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(54) Electrostatic gas cleaner.

(57) An electrostatic cleaner (1) for eliminating polluting particulate material suspended in air or in a gaseous fluid comprises an elimination chamber (3) with an inlet (4) and an outlet (5), means (6) for generating a gaseous flow through the elimination chamber, means (7) for electrostatically charging the polluting particulate material at the inlet of the chamber, at least one pair of opposite electrodes (10, 11; 12, 13) with a different electric potential in order to collect the polluting particulate material on at least one of the electrodes (12). Means are provided for the continuous or discontinuous removal of the polluting particulate material deposited on one or more of the collecting electrodes (12).

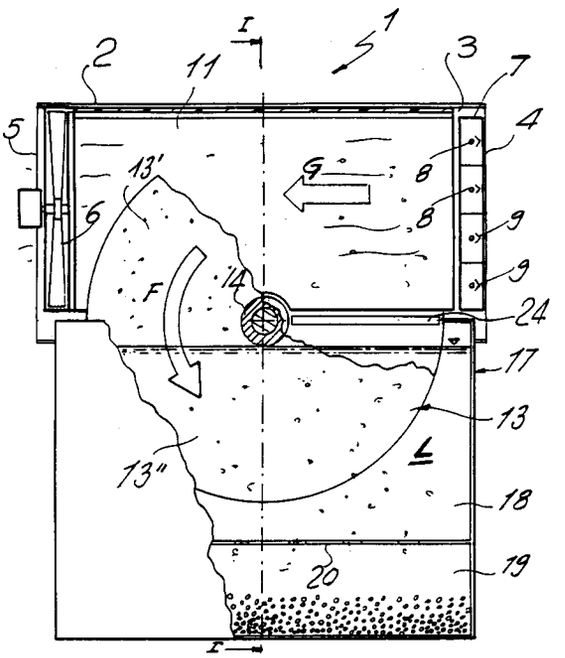

Fig. 2

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The present invention relates to an electrostatic cleaner for eliminating particles of solid material of any size and kind suspended in air or in a gaseous fluid. Devices of this type are suitable for use in working environments in which considerable amounts of dust-like materials and polluting fumes are dispersed.

Electrostatic cleaners of the above described type are known, such as the one described in the Italian industrial invention patent no. 1220153 in the name of Expansion Electronic S.r.l., wherein elimination of the polluting material is based on the concept of electrostatic precipitation. In these known devices, the air or gas are forced by means of a fan or of external compressors into the inlet of an elimination chamber, in which they initially pass through a grille for filtering large-size particles and then through an ionization device which is suitable for electrostatically charging the particulate material by means of one or more wire electrodes. The residual electrically charged particles dispersed in the flow are then conveyed toward a precipitation region, where they are attracted and collected on plate electrodes or the like which face one another and are subjected to an electric potential difference in order to generate an electrostatic field of preset power. The air, cleaned of the particles precipitated onto the electrodes, is finally expelled from the device and recycled into the environment or is expelled directly outside.

Although these known devices have characteristics of considerable functionality and effectiveness, they are not free from some acknowledged problems.

Due to the precipitation of the polluting particles onto the collecting electrodes, the intensity of the electrostatic field in fact decreases in the course of time and the filtration efficiency of the device decreases progressively.

This problem is even more severe in cleaners used in environments containing metallic particles, which due to their conductivity can short-circuit or in any case discharge the plate electrodes, reducing or eliminating the intensity of the electrostatic field.

In order to obviate these disadvantages, it is generally necessary to periodically clean the electrodes in order to remove both conducting and dielectric polluting materials from the surfaces of the electrodes, in particular the ground ones. However, in order to perform this action it is necessary to interrupt the operation of the cleaner, possibly disassembling it beforehand. If one wishes to avoid this interruption, it is necessary to double the number of cleaners, keeping one of the two in operation while the other one is cleaned. However, it is evident that this solution very negatively affects the purchase and maintenance costs of the system and furthermore does not guarantee the user against unwanted downtimes.

A further problem is constituted by the fact that known electrostatic cleaners cannot generally operate in painting areas, where the resinous materials dispersed in the air would coat the electrodes in a very short time, polymerizing on the ground ones and making them difficult to clean.

The aim of the present invention is indeed to eliminate the problems described above by providing an electrostatic cleaner which can operate continuously and with high reliability.

