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(54) **ANTI-STATIC APPARATUS**

(57) The present disclosure relates to an anti-static apparatus for neutralising an electrostatically charged surface, for example a moving web. The anti-static apparatus comprises at least one positive emitter and at least one negative emitter configured to generate an electric field. The anti-static apparatus also comprises a voltage supply unit for applying a positive voltage to the at least one positive emitter and a negative voltage to the at least one negative emitter. The voltage supply unit

is configured to receive an input voltage and comprises a transformer configured to generate an output voltage having a greater voltage than the input voltage. The voltage supply unit also comprises a gas discharge tube connected to the voltage supply unit on a high voltage side of the transformer. The gas discharge tube comprises a breakover voltage configured to refer the voltage supply unit to ground when a voltage on the voltage supply unit exceeds a breakover voltage of the gas discharge tube.

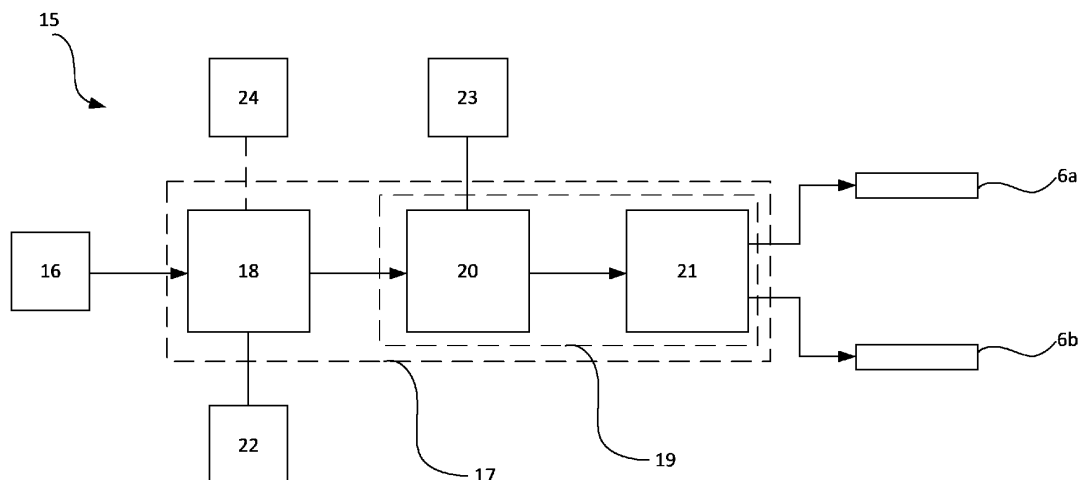


FIG. 5

Description

[0001] This invention relates to an anti-static apparatus for neutralising an electrostatically charged surface.

BACKGROUND

[0002] An anti-static bar generates an electrical field that causes the air molecules in the vicinity of the anti-static bar to break down into positive and negative ions. Any charged material passing nearby the anti-static bar will attract charged ions and the charge on the material is thereby neutralised. An anti-static bar can be used to prevent attraction of dust to the surface, and also reduces the risk of explosions, fire hazards, and electrical shocks.

BRIEF SUMMARY OF THE DISCLOSURE

[0003] In accordance with the present disclosure there is provided an anti-static apparatus for neutralising an electrostatically charged surface, for example a moving web, the anti-static apparatus comprising:

at least one positive emitter and at least one negative emitter configured to generate an electric field, and

a voltage supply unit for applying a positive voltage to the at least one positive emitter and a negative voltage to the at least one negative emitter, the voltage supply unit being configured to receive an input voltage and comprising a transformer configured to generate an output voltage having a greater voltage than the input voltage;

wherein the voltage supply unit further comprises a gas discharge tube connected to the voltage supply unit on a high voltage side of the transformer, and wherein the gas discharge tube comprises a break-over voltage configured to refer the voltage supply unit to ground when a voltage on the voltage supply unit exceeds a breakover voltage of the gas discharge tube.

[0004] In examples, the transformer may be an AC-AC transformer.

[0005] In examples, the voltage supply unit further comprises a voltage multiplier arranged to receive the output voltage of the transformer. The voltage multiplier may receive the AC output voltage of the transformer, and may output a DC voltage with higher voltage to the positive and negative emitters.

[0006] In examples, the voltage supply unit further comprises a switching circuit configured to switch the output voltage supplied to the positive and negative emitters on and off.

[0007] In examples, the switching circuit comprises an H-bridge.

[0008] In examples, the switching circuit is configured

to simultaneously apply a positive voltage to the at least one positive emitter and a negative voltage to the at least one negative emitter.

[0009] In examples, the switching circuit is adapted to switch the voltages applied to the positive and negative emitters on and off at a frequency of between 0Hz and 5kHz, for example about 150Hz.

[0010] In examples, the high voltage side of the voltage supply unit is floating with respect to ground.

[0011] In examples, the anti-static apparatus further comprises a grounding connector arranged proximal to the at least one positive emitter and the at least one negative emitter.

[0012] In examples, the anti-static apparatus may further comprise a housing, and the housing may comprise an open side. The housing may be mountable, for example by one or more fasteners, to a machine or other apparatus. For example, the housing may be mountable to a web handling machine such that the open side of the housing is directed towards a moving web of material. The at least one positive emitter and the at least one negative emitter may be arranged at the open side of the housing.

[0013] In examples, the anti-static apparatus further comprises a grounding connector arranged about the open side of the housing.

