-emitting components, are printed on in the silver conductive dye by a gravure printing
25 operation. As the resistor faces of the series resistors, consisting of graphite conductive dye, which are preferably fed by input and output lines consisting of silver are also advantageously printed on by the gravure printing method, the necessary low tolerance of the series resistors is advantageously far below 10% because of the high uniformity of the gravure printing method. The required power
30 loss of the series resistors is achieved by the relatively large-area configuration of the printed-on resistance faces. The light-emitting lighting elements are preferably bonded with a silver-containing conductive adhesive to the corresponding connection contact faces or soldered thereto. Said silver-containing conductive

adhesive has a very low coefficient of heat conduction, so good heat dissipation takes place from the light-emitting lighting elements to the metallic carrier sheet.

In a preferred configuration of the invention as a wall covering of light, respective
5 parallel branches with four or more series connections connected in series, in each case consisting of a light-emitting lighting element and a series resistor, are arranged between the current supply and current discharge lines to compensate the different forward characteristics of the lighting elements.

10 The individual light-emitting lighting elements, after they have been fastened to the corresponding connection contact faces, are advantageously further fixed and mechanically stabilised by a stabilisation coating.

As the surface of the metallic carrier sheet can be occupied practically without
15 additional costs with conductor path structures by the gravure printing method, in a preferred configuration of the invention, additional conductor paths for potential equalisation are also printed parallel to the current supply and current discharge lines. Normally, no current flows through these potential equalisation conductor paths, as all light-emitting lighting elements, which are connected in series
20 between a current supply line and a current discharge line, lie on the same potential. If a light-emitting lighting element fails, a cross current flows, which continues to supply the light-emitting lighting elements connected in series to the failed light-emitting lighting element with current. Thus the entire series of light-emitting lighting elements advantageously does not fail but only one light-emitting
25 lighting element.

An important advantage of the method according to the invention is that because of the application of the conductor paths, the current supply lines, the current discharge lines, the connection contact faces, optionally the potential equalisation
30 conductor paths and the surface series resistors by the gravure printing method in comparison to methods with etched conductor paths or with conductor paths produced by screen printing, operation can be substantially more economical, and, owing to the use of an aluminium sheet as the metallic carrier sheet, the

necessary heat distribution is simultaneously achieved to dissipate and distribute the heat that has been generated pointwise of the light-emitting lighting elements into the face on the rear of the aluminium sheet.

- 5 In a further preferred configuration of the invention, the flexible metallic carrier sheet is reinforced by a stable composite part, so self-supporting light panels can be produced. Here, a composite part which is preferably configured in a honeycombed manner and also made of a metallic material is bonded onto the metallic carrier sheet, the opposite side being covered with an optically
10 transparent plastics material or an opaque plastics material bringing about a diffuse light distribution. The light-emitting lighting elements, conductor paths and resistors are advantageously mechanically and electrically protected thereby and a stable sandwich element is produced with a heat-dissipating rear and a light-emitting front side, which can be lined up with other correspondingly configured
15 sandwich elements next to each other to provide larger light faces.

The invention and the configuration thereof are described in more detail below in conjunction with the figures, in which:

- 20 Fig. 1 shows a section through a region of a light-emitting lighting element of the lighting device according to the invention;

- Fig. 2 shows a view from above onto a lighting device according to the invention which comprises a plurality of light-emitting lighting elements and is configured as
25 a wall covering of light, to describe the arrangement of the connection contact faces and of the surface series resistors and the conductor path guidance; and

Fig. 3 shows a lighting device according to the invention configured as a light panel with a sandwich construction.

30

According to Fig. 1, which shows a section through the region of a light-emitting lighting element 1, preferably a light-emitting diode, of a lighting device 10, the latter consists substantially of a metallic carrier sheet 2, which preferably has the

form of an aluminium sheet, an insulating layer 3, which is preferably a layer of varnish, conductor paths 4, connection contact faces 8, surface series resistors 5, light-emitting diodes (LED) 1 and a stabilisation coating 6.

- 5 In the embodiment of the method according to the invention, an insulating layer 3 of varnish is firstly applied in a flat manner to the aluminium sheet 2, which is preferably hard-rolled and has a thickness of about 70 μm , the layer of varnish preferably consisting of polyurethane and being 10 μm thick. It is conceivable for the insulating layer 3 of varnish to be applied in two or more layers in order to
10 prevent insulation defects owing to holes. It is also possible to achieve the insulation by means of a paper web or plastics material sheet laminated onto the aluminium sheet.