Within the scope of the above aim, a particular object of the present invention is to provide an electrostatic cleaner which allows to keep its collecting electrodes always clean in any environment.

Not least object of the present invention is to provide an electrostatic cleaner which is constructively simple and requires minimal maintenance so as to be advantageous from a merely economic point of view.

This aim, these objects and others which will become apparent hereinafter are achieved by an electrostatic cleaner for eliminating polluting particulate material suspended in air or in a gaseous fluid, comprising an elimination chamber with an inlet and an outlet, means for generating a gaseous flow through said chamber, means for electrostatically charging the polluting particulate material at the inlet of said chamber, at least one pair of opposite electrodes with a different electric potential in order to collect the polluting particulate material on at least one of said electrodes, comprising means for the continuous or discontinuous removal of the polluting particulate material deposited on one or more of the collecting electrodes.

According to a further characteristic, the collecting electrode or electrodes, which are electrically connected to the ground, can move with respect to the other electrodes at a preset potential.

The means for removing the polluting material are furthermore of the wet type and comprise a collecting tank for a washing fluid in which said movable electrodes are at least partially immersed.

The movable collecting electrode is constituted by a series of parallel and mutually adjacent planar plates which are mutually coupled by a central conductor which defines a rotation axis for the electrode.

The planar plates of the movable electrode are immersed in the elimination chamber with their upper part, so as to collect the particulate material, and in the washing liquid tank with their remaining lower part, in order to allow the polluting material to sediment continuously.

According to a further characteristic, there are means for moving the collecting plates together

with means for adjusting and controlling the supply voltage of said plates according to the concentration by weight of the polluting particulate material dispersed in the gaseous flow.

In a preferred embodiment, said movement means are automatic and are functionally coupled to the means for adjusting and controlling the supply voltage.

By means of an electrostatic cleaner according to the present invention, elimination of the particulate material suspended in the gaseous fluid is continuous and can be performed on materials of any type and kind, even metallic and/or resinous ones.

By virtue of the automatic adjustment and control means according to the invention, the intensity of the electrostatic field generated by the plate electrodes is furthermore optimum and is continuously adapted to the actual conditions of concentration by weight of the polluting material.

Further characteristics and advantages of the invention will become apparent from the description of a preferred but not exclusive embodiment of the electrostatic cleaner according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a partially sectional schematic front view of the electrostatic cleaner according to the invention, taken along a vertical plane designated by I-I;

Figure 2 is a sectional schematic side view of the device of Figure 1, taken along a vertical plane designated by II-II;

Figure 3 is an enlarged view of a detail of Figure 2;

Figure 4 is a general electric diagram of the electrostatic device according to the invention.

With reference to the above figures, the electrostatic cleaner according to the invention, generally designated by the reference numeral 1, comprises an outer shell 2, made of metal plate or of another equivalent material, which internally defines a chamber 3 for the flow of air or of another gaseous fluid which contains polluting particles of various sizes and kinds having conducting or insulating electric properties.

The chamber 3 is open at its ends and has an inlet 4 and an outlet 5. It can be furthermore provided with a fan, schematically designated by the numeral 6, at one of the end openings in order to convey the gaseous flow through the chamber 3 in the direction indicated by the arrow G. Alternatively, the air or gaseous fluid can be forced into the chamber 3 by means of external aspiration or compression means.

An ionizing grid 7 is arranged proximate to the inlet 4 and comprises a series of electric wires 8 which have a preset electrostatic potential in order to ionize the gas and electrostatically charge the particles dispersed in the fluid; said wires may possibly be protected by shields 9. A coarse filtration panel, not illustrated in the drawings, may possibly be arranged ahead of the ionizing grid 7.

Inside the elimination chamber 3 there are at least two electrodes, preferably two series of mutually facing electrodes which have electrostatic potentials with opposite signs, in order to collect the polluting particulate material, which has been preliminarily charged electrostatically, on one of said electrodes.

In particular, the first series of electrodes 10 is constituted by a plurality of planar elements 11 made of metal plate which have an approximately rectangular shape and are connected to one another and to one of the terminals of an external voltage source.