[0014] In examples, the housing is elongate and the anti-static apparatus comprises a plurality of positive emitters and a plurality of negative emitters arranged alternately along the housing. The positive and negative emitters may be arranged in a line, or in separate rows, or in any other arrangement along the housing in which the positive and negative emitters are spaced from each other and alternating such that an electric field is generated during use.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Embodiments of the invention are further described hereinafter with reference to the accompanying drawings, in which:

FIG. 1 is a schematic view of anti-static apparatus mounted adjacent to a surface to be neutralised;

FIG. 2 shows a perspective view of the anti-static apparatus;

FIG. 3 shows a perspective view of an end of the anti-static apparatus;

FIGS. 4A and 4B show dimensions of an example anti-static apparatus;

FIG. 5 shows a schematic circuit of a voltage supply unit of the anti-static apparatus; and

FIG. 6 shows a circuit diagram of the voltage supply

unit of the anti-static apparatus.

DETAILED DESCRIPTION

[0016] As shown in FIG. 1 the anti-static apparatus, in this example an anti-static bar 1, is arranged adjacent to a surface 2 to be neutralised. The surface 2 may be electrostatically charged and the anti-static bar 1 may act to neutralise the electrostatic charge.

[0017] As described further hereinafter, the anti-static bar 1 has an elongate housing 3 having an open side. A series of emitters arranged within the housing 3. The emitters comprise positive emitters and negative emitters. A voltage supply unit applies a voltage across the positive and negative emitters and this generates an electric field that charges particles surrounding the anti-static bar 1, creating a corona discharge in the vicinity of the surface 2. The charged particles are drawn to the surface 2 by the electrostatic charge on the surface 2, thereby neutralising the electrostatic charge. A grounding connector is provided on the housing 3.

[0018] As illustrated in FIG. 1, the anti-static bar 1 has an operating range. The anti-static bar 1 is mounted or positioned relative to the surface 2 such that the surface 2 is within the operating range of the anti-static bar 1. The operating range may depend on, among other factors, the magnitude of the voltage applied across the emitters. In examples, the operating range (i.e., the distance between the anti-static bar 1 and the surface 2) is between about 5 millimetres and about 100 millimetres, or between about 10 millimetres and about 50 millimetres. The operating range 4 is measured from the grounding connector (11, see FIG. 2).

[0019] In some examples the surface 2 is a web of material, such as a polymer web. The surface 2 may be a surface of an essentially insulating material, such as a polymer, and so electrostatic charges may accumulate on the surface 2. The web may be moving, for example moving within a web handling machine. The anti-static bar 1 may be mounted to the web handling machine in a fixed position relative to the position of the web. In a web handling machine the anti-static bar 1 is preferably mounted at a position spaced from any rollers or other process units, so that the anti-static bar 1 acts on an isolated portion of the web. In other examples, the anti-static bar 1 may be positioned or mounted relative to another moving surface, or relative to a stationary surface.

[0020] As will be appreciated, the operating range of the anti-static bar 1 approximately corresponds to a volume 4 extending from the anti-static bar within which no grounded reference is present (other than any grounded reference in the anti-static bar 1 itself, as discussed below).

[0021] As shown in FIG. 2, the anti-static bar 1 includes an elongate housing 3 having an open side 5. In particular, the elongate housing 3 is substantially cuboidal, with one side 5 open defining a substantially hollow housing 3.

[0022] The anti-static bar 1 further includes a plurality of emitters 6 positioned within the housing 3. The emitters 6 are elongate, and may have pointed tips, rounded tips, and/or sharp edges, and may be directed towards the open side 5 of the housing 3. As discussed further below, the emitters 6 comprise positive emitters and negative emitters that are alternately arranged along the housing 3.

[0023] The housing 3 also comprises a grounding connector 11. The grounding connector 11 may alternatively be a grounding rod, grounding electrode, or grounding conductor. In particular, the grounding connector 11 is arranged along the open side 5 of the housing 3, adjacent to the emitters 6. The grounding connector 11 is proximal to the emitters 6, but not electrically connected to the emitters 6. The grounding connector 11 is electrically insulated from the emitters 6.

[0024] A voltage supply unit is also housed in the housing 3. The voltage supply unit is adapted to receive an input voltage from a connector 7 in the housing 3. As described further hereinafter, the voltage supply unit is configured to supply an output voltage to the emitters 6 such that an electric field is generated in the vicinity of the emitters 6.

[0025] As shown in FIG. 3, the housing 3 of the anti-static bar 1 includes a mounting rail 8 formed along one side. In the example the mounting rail 8 is formed along a side of the housing 3 opposite to the open side 5, but it will be appreciated that the mounting rail 8 may be provided on one of the other parts of the housing 3. The mounting rail 8 is adapted to receive a fastener 12 for mounting the anti-static bar 1 to further apparatus, for example a web handling machine as described above.

[0026] As also shown in FIG. 3, the housing 3 includes the connector 7 for connecting the anti-static bar 1 to a power source. The connector 7 may be an M8 connector, for example. The input voltage is provided to the voltage supply unit via the connector 7.

[0027] As shown in FIG. 4A, the emitters 6 are spaced along the housing 3 in a line approximately central in the housing 3. Positive and negative emitters 6 are alternately spaced along the housing 3. The emitters 6 may be spaced by between about 5 millimetres and about 50 millimetres along the housing 3, or between about 15 millimetres and about 25 millimetres. In some examples, the emitters 6 are spaced by between about 15 millimetres and about 20 millimetres. It will be appreciated that the number of emitters 6 on the anti-static bar 1 will depend on the overall length of the anti-static bar 3, as discussed below. In other examples, the emitters 6 may be staggered or arranged in parallel rows along the housing 3.

