July 31, 1956 F. J. MAAS 2,756,840

IONIZER FOR ELECTROSTATIC PRECIPITATIONS

Filed March 29, 1952

2 Sheets-Sheet 1

Fig. 1

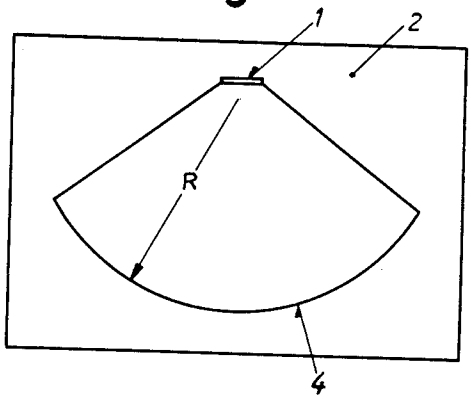


Fig. 2

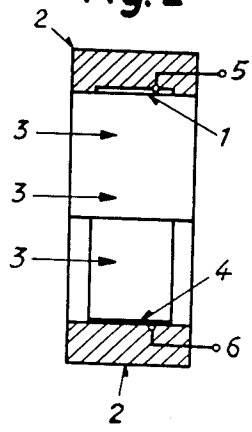


Fig. 3

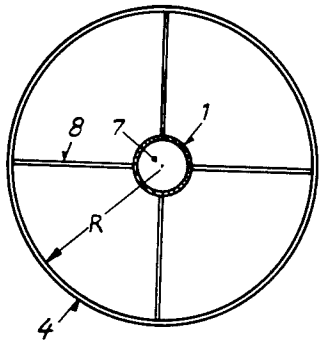


Fig. 4

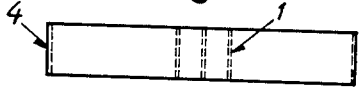
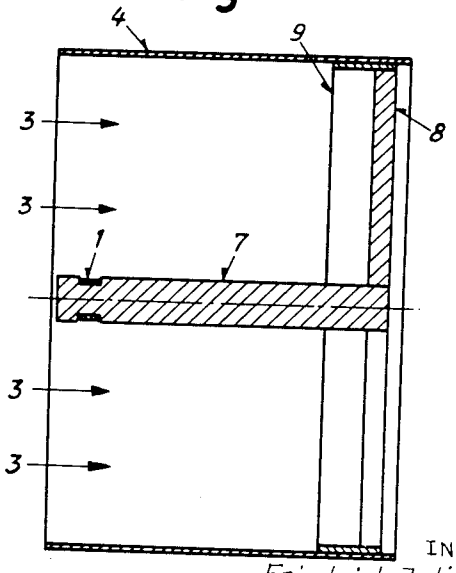


