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(56) Documents Cited:
GB 2023351 A **GB 1356211 A**
EP 1293216 A1 **EP 1067828 A1**
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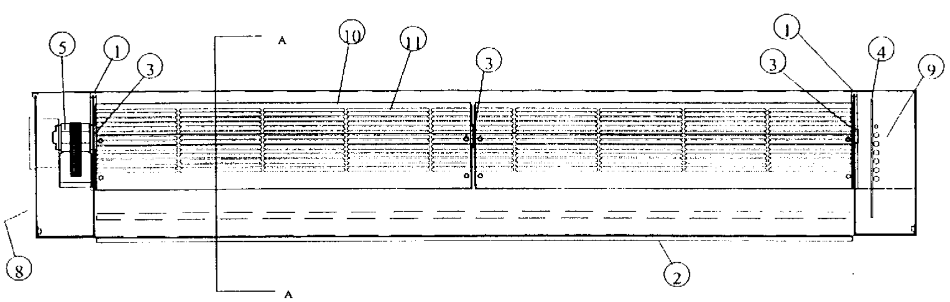
(54) Abstract Title: **An electrical ionizer using a crossflow fan**

(57) An electrical ioniser comprising a fan 10 for producing a laminar flow of air; a positive ion emitter (6b in fig 3) and a negative ion emitter (6a) for ejecting positive ions and negative ions respectively, into the flow of air; positive and negative voltage supplies (27 and 28) connected to the respective emitters; and a microprocessor (30) for controlling the positive and negative voltages to obtain a desired ion balance within the flow of air. The fan 10 (5) is a cross-flow fan, i.e. a fan with a rotational axis which is generally perpendicular to the generated airflow, which produces a highly uniform and laminar flow of air with a consistent velocity and reduced gaps in the airflow. This leads to an improved ion balance a lower ion recombination.

Figure 1



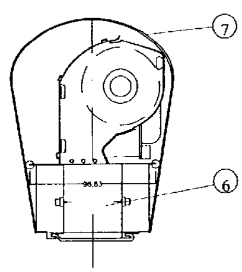


Figure 2

SECTION AA

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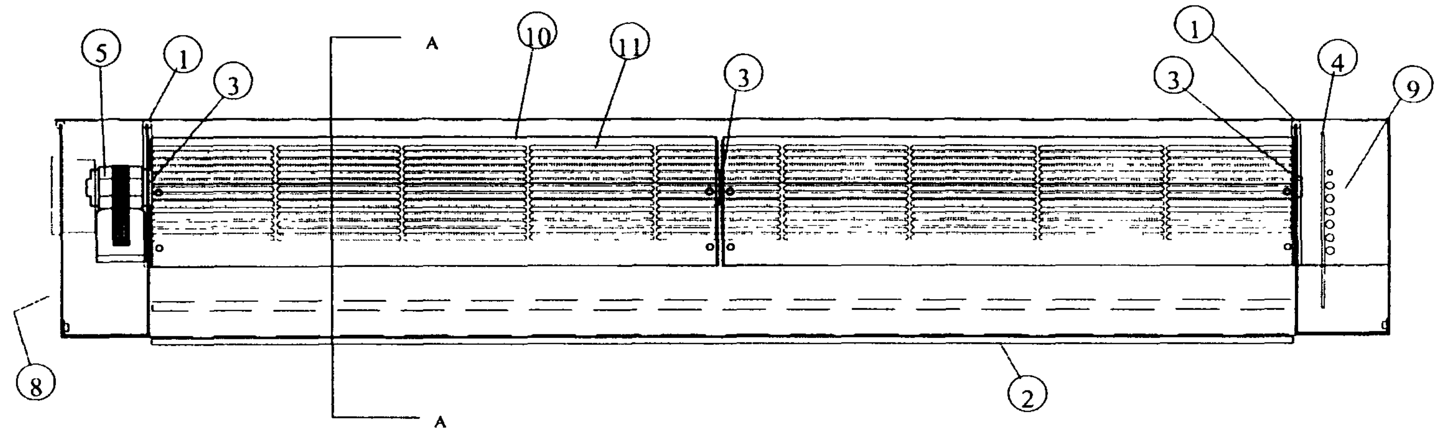
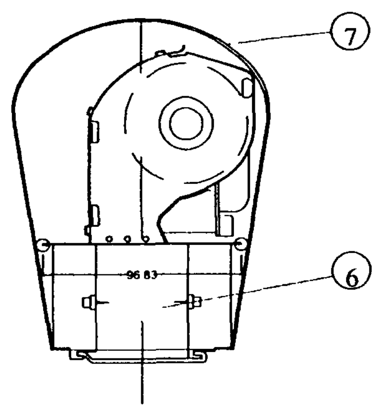
Figure 1