[0028] The emitters 6 are preferably pin emitters comprising an upstanding pin. The emitters 6 may have a pointed tip, a rounded tip, and/or a sharp edge. The emitters 6 may be permanently attached, or they may be detachable from the anti-static bar 1 for replacement.

[0029] In the example of FIGS. 4A and 4B the anti-

static bar 1 has a length of approximately 200 millimetres, but the length may be greater or less, and may be configured to correspond to the width of the surface 2 to be neutralised. In particular, for a moving web the anti-static bar 1 may have a length of approximately the same as the moving web, or approximately 10-20 millimetres greater than the width of the web so that the entire width of the web is covered. In examples, the anti-static bar 1 may have a length of between about 200 millimetres and about 2000 millimetres, for example between about 1000 millimetres and 2000 millimetres.

[0030] As shown in FIG. 4B, the cross-section of the housing 3 is approximately square. The open side 5 of the housing 3 may include a flared opening 9.

[0031] The housing 3 may be formed from a profile section 13 and end plates 14 may be attached to the profile section 13. The profile section 13 and the end plates 14 may be made from an insulative material, for example a polymer or glass fibre reinforced polymer.

[0032] The housing 3 is also provided with an indicator, in this example an LED 10 indicating the status of the anti-static bar 1. The LED 10 may change from green during operation, to red when the anti-static bar 1 is not in operation or if some error is detected such as a charge overload. Alternatively, when the anti-static bar 1 is not in operation the LED 10 may be off.

[0033] FIG. 5 schematically illustrates the voltage supply unit 15 of the anti-static bar. The voltage supply unit 15 is adapted to apply a voltage across to the positive emitter 6a and the negative emitter 6b. In particular, the voltage supply unit 15 is adapted to apply switching positive and negative voltages to positive emitter 6a and negative emitter 6b, respectively.

[0034] As shown in FIG. 5, the voltage supply unit 15 comprises a voltage input 16 adapted to receive a DC voltage input from an external power source, in particular via the connector 7 shown in FIG. 4B. The DC voltage input may comprise between 6V and 48V, for example 12V or 24V. The DC voltage input is a low voltage DC input.

[0035] The voltage supply unit 15 further comprises a voltage converter 17 adapted to increase the voltage of the low voltage DC input. In particular, the voltage converter 17 comprises a primary circuit 18 defining a low voltage side of the voltage converter 17, and a secondary circuit 19 defining a high voltage side of the voltage converter 17. The secondary circuit 19 includes a voltage multiplier 21 adapted to transform the DC voltage into a higher voltage DC voltage. The primary circuit 18 comprises a coil and the secondary circuit 19 includes a coil 20. The coils 18, 20 form a transformer adapted to step up the voltage, which is also increased by the voltage multiplier 21. The voltage converter 17 may increase the voltage to a higher voltage in the secondary circuit 19, for example between about 2kV and about 10kV, for example between about 4kV and about 9kV.

[0036] As illustrated, the primary circuit 18 is further connected to a ground reference 22. The connection to

the ground reference 22 on the primary circuit 18 is made via the connector 7 illustrated in FIG. 4B.

[0037] The secondary circuit 19 is connected to the positive and negative emitters 6a, 6b to apply the positive and negative voltages to the emitters 6a, 6b, respectively.

[0038] As illustrated in FIG. 5, the secondary circuit 19, in particular the coil 20, is connected to a gas discharge tube 23. The gas discharge tube 23 is configured to refer the secondary circuit 19 to ground when a charge load on the secondary circuit 19 exceeds a breakover voltage of the gas discharge tube 23. This may happen, for example, if the charge on the surface 2 is particularly large. The breakover voltage of the gas discharge tube 23 may be, for example, between 1 kV and 2kV, for example 1.2kV.

[0039] In this example, the primary circuit 18 further includes a switching circuit, for example an H drive circuit, which generates an AC input voltage for the transformer and is also used for switching the positive and negative voltages applied to the positive and negative emitters 6a, 6b. During operation, the voltage applied to the emitters 6a, 6b is switched by the switching circuit of the primary circuit 18 such that each of the positive and negative emitters 6a, 6b has a switched voltage applied thereto. The switching circuit is configured such that corresponding positive and negative voltages are simultaneously applied to the positive and negative emitters 6a, 6b, respectively. It will be appreciated that the anti-static bar 1 includes a plurality of positive emitters 6a and a plurality of negative emitter 6b, and a positive voltage is applied to the plurality of positive emitters 6a while a simultaneous negative voltage is applied to the plurality of negative emitters 6b.

[0040] The switching circuit may operate to switch the voltage applied to each emitter 6 at a frequency of up to about 5kHz, for example about 150Hz. The controller 24 may control the switching frequency provided by the switching circuit.

[0041] As shown in FIGS. 2 and 3 the emitters 6 may be arranged in a line along the anti-static bar 1, in which case in the positive and negative emitters 6 are arranged alternately.

[0042] A controller 24 is provided to control the switching circuit of the primary circuit 18. The controller 24 may also control the LED 25 illustrated in FIG. 3. The controller 24 may additionally communicate with an external control unit and/or display unit.