Fig. 5



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Fig. 6

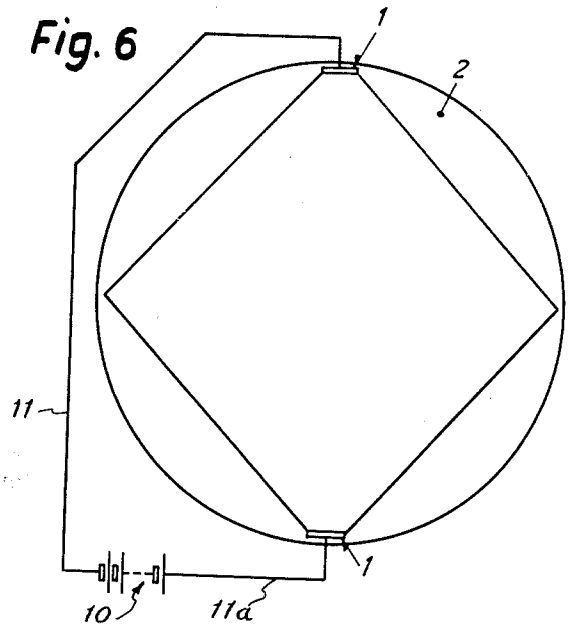


Fig. 7

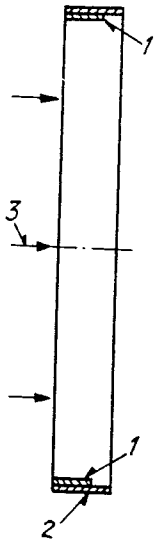


Fig. 8

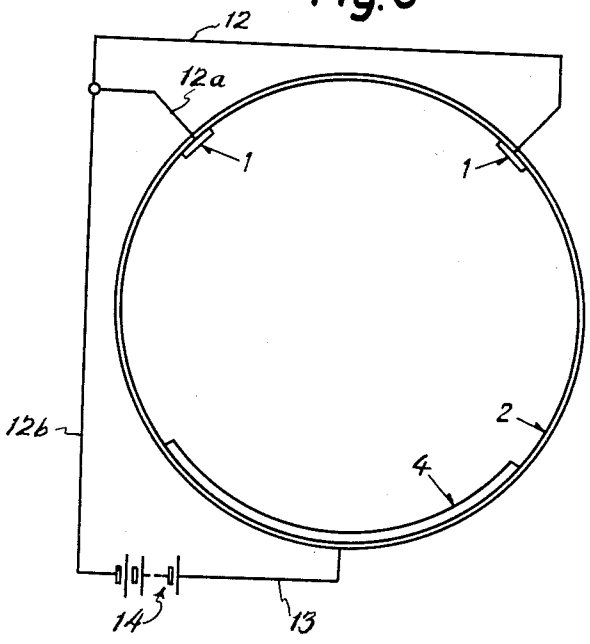
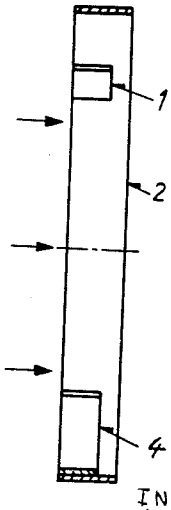


Fig. 9



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IONIZER FOR ELECTROSTATIC PRECIPITATIONS

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Application March 29, 1952, Serial No. 279,398

Claims priority, application Switzerland February 21, 1952

12 Claims. (Cl. 183—7)

The present invention concerns apparatus for the electrical charging of solid and liquid foreign particles borne by a stream of gas by collision of the particles with ionized gas molecules produced in the gas stream.

The apparatus is characterized by the fact that the gas stream is led through a space in which a radioactive beam is produced by spatially distributed radioactive sources emitting preponderantly alpha particles and practically no gamma rays and in which, by additional means, is produced an electrical field acting on at least part of the space. The flux lines of the field lie transverse to the gas stream and exercise, in the direction of the lines of force, a force on the ionized gas molecules produced by the radioactive beam.

Apparatus for the ionization of gas in order to charge foreign particles carried along in the gas are already known in the form of so-called electrofilters. These electrofilters separate the foreign particles from the gas by deviation of the charged particles by means of an electrical field in a system of electrodes through which the stream of gas is led. Such electrofilters use for the most part an electrical glow discharge (corona effect) on the surface of thin wires or electrodes of other shapes for the ionization of the gases entering the electrofilter. quite apart from the large technical expenditure required for such glow discharge ionizers, due to the high tension electricity necessary for the production of the glow effect and the good insulation required for the electrodes, this method of ionization also causes a new formation of gases. For example, ozone and nitrous gases are produced in considerable quantities in a stream of air, thus restricting the use of such electrofilters to a large extent.

Other ionizing agents have also already been proposed, for example, ultraviolet light and radioactive radiations, but have never, up to now, found technical application because such methods either possess an ionization activity which is much too small or, as with radioactive radiation of which the energy is actually sufficiently large, the energy could only be used to a very small extent for the charging of foreign particles.

In the present invention, radioactive sources with predominantly alpha emission are used, but supplementary measures are taken which, on the one hand, make possible a complete transformation of the energy of each alpha particle emitted into a correspondingly large number of ionized gas molecules and, on the other hand, by means of an electrical field superimposed in a certain manner on the space subjected to radioactive radiation, causes all the ionized gas molecules to be active in charging the foreign particles borne by the gas stream. Thus is obtained, using only very small quantities of radioactive substance, a high ionization activity without all the disadvantages of glow discharge ionizers.

The accompanying sketches, Figs. 1 to 9, are some examples of apparatus for the execution of the method, as follows:

Figs. 1 and 2 an ionizer which is of sector form in cross-section;

Figs. 3 and 4 the union of four sector-shaped ionizers to a tube ionizer;

Fig. 5 a further tube ionizer construction;

Figs. 6 and 7 an ionizer of rectangular cross-section;

Figs. 8 and 9 a tube ionizer with more than one source of radiation.

