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ELECTRODE SYSTEM FOR THE SEPARATOR OF AN ELECTRIC DUST PRECIPITATOR

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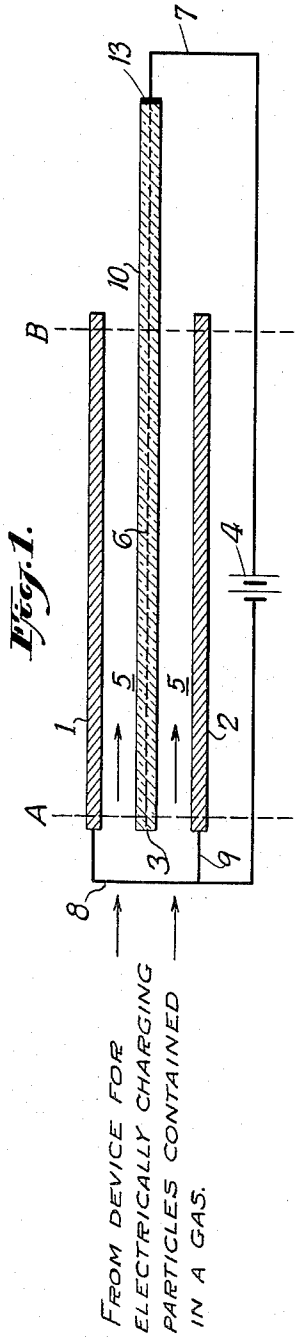


Fig. 1.

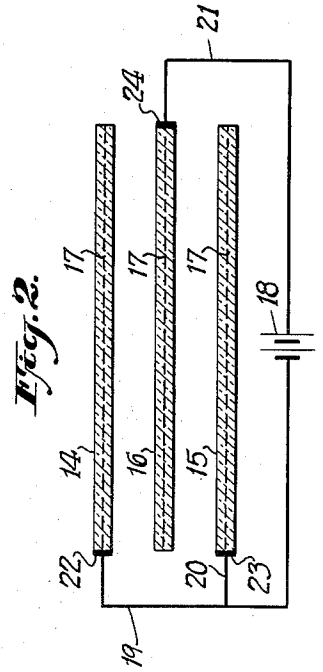


Fig. 2.

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ELECTRODE SYSTEM FOR THE SEPARATOR OF AN ELECTRIC DUST PRECIPITATOR

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4 Claims. (Cl. 183—7)

The present invention relates to an electric dust separator or electrofilter having a charging zone for the dust and a dust separating zone separate from the charging zone. The separating zone is provided with sheetlike electrodes of opposite polarity and the invention relates more particularly to an improved electrode system for the dust separating zone.

In the system according to the invention at least one electrode of one polarity in the dust separating zone of an electrofilter includes a homogenous, self-supporting, semi-conducting layer having a specific sheet resistance of at least 10^6 ohms and a metallic lead connected with one edge of the layer. The connection of the lead or current supply conductor with said electrode is so far spaced from the metallic conducting parts of electrodes of opposite polarity that even if the electric tension across the gap of the separating zone is close to the break-through tension, there is no spark between the metallic parts of the electrodes of opposite polarity.

The term "specific sheet resistance" used in this specification and in the claims appended thereto stands for a value which expresses the total electric resistance of a homogeneous plane rectangular sheetlike electrode, if this value is multiplied by the length of the electrode, i.e., the extension of the electrode in the direction of the flow of the electric current, and divided by the width of the electrode, i.e., the extension of the electrode transversely to the current flow. The thickness and lamination of the electrode are not considered in the value determination; they are included in the term "specific sheet resistance" which has the dimension "ohm" in contradistinction to the specific resistance of the material of which the electrodes are made which resistance has the dimension "ohm·cm."

In an electrofilter the particles to be separated are electrically charged and thereupon diverted in an electric field from the direction of flow of the gas in which the particles are suspended, and deposited on electrodes. Hitherto the separator electrodes have been made of good electric conducting material, particularly of metal. With this type of electrodes the field intensity between the electrodes must be considerably below the break-through intensity because, otherwise, small uneven spots on the electrode surfaces resulting from careless manufacture or from local dust accumulations cause increased field intensity and glow discharge or sparking. Since, even at reduced field intensity, there is no guarantee against sparking in the conventional separators, these separators cannot be used for purifying flammable or explosive gases, aside from the fact that sparking in electrofilters for non-flammable gases causes undesired interruption of the separation because the entire separator system is electrically discharged at each sparking.