[0043] FIG. 6 illustrates a circuit diagram of the voltage supply unit 15. The voltage supply unit 15 illustrated in FIG. 6 corresponds to the voltage supply unit 15 schematically illustrated in FIG. 5.

[0044] In particular, the voltage supply unit 15 applies switching high voltage power to the positive and negative emitters 6a, 6b. The voltage supply unit 15 includes a controller 24 having a low voltage DC input 16. The controller 24 also receives an input 33 from a processor adapted to control voltage input to the voltage supply unit 15. An output from the controller 24 is provided to a coil

of the primary circuit 18. The controller 24 may include a switching circuit to generate an AC input voltage for the transformer and is also used for switching the voltage between positive and negative. A secondary coil 20 is provided opposite the coil of the primary circuit 18, and the coils together form a transformer 26. A voltage multiplier 21 is provided in the secondary circuit 19. The transformer 26 and voltage multiplier 21 are configured to provide a high voltage DC output, as described above. In particular, the transformer 26 and voltage multiplier 21 are configured to increase the voltage from a 12V or 24V input to between about 4kV and about 9kV.

[0045] The transformer 26 also includes a sensing coil 27 is provided on the low voltage side of the transformer 26. The sensing coil 27 has a ground connection 28 and a feedback connection 29 for the processor.

[0046] The secondary coil 20 forms a part of the secondary circuit 19 of the voltage supply unit 15. The primary circuit 18 further comprises a switching circuit, in this example an H-bridge circuit, for switching the voltage applied to the positive and negative emitters 6a, 6b. The H-bridge circuit is configured to switch the voltages at a frequency of up to about 5kHz, for example about 150Hz. The skilled person will appreciate how an H-bridge circuit operates so further detail is not included herein.

[0047] As illustrated, a gas discharge tube 23 is connected to the secondary circuit 19. In particular, the gas discharge tube 23 is connected adjacent to the secondary coil 20. The gas discharge tube 23 is connected on the high voltage side of the transformer 26. The gas discharge tube 23 provides a temporary ground reference when the charge on the secondary circuit 19 is increased, as described below.

[0048] As illustrated, the only ground reference on the secondary circuit 19 is via the gas discharge tube 23.

[0049] During normal operation, a low voltage DC input is provided to the primary circuit 18 via voltage input 16. The low voltage DC input may have a voltage of 12V or 24V. The voltage converter, in particular the transformer 26 and the voltage multiplier 21, increases the voltage to a high voltage DC output, for example between about 4kV and about 9kV. The switching circuit of the primary circuit 18 switches the power applied to the positive and negative emitters 6a, 6b so that the positive and negative voltages applied to the positive emitters 6a, 6b are switched on and off. The emitters 6 are switched on and off at a frequency of about 150Hz (or up to about 5kHz).

[0050] The switching high voltage applied to the positive and negative emitters 6a, 6b generates an electric field in the vicinity of the emitters 6a, 6b. The electric field generates a corona discharge of positively and negatively charged ions that acts to neutralise any charge on the surface 2.

[0051] In normal operation the secondary circuit 20 (high voltage side) is floating with respect to ground because it has no direct reference to ground. Accordingly, the imbalance of the anti-static bar 1 is very small.

[0052] However, in the event that there is a large elec-

trostatic charge on the surface 2, the voltage in the secondary circuit 19 may increase and this could damage the primary circuit 18 and trip the transformer 26. In such a situation the gas discharge tube 23 acts to protect the voltage supply unit 15. In particular, the gas discharge tube 23 is connected to the secondary circuit 19 (i.e., on the high voltage side of the transformer 26) and is configured with a breakover voltage to protect the voltage supply unit 15. Accordingly, when the voltage on the secondary circuit 19 exceeds the breakover voltage of the gas discharge tube 23, the gas discharge tube 23 will conduct and effectively ground the secondary circuit 19 until the excess charge has dissipated, restoring balance to the voltage supply unit 15. The breakover voltage of the gas discharge tube 23 may be, for example, between 1 kV and 2kV, for example 1.2kV.

[0053] Additionally, while the gas discharge tube 23 is conducting, the emitters will discharge the excess electrostatic charge on the surface 2 faster. After which the anti-static bar 1 returns to a normal balanced state.

[0054] When the electrostatic charge is dissipated (or it has passed by), the voltage on the secondary circuit 20 reduces and the gas discharge tube 23 goes out of conduction, and the voltage supply unit 15 again has a low imbalance.

[0055] Accordingly, this disclosure provides an anti-static apparatus for neutralising an electrostatic charge on a nearby surface.

[0056] In one aspect, the anti-static apparatus includes a plurality of emitters configured to generate an electric field, and a voltage supply unit for supplying a voltage to the plurality of emitters. The voltage supply unit is configured to receive an input voltage, and comprises a voltage converter configured to generate an output voltage having a greater voltage than the input voltage. The voltage supply unit further comprises a gas discharge tube connected to the voltage supply unit on a high voltage side of the voltage converter. The gas discharge tube comprises a breakover voltage configured to refer the voltage supply unit to ground when a voltage on the voltage supply unit exceeds a breakover voltage of the gas discharge tube. The breakover voltage of the gas discharge tube 23 may be, for example, between 1 kV and 2kV, for example 1.2kV.

[0057] In another aspect, the anti-static apparatus includes a power converter adapted to generate a high voltage output for emitters of the anti-static apparatus. The emitters are adapted to generate an electric field in the vicinity of the emitters and thereby create a corona discharge that neutralises the electrostatic charge on the surface. The power converter operates on DC voltage and includes a low voltage side and a high voltage side connected to the emitters. In this aspect, the high voltage side is floating with respect to ground.