An example of an ionizer is shown schematically in Fig. 1 from the front and in Fig. 2 in cross section. The ionizer is of sector form with the radioactive deposit 1 at the acute end of the sector. The ionization space consists of a sector-shaped opening in an electrically non-conducting body 2 and possesses an opening angle (Fig. 1) of 90° or more. This form of ionizer cross section, through which the air enters in the direction shown by arrow 3 (Fig. 2), permits the use of the greatest possible fraction of alpha particles emitted by the radioactive deposit 1 for the intensive ionization of the stream of air. The deposit 1, consisting of radioactive substances possessing predominantly alpha particle emission, radiates not merely vertically to its surface but also in all directions. With a radioactive deposit 1, as in Figs. 1 and 2, composed of a very thin layer of radioactive material on a metal carrier under a gas-tight covering layer which absorbs few alpha particles, a uniform radioactive radiation is attained over practically the whole of the sector in the plane of Fig. 1, provided that the sector angle is of the order of 90° to about 120°. The radius R of the sector-shaped ionization space (Fig. 1) depends on the energy of the alpha emission of the radioactive deposit 1 and must correspond approximately to the maximum range of the most active component of the alpha emission in the gas stream. This value is exactly known for the individual radioactive substances.

Since the radiation intensity of the sector-shaped ionization space decreases with increasing distance from the radiation source 1 and since, in addition, the number of ionized gas molecules produced by an alpha particle per mm. of its path is variable, the ion density over the whole ionization space is definitely non-uniform. This is so even if the streaming velocity of the gas to be ionized is uniform throughout the whole ionizer cross section. The non-uniform ion density would naturally lead to a varying ionization activity with regard to the electrical charging of the foreign particles uniformly distributed in the gas stream. In order to avoid this undesirable effect, which up to now has made impossible the technical employment of radioactive ionizing agents, the present construction provides for an electrical field which is directed chiefly transverse to the gas stream and radially in Fig. 1. The arc-shaped periphery of the sector cross section opposite to the radioactive deposit 1 is provided for this purpose with a metallic layer 4, which possesses the same axial extension as the radioactive deposit 1. Both the metallic carrier of the radioactive source 1 and the metallic layer 4 are connected to terminals 5 and 6, respectively (Fig. 2), which themselves are connected to a source of electric current, for example, terminal 5 with the positive pole and terminal 6 with the negative pole. An electrical field arises between the radioactive deposit 1 and the metallic layer 4 acting as opposing electrode. The lines of force of this field traverse the sector space radially and predominantly transverse to the stream of air. Due to their high energy, the alpha particles are practically unaffected by the electrical field. The ionized gas ions produced by the alpha particles throughout the ionizer space are set in motion, however, in the direction of the lines of force of the field. The result is a uniform ion density in the ionizer cross section and an increase of the electrical charging of the solid and liquid foreign

particles carried by the gas stream through the ionizer space, according to the number and size of the charges. A deposition of foreign particles on the radioactive deposit 1 is hindered by embedding the deposit and its metallic carrier in the insulating body 2. Thus, even over a long period of time, no weakening of the alpha emission occurs due to such a deposit.

An especially favourable utilisation of space is made possible by the ionizer construction shown schematically in Figs. 3 and 4. Here four individual, sector-shaped ionizers each with an opening angle of about 90° and the same radius between the radioactive deposit 1 and the opposing electrode 4 are united to an ionizer of circular cross section. The ionizer then consists of a metallic spine 7 which is maintained concentrically in the metal tube 4 by means of four supports 8 composed of electrically non-conducting material. The spine 7 serves simultaneously as support for the four deposits 1 of radioactive substances. A direct electric current is applied between the spine 7 and the tube 4 as opposing electrode. Depending on the width of the radioactive deposit 1, the insulator supports 8 may also be wedge-shaped with the larger side connected to spine 7. The electrical field superimposed on the cross section of the ionizer subjected to radioactive radiation should possess a field strength of several hundred volts per cm. The positive potential should preferably be on the metallic carrier of the radioactive deposit. Depending on the maximum range of the alpha emission of the radioactive deposit and the thereby determined distance of the opposing electrode of the ionizer from the emitting layer, an electrical tension of between about 1000 and several thousand volts is necessary for the ionizer field.