SECTION AA

Figure 2

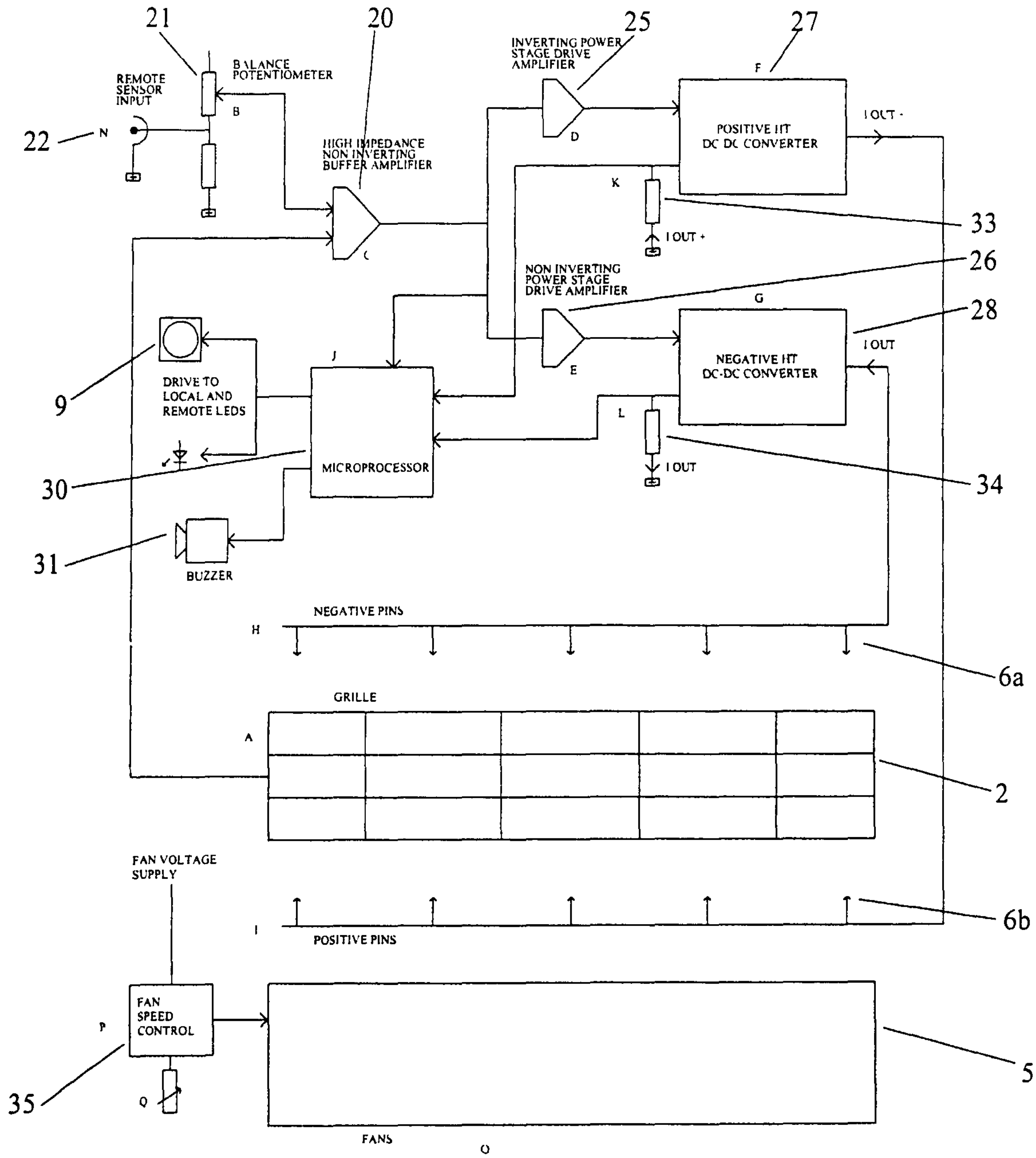

21
20
25
27
BALANCE POTENTIOMETER
REMOTE SENSOR INPUT
22
N
B
INVERTING POWER STAGE DRIVE AMPLIFIER
F
D
POSITIVE HT DC DC CONVERTER
I OUT -
HIGH IMPEDANCE NON INVERTING BUFFER AMPLIFIER
K
33
I OUT +
C
NON INVERTING POWER STAGE DRIVE AMPLIFIER
26
G
28
I OUT
NEGATIVE HT DC-DC CONVERTER
E
J
9
DRIVE TO LOCAL AND REMOTE LEDS
L
I OUT
30
MICROPROCESSOR
34
31
BUZZER
NEGATIVE PINS
H
6a
GRILLE
A
2
FAN VOLTAGE SUPPLY
I
POSITIVE PINS
6b
FAN SPEED CONTROL
P
35
Q
5
FANS
O

Figure 3.