It has been found that the current intensities at which invisible Townsend discharges occur in the air space between two electrodes are of the order of 10^{-6} amperes per square meter and that these small currents can be conducted without considerable voltage drop through a

sheetlike electrode having a specific sheet resistance between 10^6 ohms and 10^9 ohms. If such an electrode is used and care is taken that the connection of the metallic lead and its environment cannot cause disturbances, no spark and no flammable discharge can occur when nonconductive dust or aerosol particles are separated because the throttle effect of the resistance of the electrode prevents supply of enough current to produce such undesired conditions. The electrode according to the invention guarantees stabilization of the invisible Townsend discharges of the electrode and permits conducting flammable and explosive gases through the separator and electric removal of nonconductive aerosol particles from the gases.

In the German literature the term Townsend discharge defines a discharge which is less than a glow discharge, the Townsend current being between 0 and 10^{-6} amperes per cm.^{2} according to "Elektrische Gasentladung," by A. von Engel and M. Steenbeck, 1934, volume 2, page 56.

Three essential advantages are obtained by the stabilization of the invisible Townsend discharge which are important with respect to the efficiency and to the operating safety of the electrolfilter. Firstly, the aerosol and dust particles can be removed from the gas with the maximum possible break-through field intensity and with the maximum possible separation factor in continuous operation without precision engineering of the separating electrode system and without exactly maintaining the voltage of the operating current by means of special voltage stabilizers. Secondly, because of the flat volt-ampere characteristic of the Townsend-discharge the break-through field intensity is stabilized in the separating zone by the high electric resistance in the sheetlike electrode and in a high ohm covering layer also if the voltage in the current supply leads changes with the voltage of the distributing system plus minus 20%. Therefore, special voltage stabilizers in the current supply apparatus can be omitted. Thirdly, igniting sparks cannot occur, even if an electric conduit is formed anywhere between two neighboring electrodes due to mechanical deformation of the electrode plate or due to other irregularities.

It is of particular advantage if the electrode is made of semi-conducting glass or a glasslike synthetic material because, in this case, the dust accumulation in the separator can easily be observed, for example, by measuring the light passing through the separator. If glass or glasslike material is used for the electrodes of the separator, the separated matter can be washed off by a washing fluid, for example, by an acid and immediately chemically analyzed.

It is desirable to make very large not uniformly spaced electrodes substantially of a material having a specific resistance of between 10^{10} to 10^{14} ohm cm. in which at least one layer of a material of electronically conductive material having a relatively low specific resistance is embedded which layer is connected with the current supply lead. In this manner the Townsend current is uniformly distributed. The specific sheet resistance of the thus constructed electrode should be at least 10^6 ohms. If the embedded layer is transparent, the observation of the dust accumulation is not hindered.

It has been proposed to coat metallic separating electrodes with a layer of highly resistant material of great dielectric strength in order to avoid sparking. This, however, does not provide a full precaution against sparking because the highly resistant coat is stressed for break-through and a minute mechanical damage may lead to an electric break-through. With the electrode according to the invention the current intensity necessary for break-through cannot occur locally because the

current intensity is limited by the sheet resistance and the electrode resistance of the layer forming the electrode.

Precipitating electrodes have been made of glass or ceramics in electrofilters having central ionizing electrodes for precipitating acid fumes in order to prevent corrosion of the electrodes. In these filters a coherent film of an electrolyte is formed on the initially not conducting electrodes which film causes a low electric resistance of the electrodes. With these arrangements only conductive droplets can be separated from the gas flowing through the apparatus. The stabilization against sparking and voltage variation of the electric distributing system provided by the invention cannot be obtained with the conventional apparatus. The conventional systems are subject to many kinds of uncontrollable accidental conditions depending on the nature of the precipitated substance. The electrode according to the invention possesses exactly defined and measurable electrophysical qualities which can be used for reliably controlling the stabilization of the electric field in a separator electrode system against variations of the line voltage.

It is sufficient for stabilizing the Townsend discharges, if at least one of two electrodes of different polarity has a specific sheet resistance of at least 10^6 ohms.

The connections of the current supply leads with the electrodes must be so arranged that igniting discharges are prevented at these points and at the immediate neighborhood thereof. It is of advantage that the semi-conducting electrode protrudes so far beyond the separating space that the point of connection of the lead is sufficiently spaced outside of the separating field from the metallic conducting parts of the electrodes of opposite polarity. In this way the portions of the separating space which are in the neighborhood of the current supply connection are protected against excessive current intensities by sufficient electric resistance.

This safeguard can also be obtained by connecting the current supply leads with opposite marginal portions of two electrodes of opposite polarity having a specific sheet resistance of at least 10^6 ohms.

The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic illustration of an electrode system for an electric dust separator according to the invention.

Fig. 2 is a diagrammatic illustration of a modified electrode system.