The ionizer of Figs. 3 and 4 composed of four sectors may be constructed as in Fig. 5, which represents a cross-section through tube 4. The round metallic rod 7 is held by an insulating support 8, which is fastened to a ring 9 in the inside of the metal tube 4. The radioactive deposit 1 is placed in a ring-shaped depression of the metal rod 7 and is of little axial extent. A number of such ring-shaped depressions along the metal rod 7 each with its radioactive deposit may also be employed. A direct current is applied between the outer metal tube 4 and the inner metal tube 7, more especially with the positive pole on the inner conductor 7.

An example of an ionizer with rectangular or quadratic cross section is shown in plan in Fig. 6 and in longitudinal section in Fig. 7. Two similar sources of radiation are arranged opposite to one another. Each consists of a narrow band-shaped deposit of radioactive substances with predominantly alpha emission. Narrow metal bands are provided as carriers and the radioactive substances are placed on these and covered by a thin foil making a gas-tight connection with the carrier metal. The foil absorbs alpha particles to only an unimportant extent. Both band-shaped radiation sources extend in the axial direction over the whole of the ionizer space and are embedded in the outer walls of the ionizer space composed of electrically non-conducting material. The gas flows through the rectangular or quadratic ionizer space in the direction of arrow 3. The metal bands serving as carriers for the radiation sources 1 are connected by means of connecting leads 11 and 11*a* to the opposite poles of a source of direct current which in Fig. 6 is formed by the battery 10. The ionizer section subjected to radioactive radiation represents to some extent two radiated sections on which are simultaneously superimposed an electrical field whose lines of force, in Fig. 6, flow in a straight line between the radiation sources 1 and are bent outwards in known fashion in the space to the left and right of them.

Two pairs of opposing radiation sources 1 can also be arranged in an ionizer similar to that of Figs. 6 and 7. Then, all four corners of the body 2 possess a radiation source 1. Two of the sources are connected to the positive pole and two to the negative pole of the source of direct current. Such ionizers of rectangular or quadratic cross section similar to that of Figs. 6 and 7 possess the advantage that the full range in air of the majority of the alpha particles emitted from the radiation sources is utilised.

An example of an ionizer of circular cross section and more than one source of radiation is shown in plan from the front in Fig. 8 and in longitudinal section in Fig. 9. The radiation sources 1, of which as example two are sketched here, are arranged on the inside of the tube-shaped insulator body 2 opposite a metallic deposit 4 acting as counter electrode. Each radiation source 1 consists once again of a deposit of radioactive substances with predominantly alpha emission placed in a gas-tight manner on a narrow metal band. All radiation sources 1 are connected via the metallic carriers by means of connecting leads 12, 12*a*, and 12*b* to one pole and the counter electrodes 4 by means of a connecting lead 13 to the other pole of a source of direct current shown in Fig. 8 as a battery 14. In this example of an ionizer with more than one source of radiation, the maximum range of the alpha particles in air is well utilised.

The object of the batteries, that is the electric field created in the ionizer chamber lies in the fact that after charging the foreign particles there are still many ions in the air current, and if these surplus ions remain in the gas stream they could again neutralize particles already charged. Since this effect should be avoided, the surplus ions are removed by means of the electric field created in the ionizer chamber, the field having its flux lines predominantly transversely to the direction of gas flow.

The ionizer of the present invention employs radioactive substances with predominantly alpha emission and negligible amounts of gamma radiation for the ionization of solid and liquid impurities in the gas. The radioactive source consists more especially of a metal foil with a finely divided, very thin deposit of radium D on one side. The foils are stored for at least 6 months before being built into the ionizer so that a sufficient amount of polonium has been produced; the polonium is the source of the alpha emission. Use of such aged radium D guarantees, on the one hand, a sufficiently intensive alpha emission for the ionization of the gas stream and, on the other hand, practically absence of gamma radiation with its great power of penetration. Thus no danger to health is to be feared during use, transport, or storage of the ionizer.

I claim:

1. An ionizer for the electrostatic precipitation of solid and liquid particles borne by a gas, said ionizer comprising an ionization chamber, two electrodes located opposite each other on opposite walls of said chamber, neither of said electrodes being of a form to promote ionization means connected with said electrodes for supplying an electrical current thereto to form an electrical field extending across said chamber and between said electrodes, said chamber being open for the passage of gases therethrough in one direction transversely to the direction of said electrical field, and a layer of radio-active source of radiation carried upon one of said electrodes and emitting ionizing rays passing through said chamber and superposed over said electrical field.