Various electrically conductive paths or faces, which preferably consist of
15 conductive dyes and are used for the production of the current supply and current discharge lines 4', of the conductor paths 4 for distribution of current into the face of the lighting device 10, the connection contact faces 8 for the light-emitting diodes 1, and the surface series resistors 5, are preferably printed, in several layers, on the surface of the insulating layer 3 of varnish by the gravure printing
20 method. The current supply and current discharge lines 4', the conductor paths 4 and the connection contact faces 8 particularly preferably consist of a silver conductive dye printed on by a gravure printing method step. The surface series resistors 5 preferably consist of a graphite conductive dye printed on in a separate gravure printing method step.

25

The surface series resistors 5 are produced overlapping the corresponding conductor paths 4 in the separate gravure printing method step, so good electrical connections are produced.

- 30 The connections 7 of the light-emitting diodes 1 are then fastened to the connection contact faces 8 of the conductor paths 4. For this purpose, the connections 7 are then applied in the correct position with respect to the connection contact faces 8 in an assembly process and fastened or bonded

thereto with the aid of a conductive adhesive, a good electrical connection and a connection with a good heat conductivity being brought about. Alternatively, the connections 7 of the diodes 1 can also be soldered at the connection contact faces 8.

5

In the correct position, the heat-conductive body part 9 of the diodes 1, which preferably consists of copper, is seated on a connection contact face 8 located therebelow, so good heat dissipation from the body part 9 in the direction of the arrow 11 takes place by way of the conductor path 4 and the layer 3 of varnish to
10 the aluminium sheet 2.

The connection contact faces 8 can also be formed directly by a partial region of the conductor paths 4.

15 To stabilise and mechanically fix the diodes 1, a stabilisation coating 6 is expediently applied to the fastening region of the diodes 1, care being taken that the diodes 1 are only embedded to such an extent into the material of the coating 6 that their light-emitting front side 12 is exposed. The stabilisation coating 6 simultaneously also covers in each case the contacts between the connections 7
20 of the diodes 1 and the corresponding connection contact faces 8. The application of the stabilising coating 6 is particularly advantageous because, by it, a fixed bond is produced between the diodes 1 and the aluminium sheet 2, which is rigid compared to the aluminium sheet 2 which is flexible *per se*. Bending radii, which are produced during the handling of the lighting device 10 by deformations, are
25 therefore not introduced directly into the contact points, but, as shown by the arrows 13, into the aluminium sheet 2. The contact points are thus substantially relieved of pressure.

According to Fig. 2, parallel branches, arranged next to one another, run between
30 the parallel current supply and current discharge lines 4' and, in each case, comprise a plurality (for example four) of series connections in each case of a surface series resistor 5 and a diode 1 in series. The surface series resistor 5 and the diode 1 of the series connections are connected to one another in each case

by way of a conductor path 4. The series connections of a branch are also connected to one another or to the current supply and current discharge line 4' by conductor paths 4.

- 5 The points 16, arranged next to one another in the direction of the current supply and current discharge lines 4', of the conductor paths 4 of the branches, which are in each case located between two corresponding series connections of the branches, may preferably be connected to one another by potential equalisation lines 4", which run parallel to the current supply and current discharge lines 4', for
10 the reasons mentioned at the outset.

To produce a stable lighting device 10', which can be handled as a light panel, according to Fig. 3, a preferably honeycombed metallic composite part 14 is fastened, preferably bonded, to the side of the aluminium sheet 2 remote from the
15 diodes 1, the composite part expediently consisting of aluminium. An optically transparent cover 15 or a cover which is opaque for diffuse light distribution, preferably consisting of a plastics material, can then be applied to the side of the diodes 1. A lighting device 10' in a sandwich construction with a heat-diffusing aluminium rear and a light-emitting front side is thus produced, the diodes 1, the
20 conductor paths 4, the connection contact faces 8, the connections 7 of the diodes 1 and the surface series resistors 5 being mechanically and electrically well protected.

