March 18, 1941. R. A. NIELSEN ET AL 2,235,081

ELECTRICAL PRECIPITATOR DEVICE

Filed Dec. 13, 1939 2 Sheets-Sheet 1

Fig. 1.

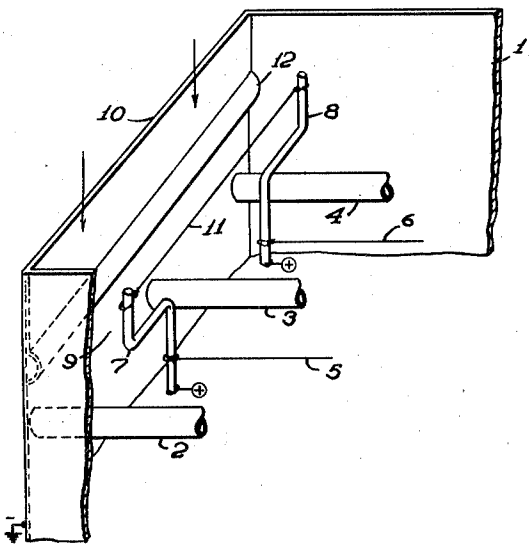


Fig. 2.

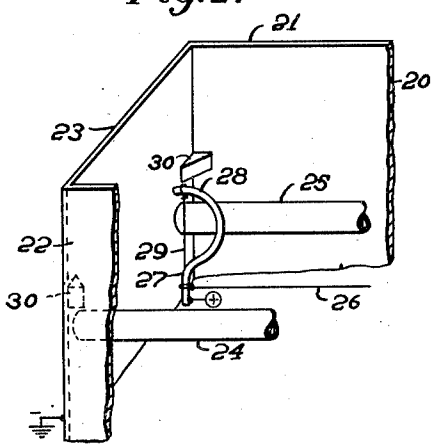


Fig. 6.

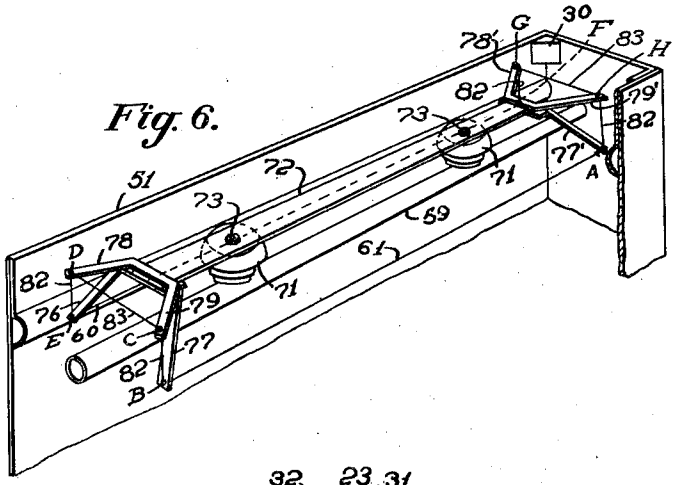
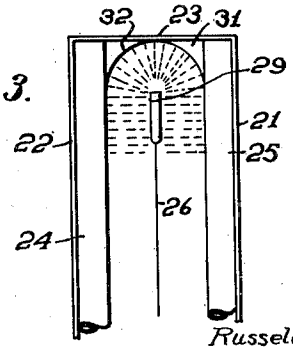


Fig. 3.