2. Apparatus as in claim 1 in which the radio-active source comprises: radium D with an enrichment of polonium.

3. Apparatus as in claim 1 in which the radio-active source comprises: radium D aged before use.

4. An ionizer for the electrostatic precipitation of solid and liquid foreign particles borne by a gas, said ionizer comprising: an ionization chamber through which gases may flow in one direction, said chamber having a relatively large arcuate cross-section but small depth perpendicular to the direction of flow of the gas stream; a

radio-active source of radiation for emitting ionizing rays located at the apex of said arcuate cross-section and setting up a radio-active field throughout said chamber; and an electrical source setting up an electrical field and in the region of said ionizing rays superposed over said radio-active field and transverse to the direction of gas flow.

5. An ionizer according to claim 1, characterized in that the ionization space is of small cross section but large depth in the direction of flow of the air stream.

6. An ionizer according to claim 1, characterized in that the ionization space is of sector shape transverse to the direction of flow of the air stream, the sector having an angle opening of at least 90° and a radius of a size which permits free radial entry into the ionization space of the majority of the alpha particles emitted by the radio-active deposit when in the angle opening of the sector.

7. An ionizer according to claim 6, characterized in that the radioactive deposit is disposed on a metal carrier and sealed in a gas-tight manner by a covering layer, the layer absorbing practically none of the alpha emission and further characterized in that a metallic layer is disposed opposite the radioactive deposit on the inner side of the arc and an electrical field set up intermediate the metal carrier and one pole of an electrical source, and intermediate the metallic layer and the opposite pole of the electrical source.

8. An ionizer according to claim 7, thereby characterized in that the metallic carrier of the radioactive deposit is connected to the positive pole and the metallic layer to the negative pole of the electrical source.

9. An ionizer for the electrostatic precipitation of solid and liquid foreign particles borne by a gas in combination with an electric supply, the carrier comprising a metal tube, a metallic spine concentrically disposed in said tube, four electrically non-conductive supports for said spine radially disposed intermediate said tube and said spine, the angle between each pair of successive supports being substantially 90°, a radioactive substance for emitting ionizing rays disposed on said spine intermediate each successive pair of supports, and means for connecting said tube and said spine to opposite poles of the electric supply and providing a superposed electrical field over the field produced by the radioactive substance in the region of said ionizing rays, neither said tube nor said spine being of a form to promote ionization.

10. An ionizer for the electrostatic precipitation of solid and liquid foreign particles borne by a gas in combination with an electric supply, the ionizer comprising a metal tube, a round metallic rod concentrically disposed in said tube, means intermediate one end of said tube and said rod for maintaining said rod concentric

within said tube, said rod having at least one ring circumferentially formed therearound, a radioactive substance emitting ionizing rays consisting substantially of alpha particles disposed in said ring, the radial distance intermediate said rod and said tube being substantially equal to the maximum radial range of the alpha particles emitted by the radioactive substance, and means for connecting said tube and said rod to opposite poles of the electric supply to provide a superposed electrical field in the region of said ionizing rays.

11. An ionizer for the electrostatic precipitation of solid and liquid foreign particles borne by a gas in combination with an electric supply, the ionizer comprising an electrically non-conductive body of rectangular cross section, a metal band axially disposed in at least two opposite corners of said body, a radioactive substance emitting ionizing rays consisting substantially of alpha particles disposed on each band, foil disposed over said substance, said foil making a gas-tight connection with said band and being substantially non-absorbent of alpha particles, and means for connecting said metal bands to opposite poles of the electric supply to provide a superposed electrical field in the region of said ionizing rays.

12. An ionizer for the electrostatic precipitation of solid and liquid foreign particles borne by a gas in combination with an electric supply, the ionizer comprising an electrically non-conductive body of circular cross section, at least two bands disposed on the inner surface of said body in spaced parallel arrangement with each other and within an arc of 180°, a radioactive substance emitting ionizing rays consisting substantially of alpha particles disposed on each band, foil disposed over said substance, said foil making a gas-tight connection with said band and being substantially non-absorbent of alpha particles, a metallic deposit disposed on the inner surface of said body in substantially opposed relationship with said bands, means for connecting said bands to one pole of an electric supply, and means for connecting said metallic deposit to the opposite pole of the electric supply, whereby a superposed electrical field is provided in the region of said ionizing rays.

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