Electrical Ioniser

The present invention relates to electrical ionisers, in particular electrical ionisers for use in "clean rooms" used for the assembly of sensitive electronic equipment, such as computer components.

Electrical ionisers are commonly used in such environments to generate ions in the air and thereby enable neutralisation of surface charges. In the majority of applications, the reduction of a static charge to a few hundred volts is normally sufficient to eliminate dust attraction. In the electronics industry, however, and in particular, in clean rooms, static charges of a few hundred volts can have disastrous effects on modern micro-processor chips. In these instances it is important to ensure that the ionisation delivered by a neutralisation system is balanced and targeted specifically to areas where neutralisation is required.

Electrical ionisers used in such applications generally have one or more fans for directing a flow of ionised air and targeting it at a workbench at a distance from the electrical ioniser. Many electrical ionisers of this kind constantly monitor the ion output to ensure that the flow of air leaving the ioniser is balanced to enable very exact neutralisation.

The practice in the industry is to employ one or more axial fans (i.e., one in which the airflow is axial with the rotation axis of the fan) to drive an airflow over or past an ionising source (emitters) and then downward onto the surface to be neutralised. Axial fans are problematic in that the air flow that they produce is turbulent. This can lead to ion recombination which can in turn upset the ionisation balance, and is more likely to lead to contamination. In addition, air flow velocities can vary from fan to fan when a series of axial fans is used, and gaps or areas of overlap can arise in the airflow, caused by the spacing between fans. This makes the control of the ionisation balance very difficult to achieve. Attempts have been made to overcome the problem of ion imbalance by using a dedicated control circuit for each of the fans. This has some beneficial effect on ion balance but separate control circuits create problems in achieving a balanced overall set-up, and result in additional expense.

According to a first aspect of the present invention, there is provided an electrical ioniser comprising:

a fan for producing a laminar flow of air;

a positive ion emitter for ejecting positive ions into the flow of air;

a negative ion emitter for ejecting negative ions into the flow of air;

means for supplying a positive voltage to the positive ion emitter;

means for supplying a negative voltage to the negative ion emitter; and

control means for controlling the said positive and negative voltages to obtain a desired ion balance in the flow of air;

wherein the fan is a crossflow fan.

A crossflow fan, in the sense in which that term is used herein, is a fan in which the airflow is generally perpendicular to the rotation axis of the fan. Crossflow fans typically consist of a plurality of generally parallel vanes arranged in a cylindrical configuration about a rotation axis, and confined within a fan enclosure with an elongate air inlet and an elongate air outlet disposed generally parallel to the rotation axis, at different radial positions around the rotation axis. Air is entrained by the vanes at the inlet, and centrifugally expelled at the outlet.

The flow of air thus produced is generally a highly uniform and laminar beam of air along the entire length of the fan. The use of such a fan in an ioniser is therefore highly advantageous in preventing gaps in the air flow and maintaining a consistent velocity of air to ensure good ion balance.

The use of a crossflow fan not only permits an improvement in the air flow, it also enables the operating mechanism to be contained within a simple "teardrop" profile. It also makes it possible for most of the operative parts of the device, for example the motor, the bearings, and electronics such as printed circuit boards to be housed outside the air flow, thereby eliminating a possible source of contamination of the air flow. It is also found that, for a comparable size of ioniser enclosure, it is possible to generate approximately twice the mass flow, at up to 3 times the velocity, as a similar conventional device using axial fans. Much quicker charge neutralisation and more even offset voltages across the target surface can therefore be achieved. Noise levels are also considerably reduced.

The electrical ioniser preferably includes means for setting a reference value representative of the desired ionic balance in the flow of air, for example a manually-adjustable potentiometer. An ionic balance sensor may also be provided, for measuring the actual ionic balance in the flow of air, and the control means may include means for comparing the reference value with the value measured by the ionic balance sensor, to generate a control voltage for controlling said positive and negative voltage supply to the ion emitters.