List of reference numerals

	1	lighting element
	2	carrier sheet
5	3	insulating layer
	4	conductor path
	4'	current supply and current discharge line
	4"	potential equalisation line
	5	surface series resistor
10	6	stabilisation coating
	7	connection
	8	connection contact faces
	9	body part
	10	lighting device
15	10'	lighting device
	11	arrow
	12	front side
	13	arrow
	14	composite part
20	15	cover
	16	point

Claims

1. Flat lighting device comprising light-emitting lighting elements arranged on a carrier, which are connected to current supply and current discharge lines to supply current, characterised in that the carrier has the form of a metallic sheet (2), which is covered with an insulating layer (3), on which, in each case, series connections of a lighting element (1) and a surface series resistor (5), in each case, are arranged between the current supply and current discharge lines (4'), and in that in each case a lighting element (1) and a surface series resistor (5) of a series connection as well as the series connections and the current supply and current discharge lines (4') are connected to one another by conductor paths (4).
2. Lighting device according to claim 1, characterised in that a plurality of series connections are arranged next to one another between the current supply and current discharge lines (4').
3. Lighting device according to claim 1, characterised in that a plurality of branches, which in each case comprise, one behind the other, a plurality of series connections of a lighting element (1) and a surface series resistor (5) in each case, are arranged between the current supply and current discharge lines (4').
4. Lighting device according to claim 3, characterised in that potential equalisation lines (4'') are provided, which in each case connect to one another the points (16), arranged next to one another, of the conductor paths (4) of the branches, which are arranged between series connections of a lighting element (1) and a surface series resistor (5), in each case.
5. Lighting device according to any one of claims 1 to 4, characterised in that the metallic sheet (2) is an aluminium sheet.

6. Lighting device according to claim 5, characterised in that the aluminium sheet has a thickness of about 70 μm .
7. Lighting device according to any one of claims 1 to 6, characterised in that the insulating layer (3) is a varnish layer applied in a flat manner.
8. Lighting device according to claim 7, characterised in that the layer (3) of varnish, consists of polyurethane.
9. Lighting device according to claim 7 or 8, characterised in that the layer of varnish is about 10 μm thick.
10. Lighting device according to any one of claims 7 to 9, characterised in that the layer of varnish is applied in two or more layers on top of one another to avoid insulation defects owing to holes.
11. Lighting device according to any one of claims 1 to 6, characterised in that the insulating layer (3) is formed by a plastics material sheet laminated onto the metallic sheet (2).
12. Lighting device according to any one of claims 1 to 6, characterised in that the insulating layer (2) is formed by a paper web laminated on to the metallic sheet (2).
13. Lighting device according to any one of claims 1 to 12, characterised in that the conductor paths (4), the current supply and current discharge lines (4') and optionally the potential equalisation lines (4'') are printed onto the surface of the insulating layer (3) by a gravure printing method.
14. Lighting device according to any one of claims 1 to 13, characterised in that the conductor paths, the current supply and current discharge lines (4') consist of a conductive dye.