The second series of electrodes 12 is constituted by a plurality of planar plates 13 which have an approximately circular shape and are arranged mutually side by side in the interspaces comprised between the planar elements 11 of the first series 10. In particular, the planar plates 13 of the series 12 extend further downward with respect to the corresponding planar elements 11 of the series 10, so that only the upper portion 13' of said plates faces the planar elements. The plates 13 are furthermore mutually connected by a central conductor 14, which is in turn arranged in contact with the other terminal of said voltage source, and are grounded to the shell 2 of the cleaner. An electrostatic field of preset power, suitable for collecting the polluting particulate material on the faces of one of the series of electrodes, in particular on the portions 13' of the planar plates 13 at non-zero potential, will thus be generated between the electrodes of the two series 10 and 12 which have potentials with opposite or in any case different signs.

A peculiar characteristic of the present invention consists of the fact that it provides means for the continuous or discontinuous removal of the polluting particulate material deposited on the collecting electrodes.

In the illustrated embodiment, said means are of the wet type and comprise a tank 17 for collecting a washing liquid which is suitable for continuously removing the material deposited on the surfaces of the electrodes 13, so as to keep cleaning effectiveness substantially unchanged.

In particular, while the upper part 13' of the plates 13 is immersed in the gaseous current, the remaining lower part 13'' is immersed in the washing liquid L collected in the grounded tank 17.

The series of electrodes 12 can move with respect to the series of fixed electrodes 10 so as to periodically subject all the regions of the collecting

electrodes to the necessary washing. In the illustrated embodiment, the central conductor 14 which connects the series of planar plates 13 is supported by terminal bearings 15 and 16 which are rigidly associated with the shell 2 of the cleaner, so as to allow the series of electrodes 12 to rotate. Thus, during operation, the part of the plates 13 which is located in the lower region 13' and is immersed in the liquid will be progressively rotated so as to occupy the position of the upper part 13'' which faces the fixed electrodes 11, and vice versa, continuing the washing cycle indefinitely during uninterrupted operation.

Advantageously, the tank 17 is divided into an upper part 18 and into a lower part 19 which are separated by a perforated plate 20 in order to allow the material removed by the washing liquid L to sediment and collect in the lower part 19. The liquid can be constituted by water with the possible addition of surface-active products, or by appropriate diluents in order to remove from the plates resinous materials or materials which strongly adhere to said plates, such as paints or the like. Holes 21 and 22 with related discharge valves are provided in order to allow periodic removal of the sludge sedimented in the lower part 18 of the tank and in order to replace the washing liquid.

In order to rotate the movable plates 13, the axial conductor 14 is coupled to a gearmotor 23 of a per se known type which is supplied by an external electric power source.

In order to completely remove the washing liquid and the particles dissolved therein, there are appropriate scraping means 24, such as rubber brushes or the like, which act on the opposite faces of the collecting plates 13 so as to ensure the complete drainage of the liquid from the collecting surfaces together with the particles of material dissolved therein.

In an alternative embodiment, the means for removing the polluting particulate material are of the dry type. In particular, instead of the scraping brushes it is possible to provide brushes or other means suitable for removing the materials deposited on the movable electrodes. This embodiment is preferable for purifying environments with polluting materials such as sawdust and quartz, which are difficult to remove with wet methods.

Figure 4 schematically illustrates a possible embodiment of the electric circuit of the electrostatic cleaner according to the invention. The series of electrodes 10 and 12 are connected respectively to the terminals of a voltage source 30 by means of electric lines 31 and 32, the second of which is connected to the ground. A voltage regulator R is inserted along the line 31 and can be actuated manually or automatically according to the concentration $\underline{c}$ of the polluting material, possibly detected by means of appropriate probes or experimental tests. A current signal which is proportional to the value of the potential difference on the collecting electrodes 12 and is controlled by the regulator R is sent along the line 33 to a speed variator V, also of a per se known type, which varies the supply current of the gearmotor M so as to vary its rotation rate. The rate can be varied either continuously or discontinuously by means of programmed pulses in order to obtain stepwise rotation. The position and rotation rate of the collecting electrodes 12 is thus fedback by the value of the voltage applied to the plates, which in turn depends on the concentration by weight of the polluting material.

To conclude, by virtue of this arrangement, the means for moving the collecting plates are functionally coupled to the means for adjusting and controlling the supply voltage so as to adapt, automatically and at all times, the relative movement of the series of collecting electrodes to changes in the pollution conditions of the environment, keeping the effectiveness of the cleaner substantially and continuously unchanged.

In practice it has been observed that the device according to the invention fully achieves the intended aim, since the uninterrupted operation of the cleaner in optimum functional conditions is obtained by virtue of the continuous washing of the collecting electrodes and of their relative movement with respect to the other series of electrodes according to the concentration by weight of the polluting particulate material dispersed in the air or gas to be purified.