Connection means, for example an electrical connector, may also be provided, for connecting a remote sensor for measuring the ionic balance in the flow or air at a distance remote from the ioniser. The use of a remote sensor can be of particular value if, for example, the calibration of the unit changes, because of a change in the distance between an ioniser and its target work surface, or because of a change in the humidity or temperature of the surroundings.

In a preferred embodiment the ioniser includes means for generating an alarm signal when the ion balance in the ionised air drifts by more than a desired amount from the reference value, for example by more than +/- 25V. When the reference value is set manually by means of a potentiometer, means are preferably provided for detecting the potentiometer setting, in order that the "out of balance" trigger levels may be set appropriately. In a particularly convenient embodiment, this may be done by providing an optical sensor for sensing a change in the potentiometer setting, and for resting the trigger levels around the new calibration point, when the optical sensor detects that the calibration point has changed.

The invention also extends to a method of producing a flow of air containing positive and negative ions, comprising operating an ioniser as described above.

A preferred embodiment of the invention will now be described, with reference to the accompanying drawings, in which;-

Figure 1 shows a schematic front–view of an electrical ioniser in accordance with the invention,

Figure 2 is a section on AA of Figure 1, and Figure 3 is a simplified schematic diagram of the control circuitry associated with the device of Figure 1.

Referring first to Figures 1 and 2, electrical ioniser comprises a crossflow fan having an impeller 10, driven by an impeller motor 5, and housed within a casing 7. Air enters the unit through an inlet 11, and is expelled through an exit opening 12. Bulkheads 1 are provided at each end of the unit and are sealed to the outer casing 7 by means of gaskets, so as to confine the air flow within the desired part of the unit.

Control circuitry is provided on a printed circuit board 4, at the end of the unit opposite the impeller motor 5. Sealed bearings 3 are used to prevent ingress of dust into the air flow. Emitter pin 6a and 6b located in the airflow exit 12 are connected respectively to negative and positive high voltage sources 28 and 27 in Figure 3. A sensor grille 2 is provided at the outlet of the unit, for measuring the ion balance in the air leaving the unit.

As shown in Figure 3, sensor grille 2 provides one of two inputs to a high impedance non-inverting buffer amplifier 20. The other input to amplifier 20 is provided by a balance potentiometer 21. A connection point 22 is provided for connection of a remote sensor (not shown) which may be located for example on the work bench. Output from amplifier 20 is passed to the input of respective inverting power stage drive amplifiers 25 and 26. Amplifiers 25 and 26 respectively provide drive inputs for a positive high tension DC-DC converter 27, and a negative high tension DC-DC converter 28. Outputs from DC converters 27 and 28 are connected respectively to positive and negative emitter pin arrays 6b and 6a. The DC-DC converters 27 and 28 are fixed duty cycle resonant converters, with an HT output which is proportionate to the applied DC input.

The resulting output current from each is sensed in ground referenced resistors 33 and 34 respectively, and the resulting voltages passed to microprocessor 30. Microprocessor 30 is programmed and arranged to monitor reduction in ion current with time, and to generate an alarm and/or shut down the unit, via status indicator LEDs 9, and buzzer 31 if the values exceed pre-defined limits.

An additional input to microprocessor 30 is provided by an optical sensor (not shown) arranged to sense change in the setting of potentiometer 21.

The fan speed may be controlled by a fan speed selector switch 35.

In the event that the relative voltage to the negative and positive pin erase 6a and 6b cannot be adjusted to the desired level, and "out of balance" indicator in LED's 9 is illuminated. The level of voltage that typically triggers the "out of balance" alarm is typically set at +/- 25V, although for some applications it may be set asymmetrically. However, the trigger voltage may be adjusted within the range of +/- 5V to +/- 75V, depending upon the specific application requirements.

The microprocessor is preferably programmed and arranged so as to turn off the high voltage supplies to the emitter arrays, in the event of an excessive "out of balance" signal, in order to minimise the likelihood of damage to sensitive components being processed. Detection of the positive and negative ion currents, via the voltages produced at resistors 33 and 34 can also be used by the microprocessor to ascertain whether the emitter pin 6a and 6b have become dirty or degraded. When the currents fall to below a pre-set level (for example 40% of their initially calibrated levels) an alarm is indicated on the LED's 9.