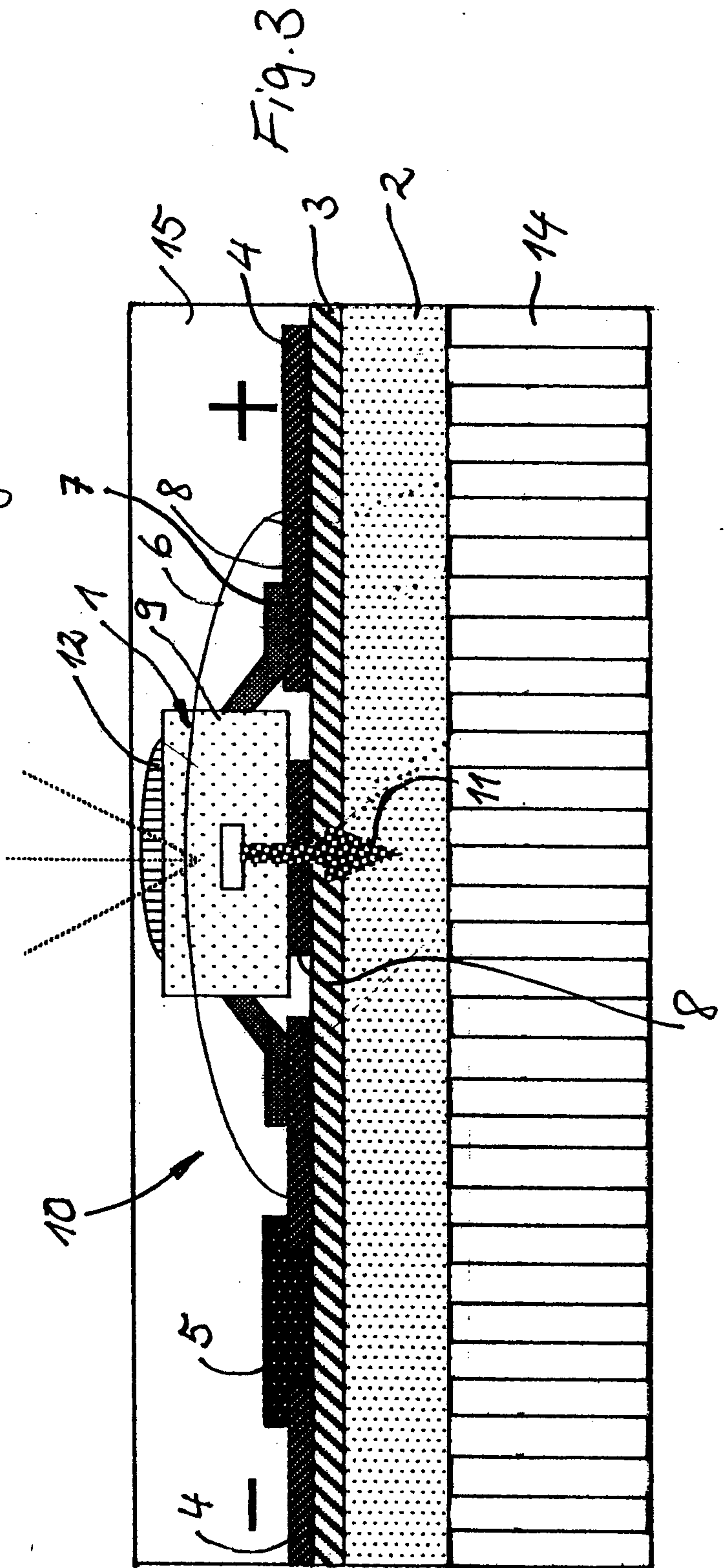
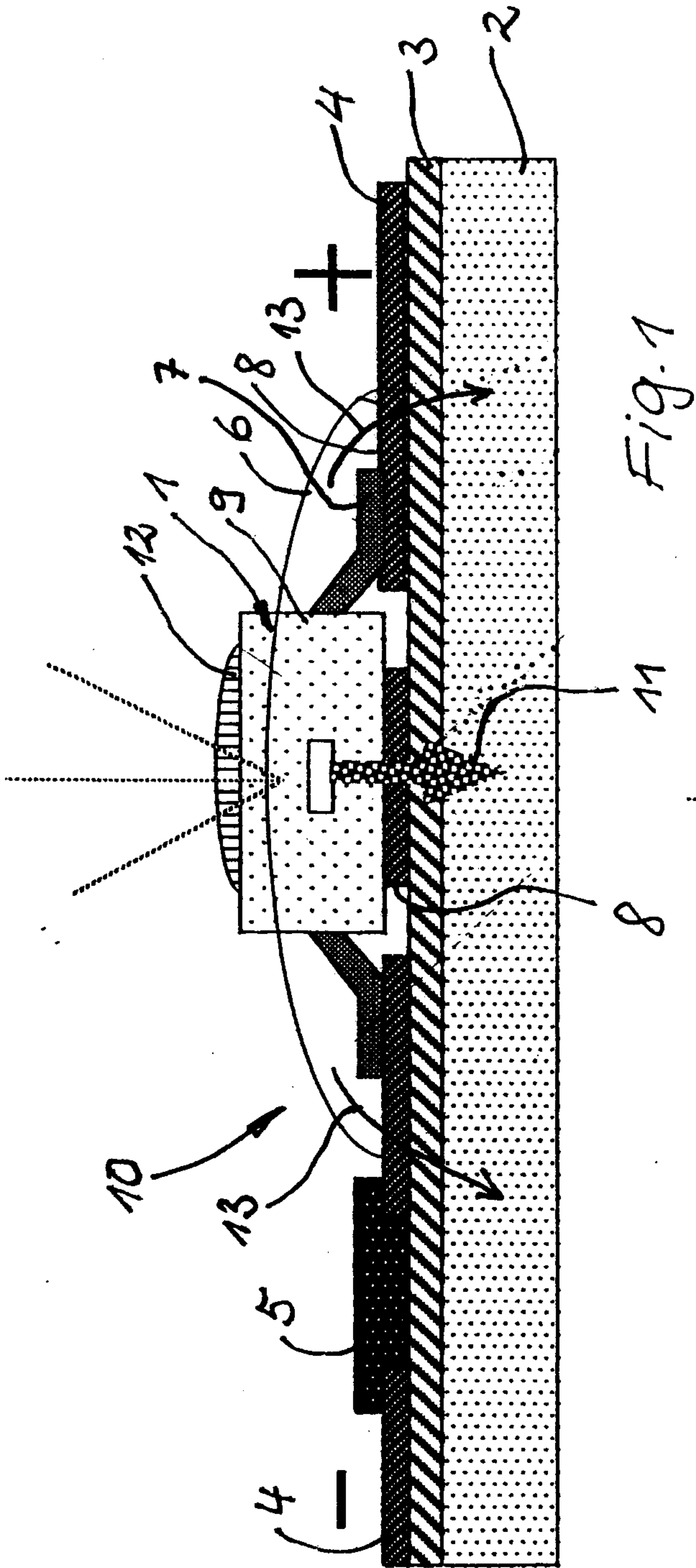
15. Lighting device according to claim 14, characterised in that the conductive dye is a silver conductive dye.
16. Lighting device according to any one of claims 1 to 15, characterised in that
5 the surface series resistors (5) are printed onto the surface of the insulating layer (3) by the gravure printing method.
17. Lighting device according to claim 16, characterised in that the surface
10 series resistors (5) and the conductor paths (4) are printed on so as to overlap.
18. Lighting device according to claim 16 or 17, characterised in that the surface series resistors consist of a further conductive dye.
- 15 19. Lighting device according to claim 18, characterised in that the further conductive dye is a graphite conductive dye.
20. Lighting device according to any one of claims 1 to 19, characterised in that
20 the connections (7) of the lighting elements (1) are in each case bonded to connection contact faces (7) which are arranged on conductor paths (4) with a conductive adhesive, or soldered.
21. Lighting device according to claim 20, characterised in that the connection
25 contact faces (7) are printed on together with the corresponding conductor paths (4) by a gravure printing method.
22. Lighting device according to any one of claims 1 to 21, characterised in that the lighting elements (1) are light-emitting diodes.
- 30 23. Lighting device according to any one of claims 1 to 22, characterised in that the body part (9) of a fixed lighting element (1) is seated on a contact connection face (8) located therebelow, so good heat dissipation takes place from the body part (9) to the metallic sheet (2).