The electrode system shown in Fig. 1 comprises two outside electrodes 1 and 2 whose potential is the same. An electrode 3 is interposed between the two outside electrodes 1 and 2 and is electrically connected with the latter by means of a source 4 of D.C. current so that there is a strong electric field in the spaces 5 between the electrodes and the dotted lines A and B in Fig. 1. If gas containing electrically charged particles is conducted in the direction of the arrows through the field spaces 5, the particles will be precipitated onto the electrodes which have a polarity which is opposite to the polarity of the charge of the particles. Since the particles are preferably charged with the same polarity, precipitation occurs only on the electrodes which have the opposite polarity.

In the embodiment of the invention shown in Fig. 1 the electrodes 1 and 2 are made of metal whereas the electrode 3 is made of glass or of synthetic material. The electric resistance of glass is between $8 \cdot 10^{11}$ to $3 \cdot 10^{14}$ ohm cm. Therefore, sheetlike electrodes can be made of glass whose specific sheet resistance is at least 10^6 ohms.

In order to prevent too much voltage drop in the electrode 3 a high ohm layer 6 is embedded which is, for example, in the form of a thin translucent metal film or of a semi-conductive layer. The electrode 3 has a portion 10 projecting outside of the precipitating zone between the dotted lines A and B and beyond the electrodes 1 and 2. A metallic electrically conductive strip 13 is connected with the end edge of the projecting portion 10 and is electrically connected by means of a current supply lead 7 with one pole of the source 4 of D.C. current. The ends of the electrodes 1 and 2 at the gas inlet side of the separator are connected by current supply leads 8 and 9 with the other pole of the source 4.

If all electrodes are made of glass with a translucent layer of metal or a translucent semi-conductor embedded therein, the degree of precipitation and dust accumulation in the separator can be observed, if necessary, by directing light from a light source through the electrodes.

Fig. 2 diagrammatically illustrates a system in which all electrodes, i.e., the electrodes of both polarities are constructed in the same manner. Each of the electrodes 14 and 15 and the electrode 16 placed therebetween have a specific sheet resistance of at least 10^6 ohms. In each electrode a layer 17 is embedded whose electric conductivity is great relatively to the conductivity of the material in which the layer is embedded. A current supply lead 21 is connected with a conducting rail 24 at the right side of the middle electrode 16. Current supply leads 19 and 20 are connected with contact rails 22 and 23 connected with the left ends of the electrodes 14 and 15, respectively. The current supply leads 21 and 19, 20 are connected with opposite poles of a source 18 of D.C. current. The current supply leads are thus connected with the opposite marginal end portions of electrodes of different polarity so that there is substantially the same total resistance for the electric current passing through the field spaces between the electrodes at all locations of the precipitator. This total resistance consists essentially of the resistance of the portions of the electrodes through which the current passes.

The electrodes 3 (Fig. 1) and 14, 15 and 16 (Fig. 2) may be made of a single high ohm layer of semi-conducting material having a suitable specific resistance. Polyvinyl chloride, for example, is suitable for this purpose, if it is compounded with a suitable percentage of soot or graphite. More than two electrodes of the same polarity can be connected to form a group in order to increase the precipitating surfaces. The sheetlike electrodes may have any suitable configuration; they may be not only plane but also cylindrical, conical, or shaped in any other fashion.

I claim:

1. In an electrode system for an electric separator for precipitating electrically charged particles contained in a gas flowing through the separator, spaced parallel sheetlike electrodes of opposite polarity forming a precipitating zone therebetween, at least one electrode of one polarity being made of self-supporting electrically semiconducting material and having a specific sheet resistance of at least 10^6 ohms, metallic current supply leads individually connected to an edge portion of said electrode of one polarity, and metallic current supply leads individually connected to an edge portion of an electrode of the opposite polarity which edge portion is distant from said edge portions of the electrode of the first polarity, the voltage between said leads being higher than the break-through voltage across the gap between electrodes of opposite polarity forming a precipitating zone, and the distance between the current supply leads of opposite polarity being greater than the length of a spark producible by the maximum voltage of the current in said leads.

2. In an electrode system as specified in claim 1 wherein said semiconducting material is glass.

3. In an electrode system as specified in claim 1 where-

in said electrodes which are made of semiconducting material include at least one layer of a material having a relatively high specific resistance, and an electronically low conductive high ohm second layer made of a material of relatively low specific resistance and being adjacent to said first layer, said metallic current supply leads being individually electrically conductively connected with the respective second layers, and the entire specific sheet resistance of the individual multilayer electrodes being at least 10^6 ohms.

4. In an electrode system according to claim 3 in which said second layer is embedded in said layer of relatively high specific resistance, the latter being made

of glass, and said second layer being made of a translucent material.

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