A remote sensor may be connected to the external connector 22. The signal from the remote sensor is fed into the circuit and merged with the grille control signal to control the ion balance of the unit. The merging of these two signals is found to improve both short and long term ion balance stability. In normal operation, ion balance can typically be maintained to within +/- 2V. The use of a remote sensor enables us to improve to +/- 0.5V.

A remote connector may also be provided to printed circuit board 4, to enable various functions to be monitored, for example when inspection of the emitter arrays is required, when shut down has been activated, when power to the unit has been switched on, when positive and/or negative out of balance conditions have occurred, and the current value of the sensor or signal.

It will be clear to one of skill in the art that numerous variations are possible with the scope of the appended claims in addition to the embodiment specifically described above.

Claims

1. An electrical ioniser comprising:

a fan for producing a laminar flow of air;

a positive ion emitter for ejecting positive ions into the flow of air;

a negative ion emitter for ejecting negative ions into the flow of air;

means for supplying a positive voltage to the positive ion emitter;

means for supplying a negative voltage to the negative ion emitter; and

control means for controlling the said positive and negative voltages to obtain a desired ion balance in the flow of air;

wherein the fan is a crossflow fan.

2. An electrical ioniser as claimed in Claim 1, including means for setting a reference value representative of the desired ionic balance in the flow of air, an ionic balance sensor for measuring the actual ionic balance in the flow of air, wherein the control means include means for comparing the reference value with the value measured by the ionic balance sensor, to generate a control voltage for controlling said positive and negative voltage supply to the ion emitters.

3. An electrical ioniser as claimed in any of Claims 1 or 2, wherein the means for setting a reference value includes a potentiometer.

4. An electrical ioniser as claimed in Claim 3, further comprising means for sensing variations in the potentiometer setting.

5. An electrical ioniser as claimed in Claim 4, wherein the means for sensing variation of the potentiometer includes an optical sensor.

6. An electrical ioniser as claimed in any preceding claim further comprising means for connecting a remote sensor for measuring the ionic balance in the flow of air at a distance remote from the ioniser.

7. An electrical ioniser as claimed in Claim 6, including means for merging a signal from the remote sensor with the signal from the ion balance sensor.

8. An electrical ioniser as claimed in any preceding claim further comprising a microprocessor.

9. An electrical ioniser as claimed in any preceding claim including display means for indicating out of balance conditions.

10. An electrical ioniser as claimed in any preceding claim, further comprising means for controlling the fan, wherein the means are located outside the flow of air.

11. A method of producing a flow of air containing positive and negative ions, comprising operating an ioniser as claimed in any one of the preceding claims.

12. A method as claimed in Claim 11, further comprising the steps of:

setting a reference value representative of the desired ionic balance in the flow of air;

measuring the actual ionic balance in the flow of air;

comparing the measured ionic balance with the reference value; and

generating a control voltage for controlling the positive and negative voltage supplies to the ion emitters.

13. A method as claimed in Claims 11 or Claim 12, further comprising sensing the ionic balance in the flow of air at a distance remote from the electrical ioniser, by means of a remote sensor.

14. A method as claimed in Claim 13 further comprising calibrating the ionic balance sensor from the remote sensor.

15. An electrical ioniser substantially as hereinbefore described with reference to, and as illustrated by, the accompanying drawings.

Application No:	GB0322160.3	**Examiner:**	Geoff Holmes
Claims searched:	All	**Date of search:**	3 September 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage of particular relevance
X,Y	X: 1 & 12 at least Y: 2 & 13 at least	US 4794486 A [BLACH et al.] see figure 1
X,Y	X: 1 & 12 at least Y: 2 & 13 at least	EP 1293216 A1 [SHARP] see abstract & figure 4
X,Y	X: 1 & 12 at least Y: 2 & 13 at least	GB 2023351 A [FIAP] see figure 1 in particular
X,Y	X: 1 & 12 at least Y: 2 & 13 at least	WO 02/17978 A1 [SHARP] see abstract & figure 14
X,Y	X: 1 & 12 at least Y: 2 & 13 at least	US 4878149 A [SEBALD et al.] see abstract & figure 3
X,Y	X: 1 & 12 at least Y: 2 & 13 at least	GB 1356211 A [BOLASNY] see figure 8 in particular
Y	2 & 13 at least	US 4757422 A [BOSSARD et al.] see abstract & figure 1
Y	2 & 13 at least	EP 1067828 A1 [GOOD] see abstract

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Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

H1X

Worldwide search of patent documents classified in the following areas of the IPC[07]

H01T

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, JAPIO