24. Lighting device according to any one of claims 1 to 23, characterised in that a stabilising coating (6) is arranged on the lighting elements (1) for stabilisation and for mechanical fixing thereof and also covers the regions of the connections (7) of the lighting elements (1) and of the connection contact faces (8), but leaves the light-emitting front side of the lighting elements (1) free.
25. Lighting device according to any one of claims 1 to 24, characterised in that a stabilising metallic composite part (14) is fastened to the side of the metallic sheet (2) remote from the lighting elements (1).
26. Lighting device according to claim 25, characterised in that the composite part (14) is honeycombed.
27. Lighting device according to claim 25 or 26, characterised in that the composite part consists of aluminium.
28. Lighting device according to any one of claims 25 to 27, characterised in that a cover (15) is fastened to the side of the lighting device opposing the composite part (14).
29. Lighting device according to claim 28, characterised in that the cover (15) consists of a transparent or opaque material.
30. Lighting device according to claim 29, characterised in that the cover (15) consists of a plastics material.
31. Method for producing a lighting device according to any one of claims 1 to 30, characterised in that the insulating layer is applied to the metallic sheet (2) and in that the conductor paths (4), the current supply and discharge lines (4'), the connection contact faces (8) and optionally the potential

equalisation lines (4'') are printed onto the insulating layer (3) by the gravure printing method.

- 5 32. Method according to claim 31, characterised in that the conductor paths (4), the current supply and discharge lines (4'), the connection contact faces (8) and optionally the potential equalisation lines (4'') are printed on in one or more layers.
- 10 33. Method according to claim 32, characterised in that a conductive dye, preferably a silver conductive dye, is printed on as the material for the conductor paths (4), the current supply and current discharge lines (4'), the connection contact faces (8) and optionally the potential equalisation lines (4'').
- 15 34. Method according to any one of claims 31 to 33, characterised in that the surface series resistors (5) are printed on separately in one or more layers by the gravure printing method.
- 20 35. Method according to claim 34, characterised in that the surface series resistors (5) and the conductor paths (4) are printed on so as to overlap.
36. Method according to claim 34 or 35, characterised in that the surface series resistors (5) are printed on in one or more layers.
- 25 37. Method according to any one of claims 34 to 36, characterised in that a further conductive dye, preferably a graphite conductive dye, is used as the material for the surface series resistors (5).
- 30 38. Method according to any one of claims 31 to 37, characterised in that a layer of varnish is applied in a flat manner as the insulating layer (3) and preferably consists of polyurethane and is preferably about 10 μm thick.