[0058] In another aspect, the anti-static apparatus includes a power converter adapted to generate a switching high voltage output for emitters of the anti-static apparatus. The switching high voltage output simultaneous-

ly applies positive voltage on a first emitter and a negative voltage on a second emitter. The emitters are thereby adapted to generate an electric field in the vicinity of the emitters and thereby create a corona discharge that neutralises the electrostatic charge on the surface. The power converter is adapted to switch the voltages applied to the emitters at a frequency of up to about 5kHz, for example about 150Hz.

[0059] Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of them mean "including but not limited to", and they are not intended to (and do not) exclude other components, integers or steps. Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0060] Features, integers, characteristics or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An anti-static apparatus for neutralising an electrostatically charged surface, for example a moving web, the anti-static apparatus comprising:

at least one positive emitter and at least one negative emitter configured to generate an electric field, and

a voltage supply unit for applying a positive voltage to the at least one positive emitter and a negative voltage to the at least one negative emitter, the voltage supply unit being configured to receive an input voltage and comprising a transformer configured to generate an output voltage having a greater voltage than the input voltage;

wherein the voltage supply unit further comprises a gas discharge tube connected to the voltage supply unit on a high voltage side of the transformer, and wherein the gas discharge

tube comprises a breakover voltage configured to refer the voltage supply unit to ground when a voltage on the voltage supply unit exceeds a breakover voltage of the gas discharge tube.

2. The anti-static apparatus of claim 1, wherein the transformer is an AC-AC transformer.
3. The anti-static apparatus of claim 2, wherein the voltage supply unit further comprises a voltage multiplier arranged to receive the output voltage of the transformer.
4. The anti-static apparatus of claim 2 or claim 3, wherein the voltage supply unit further comprises a switching circuit configured to switch the output voltage supplied to the at least one positive emitter and the at least one negative emitter on and off.
5. The anti-static apparatus of claim 4, wherein the switching circuit comprises an H-bridge.
6. The anti-static apparatus of claim 4 or claim 5, wherein the switching circuit is configured to simultaneously apply a positive voltage to the at least one positive emitter and a negative voltage to the at least one negative emitter.
7. The anti-static apparatus of any of claims 4 to 6, wherein the switching circuit is adapted to switch the voltages applied to the at least one positive emitter and the at least one negative emitter on and off at a frequency of between 0Hz and 5kHz, for example about 150Hz.
8. The anti-static apparatus of any preceding claim, wherein the high voltage side of the voltage supply unit is floating with respect to ground.
9. The anti-static apparatus of any preceding claim, further comprising a grounding connector arranged proximal to the at least one positive emitter and the at least one negative emitter.
10. The anti-static apparatus of any preceding claim, further comprising a housing, and wherein the housing comprises an open side and the at least one positive emitter and the at least one negative emitter are arranged at the open side of the housing.
11. The anti-static apparatus of claim 10, further comprising a grounding connector arranged about the open side of the housing.
12. The anti-static apparatus of claim 10 or claim 11, wherein the housing is elongate and the anti-static apparatus comprises a plurality of positive emitters and a plurality of negative emitters arranged alter-

nately along the housing.

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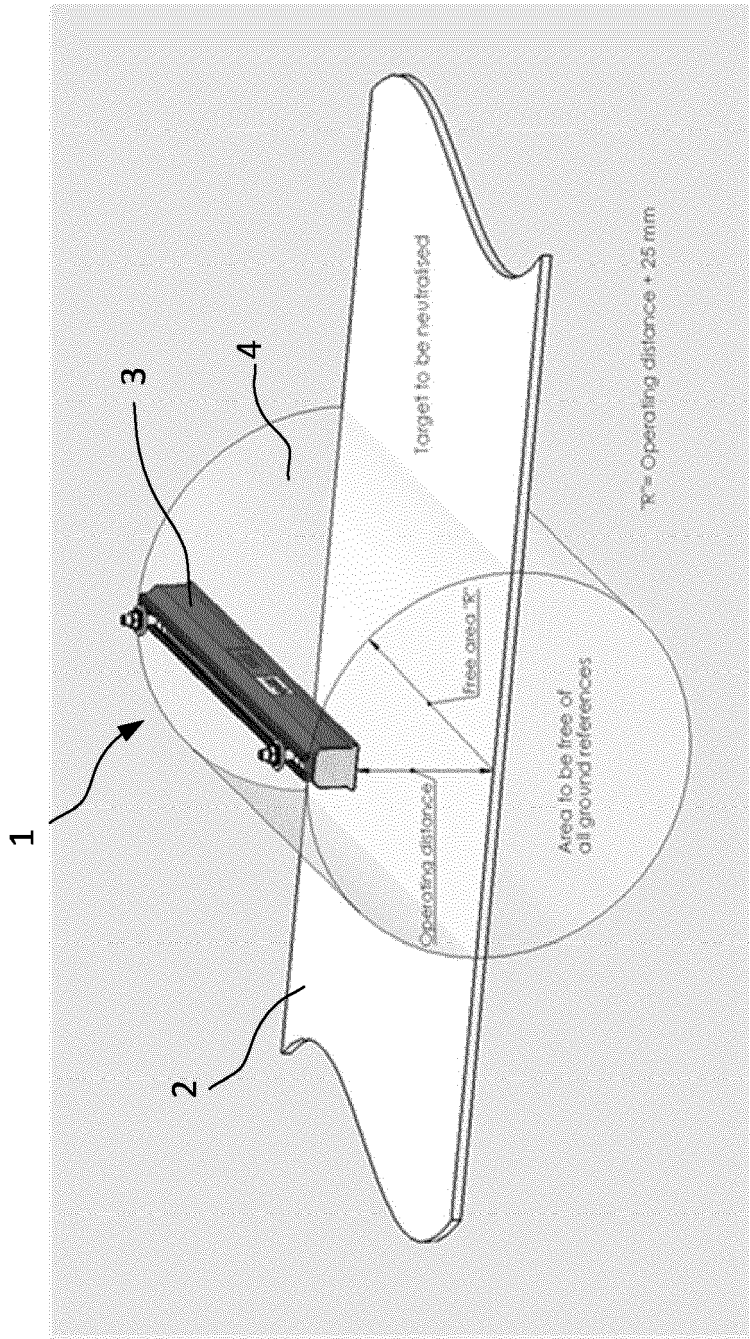