The electrostatic cleaner thus conceived is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept defined in the accompanying claims. Thus, instead of automatic motorized movement means, it is possible to provide manual means which can be accessed from outside. The voltage regulator R may furthermore be provided with acoustic or optical indicators in order to indicate elimination voltage values lower than preset limits which correspond to the maximum allowable pollution of the electrodes.

The shape of the collecting plates may also differ from the circular one; for example, it may be square or polygonal, and in this case it is convenient to give a stepwise manual or automatic rotation to the central conductor 14 by means of a step motor which operates discontinuously with programmable pulses. Finally, it is possible to provide in the cleaner's control circuit a programmable timer in order to vary the voltage and rotation rate of the collecting electrodes so as to adapt them to working hours and to their pollution hours, also according to the time of the year.

All the details may be replaced with technically equivalent elements. In practice, the materials employed and the dimensions may be any according to the requirements and to the state of the art.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Electrostatic cleaner (1) for eliminating polluting particulate material suspended in air or in a gaseous fluid, comprising an elimination chamber (3) with an inlet (4) and an outlet (5), means (6) for generating a gaseous flow through said chamber, means (7) for electrostatically charging the polluting particulate material at the inlet of said chamber, at least one pair of opposite electrodes (10, 11; 12, 13) with different electric potentials in order to collect the polluting particulate material on at least one of said electrodes (12), comprising means for the continuous or discontinuous removal of the polluting particulate material deposited on one or more of said collecting electrodes (12).

2. Electrostatic cleaner according to claim 1, characterized in that said collecting electrode or electrodes (12, 13) is or are electrically grounded and can move with respect to the other electrodes (10, 11).

3. Electrostatic cleaner according to claim 2, characterized in that said removal means are of the wet type.

4. Electrostatic cleaner according to claim 3, characterized in that said wet removal means comprise a collecting tank (17) for a washing liquid (L) in which said collecting electrode or electrodes (12, 13) is or are at least partially immersed.

5. Electrostatic cleaner according to claim 4, characterized in that said movable collecting electrode (12) is constituted by a series of planar plates (13) which are mutually parallel and adjacent and are mutually coupled by a central conductor (14) which defines a rotation axis for said series (12).

6. Electrostatic cleaner according to claim 5, characterized in that said planar plates (13) of said movable electrode (12) are continuously immersed in said elimination chamber (3) with their upper half (13') in order to collect the polluting particulate material, and are immersed in said collecting tank (17) for the washing liquid with their lower half (13'').

7. Electrostatic cleaner according to any one of the preceding claims, characterized in that said fixed electrode (10) is constituted by a series of planar and parallel elements (11) which at least partially face the planar plates (13) of said movable electrode and are at an electric potential of preset value.

8. Electrostatic cleaner according to claim 4, characterized in that said tank (17) comprises an upper chamber (18) for collecting the washing liquid which is separated from a lower chamber (19) for decanting and draining the particulate material by means of a partially perforated partition (20).

9. Electrostatic cleaner according to claim 8, characterized in that it has scraping brushes (24) or the like which act on the opposite faces of said planar plates (13) of said movable electrode (12), said brushes (24) being fixed to said tank (17) above the free surface of said liquid (L).

10. Electrostatic cleaner according to claim 9, characterized in that it has means (R) for adjusting and controlling the electric potential of said fixed electrode (10) according to the concentration by weight (c) of the polluting particulate material.

11. Electrostatic cleaner according to claim 2, characterized in that it has means for moving said movable electrode.

12. Electrostatic cleaner according to claim 11, characterized in that said movement means are of the manual type.

13. Electrostatic cleaner according to claim 11, characterized in that said movement means are automatic and are functionally coupled to said means (R) for adjusting and controlling the supply voltage.

14. Electrostatic cleaner according to claim 13, characterized in that said automatic movement means are constituted by an electric gearmotor (23) which is mounted on the rotation axis of said movable electrode.

15. Electrostatic cleaner according to claim 14, characterized in that said movement means furthermore comprise an electric or electronic variator (V) for the rotation rate of said gearmotor (23), which is functionally coupled to said means (R) for adjusting and controlling the electric potential of said fixed electrode.

16. Electrostatic cleaner according to claim 15, characterized in that said variator (V) is preset to vary the speed of said gearmotor (23) continuously or discontinuously with programmable pulses.