39. Method according to any one of claims 31 to 38, characterised in that the insulating layer (3) is applied in two or more layers on top of one another to avoid insulation defects owing to holes.
- 5 40. Method according to any one of claims 31 to 37, characterised in that a plastics material sheet or a paper web is laminated as the insulating layer (3) onto the metallic sheet (2).
- 10 41. Method according to any one of claims 31 to 40, characterised in that the connections (7) of the lighting elements are bonded in each case to conductor paths (4) or to connection contact faces (8) arranged on conductor paths (4) by a conductive adhesive, or soldered.



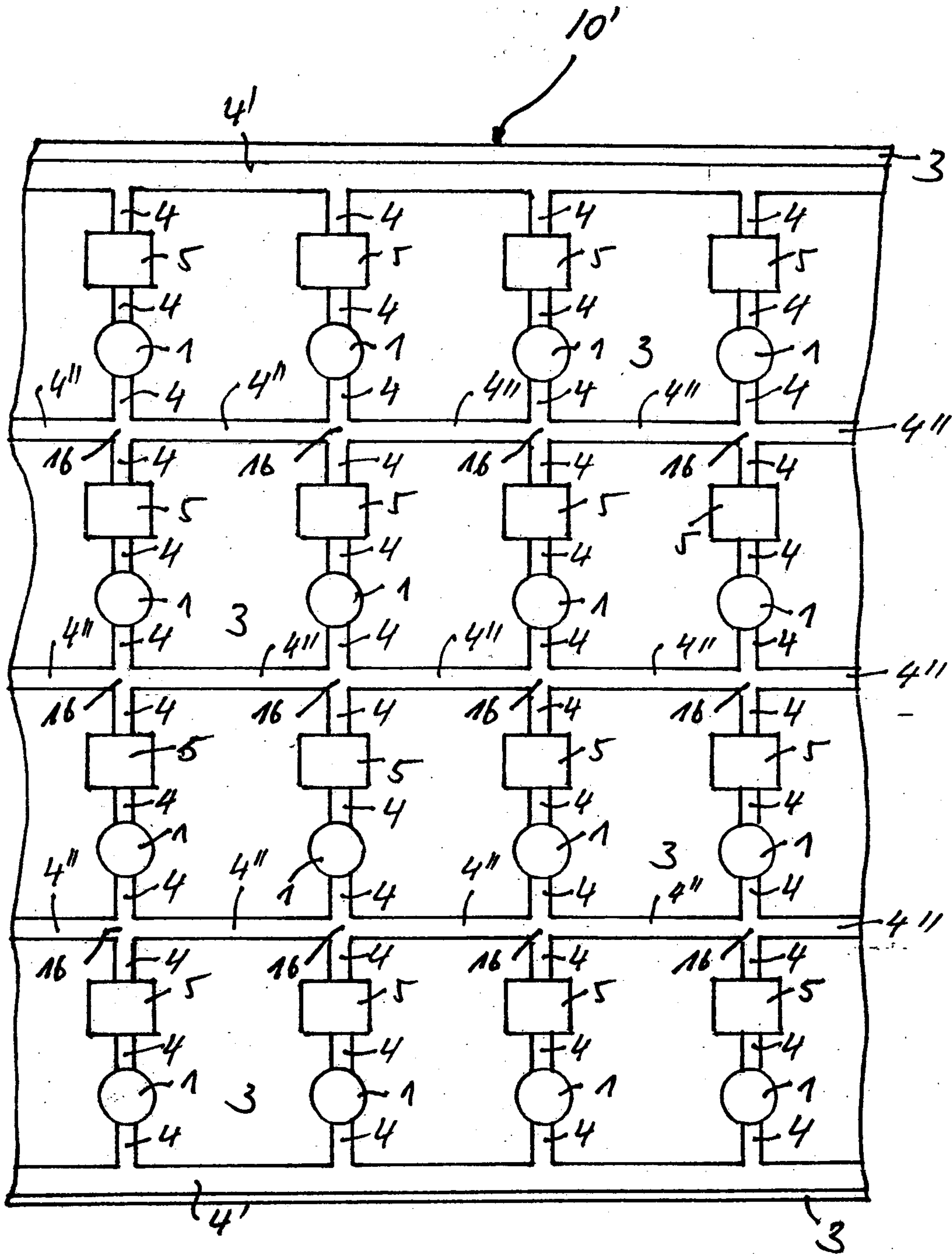


Fig. 2