FIG. 1

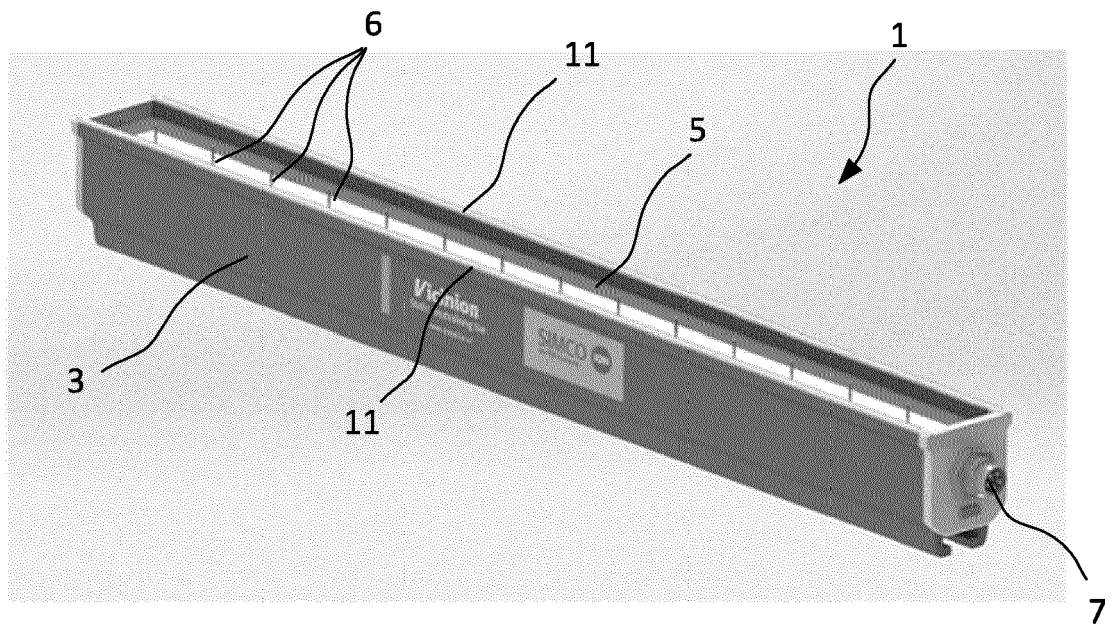


FIG. 2

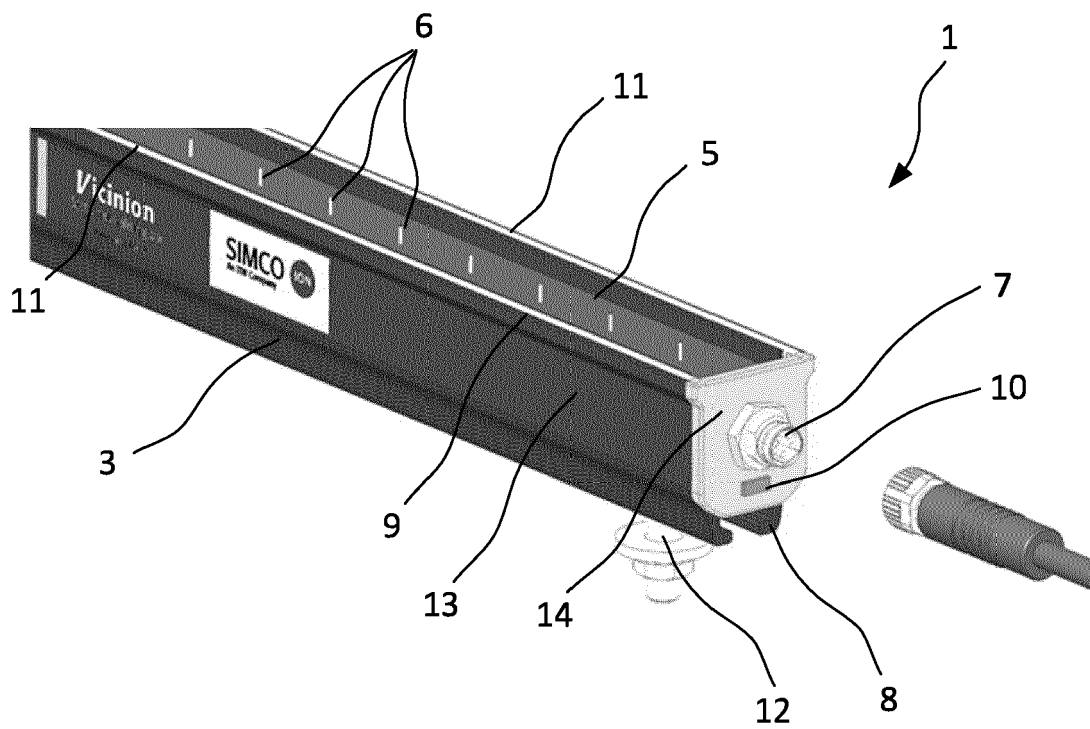


FIG. 3

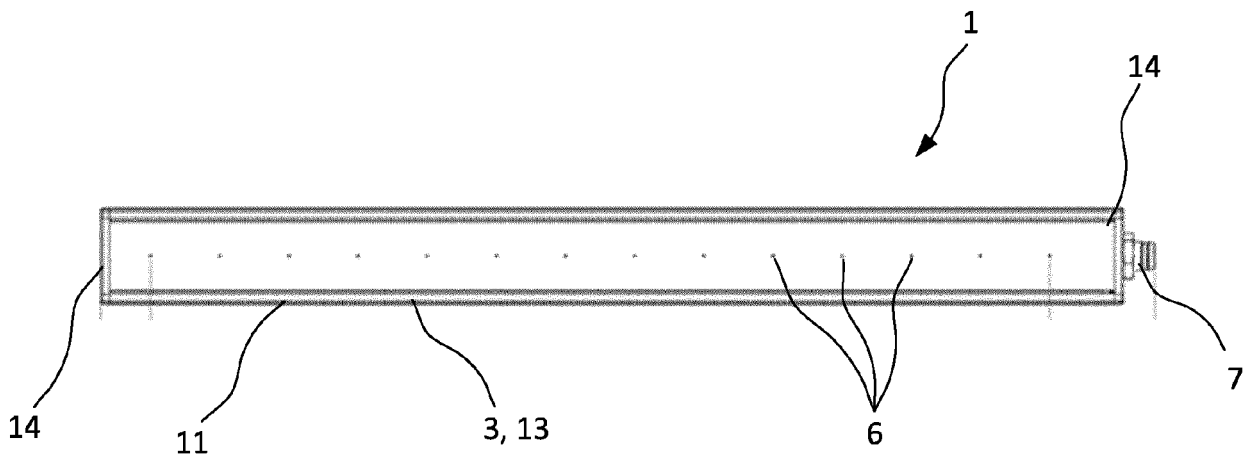


FIG. 4A

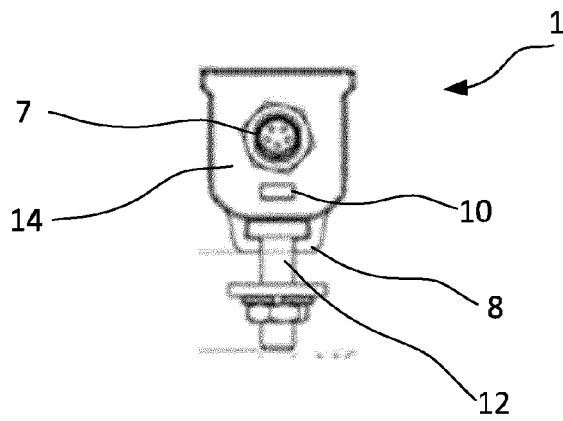