17. Electrostatic cleaner according to claim 4, characterized in that said washing liquid (L) is constituted by water or by a diluent agent for the particles of polluting material.

18. Electrostatic cleaner according to claim 2, characterized in that said removal means are of the dry type and comprise brushes or the like which act on the opposite faces of said movable electrode (12, 13).

19. Each and every novel feature or novel combination of features herein disclosed.

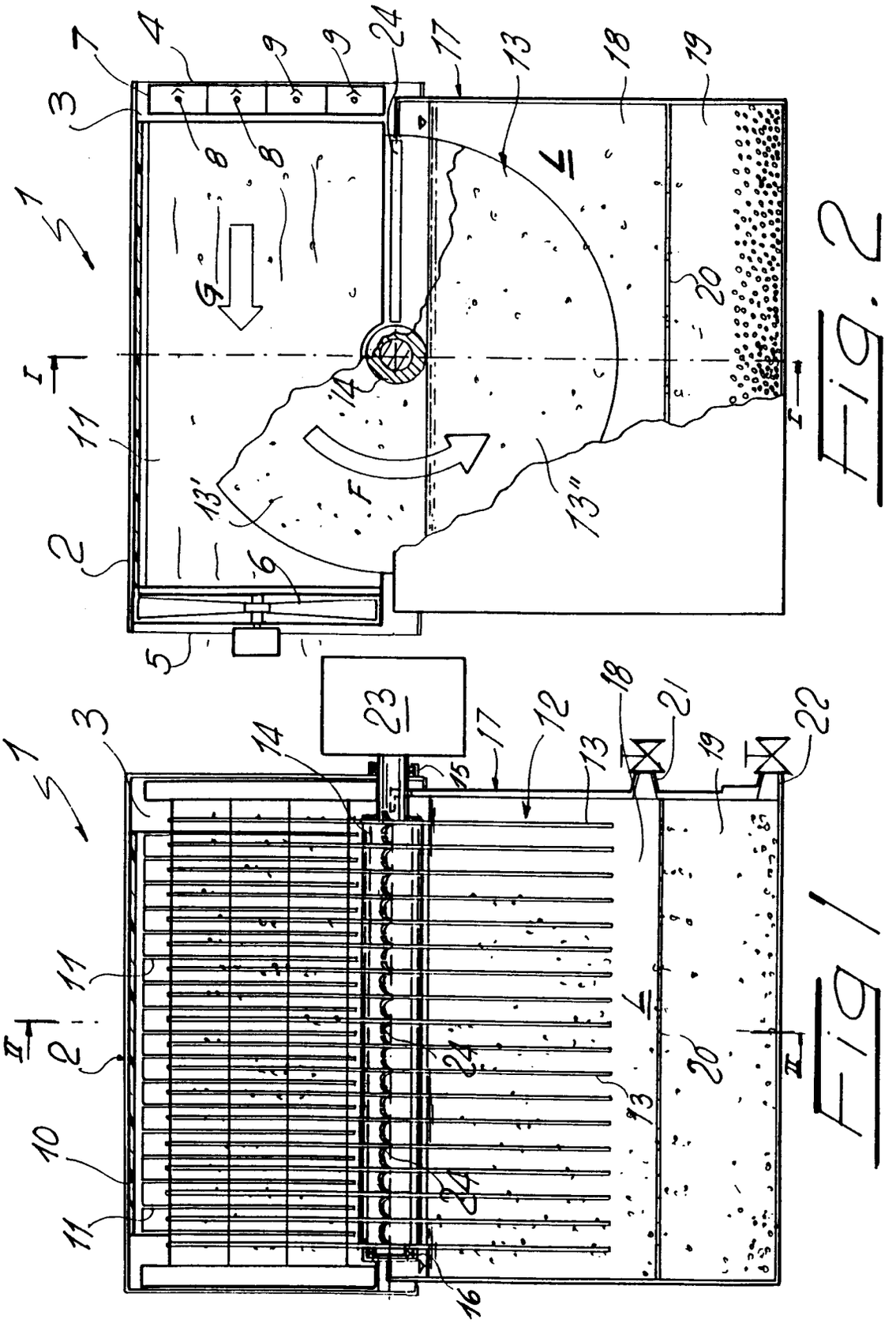

Fig. 2

Fig. 1

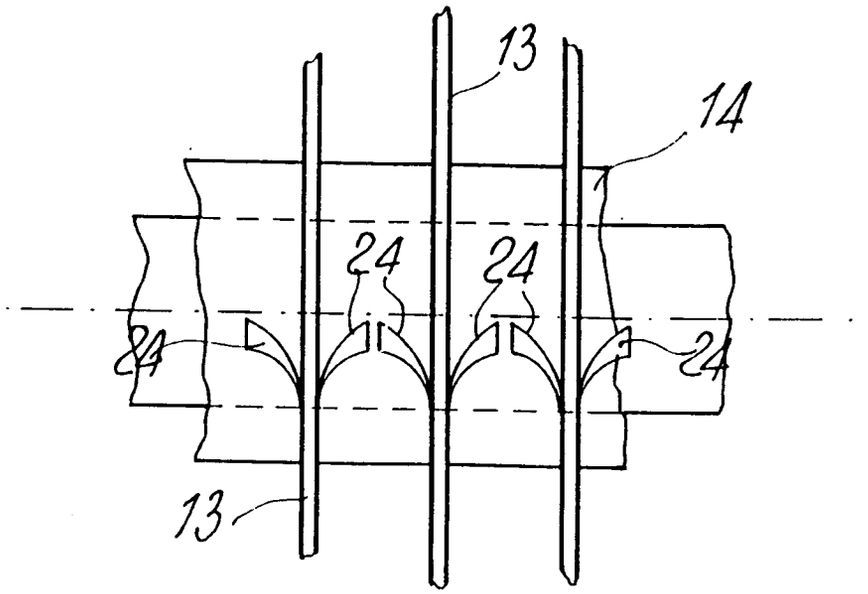

Fig. 3

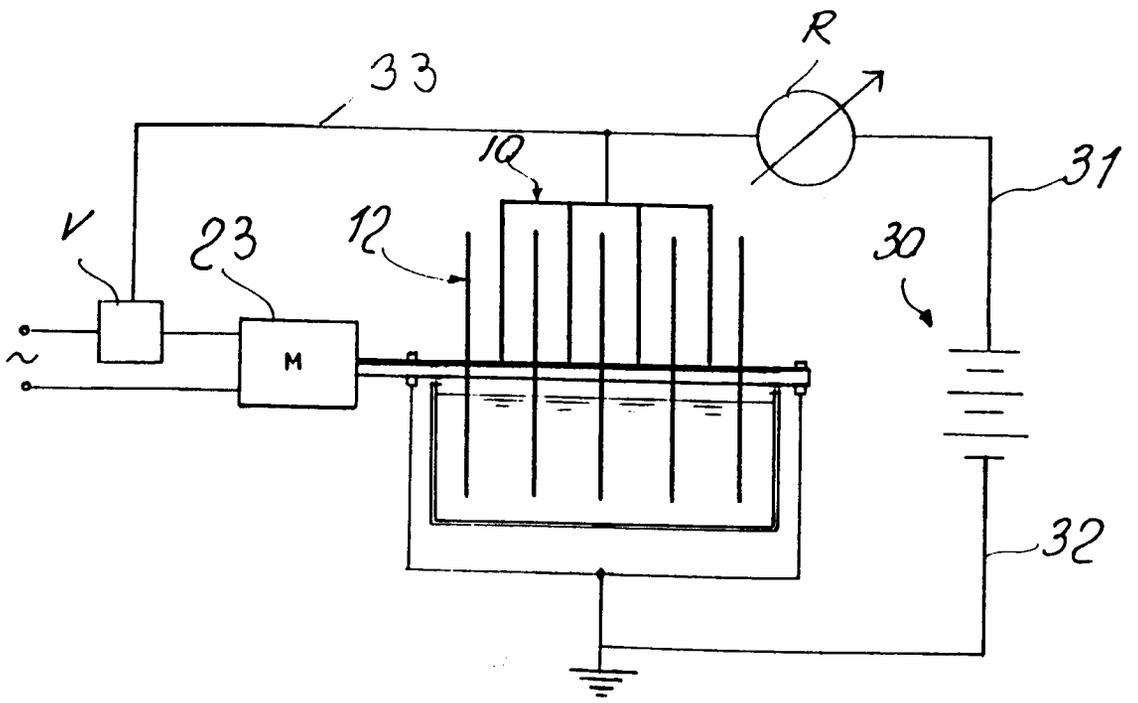

Fig. 4