FIG. 4B

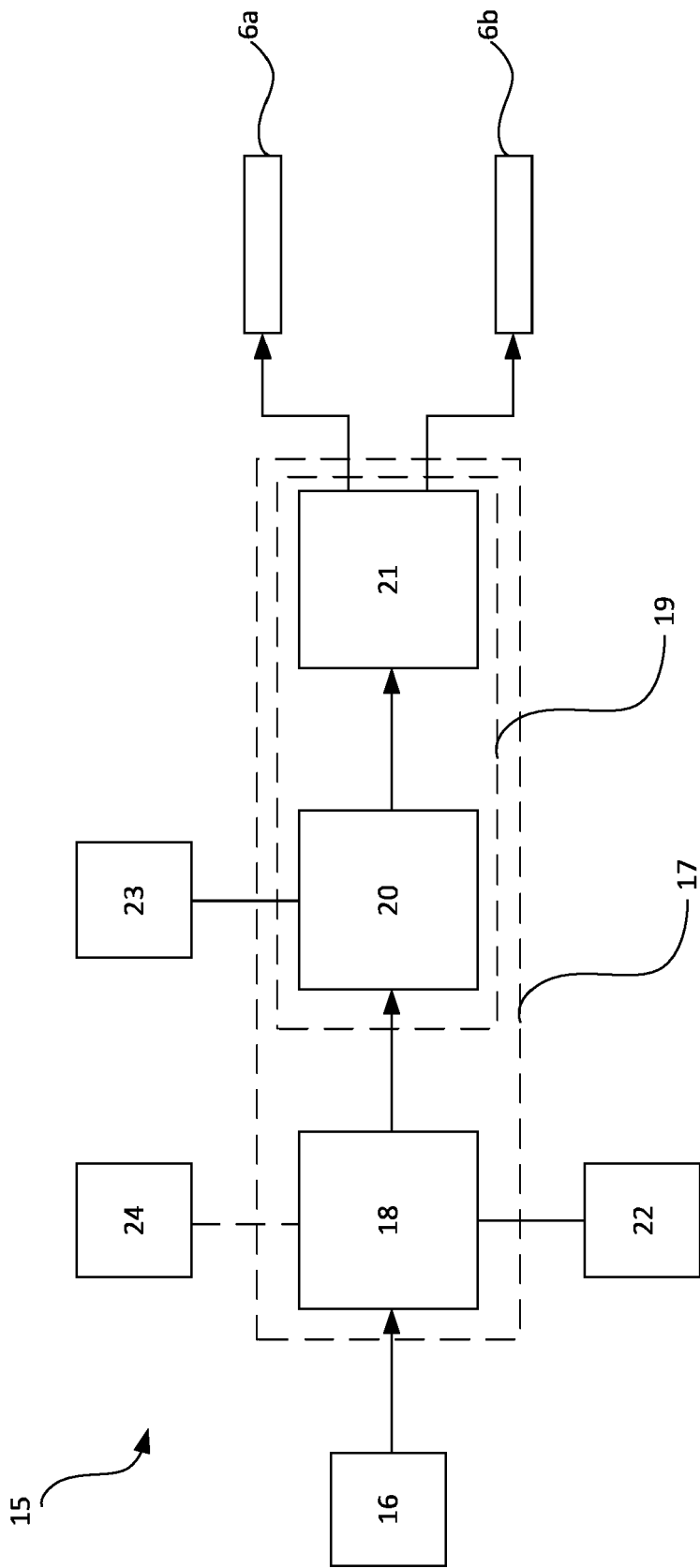


FIG. 5

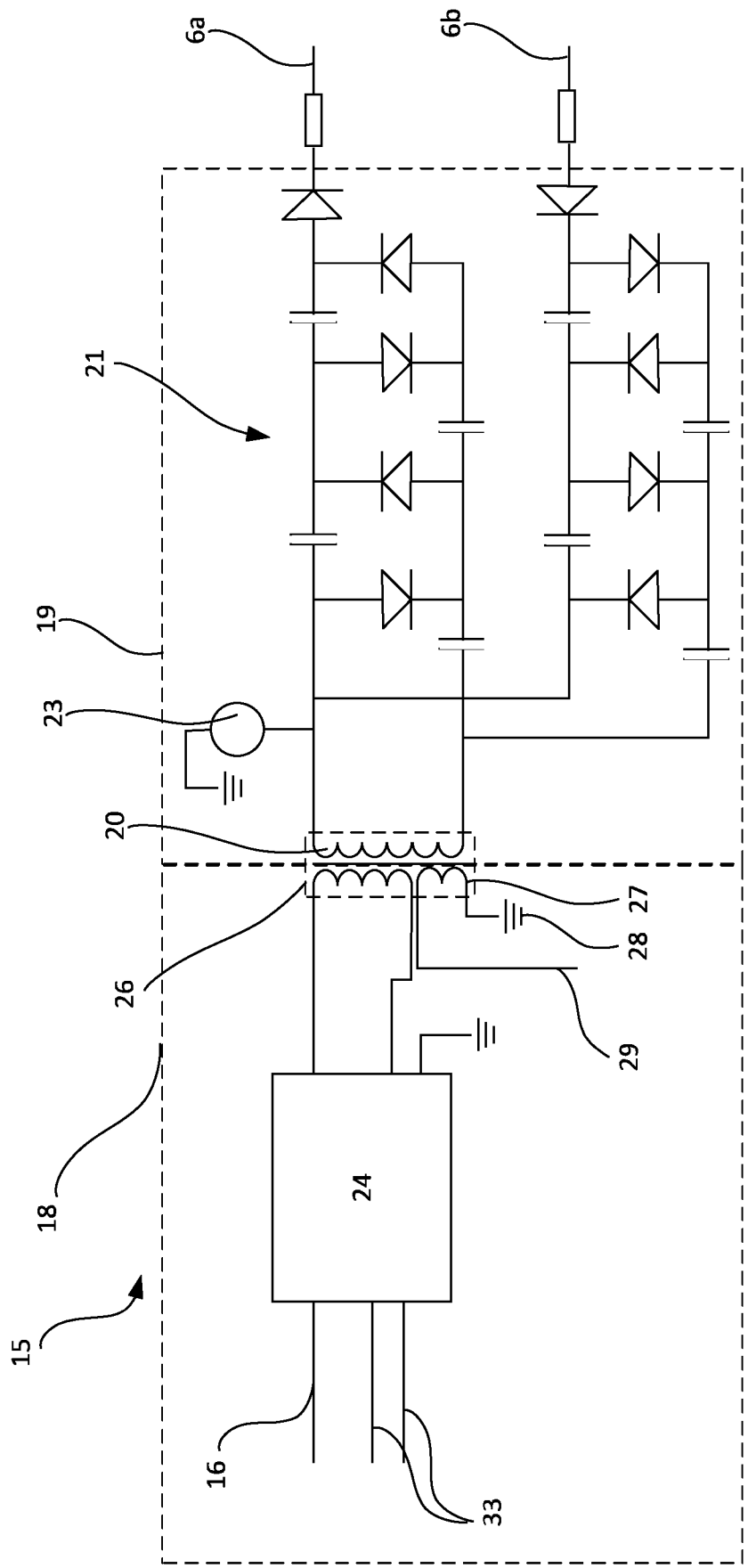


FIG. 6



EUROPEAN SEARCH REPORT

Application Number

EP 21 20 7426

DOCUMENTS CONSIDERED TO BE RELEVANT

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		4 April 2022	Ernst, Uwe
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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