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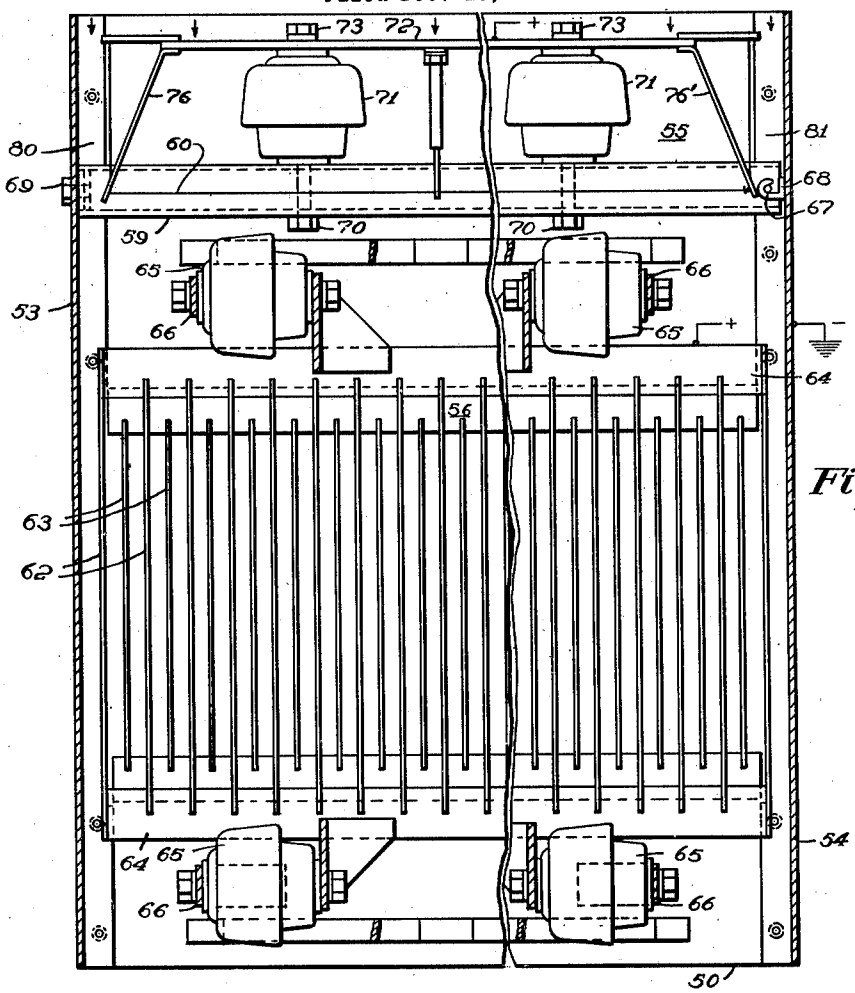


Fig. 4.

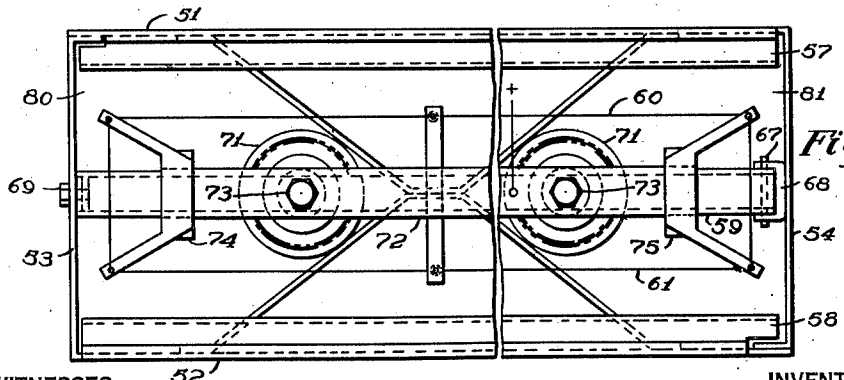


Fig. 5.

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UNITED STATES PATENT OFFICE

2,235,081

ELECTRICAL PRECIPITATOR DEVICE

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Application December 13, 1939, Serial No. 308,986

12 Claims. (Cl. 183—7)

Our invention relates to electrical precipitators employed to electrically precipitate from air, or any other gaseous medium, any contained, or suspended, dust particles, fogs, smokes, or other particulate matter, and which, for convenience, is hereinafter embracively termed dust.

The present invention is related somewhat to the gas-purifying electrical precipitator comprising the subject matter of Patent No. 2,129,783, issued to Gaylord W. Penney, September 13, 1938, and assigned to the Westinghouse Electric & Manufacturing Company. In such a precipitator, the gas is first blown through an ionizing zone or chamber and then through a precipitating zone or chamber, a significant feature of the precipitator being that the ionizing wire or wires are of such small diameter that practically utilizable ionization of the suspended particles of dust may be obtained at a wire-charging voltage giving ionizing currents at which negligible ozone generation occurs, and that the power input is low when the precipitator is used for cleaning air.

The ionizing wire of such a precipitator is preferably less than 32 mils in diameter. In the usual construction of a precipitator built in accordance with the teachings and principles contained in the aforesaid Penney patent, the wire may be much finer than this upper limit and is frequently as little as 5 mils in diameter, or even less, the actual diameter being kept as small as possible, consistent with sufficient strength to withstand rough usage in the actual commercial embodiments of the apparatus. In general, the ionizing wire of such a precipitator is usually maintained taut, or in some degree of tension.

The ionizing wire itself is part of an ionizing means which usually comprises one or more such ionizing wires alternating with non-discharging curved electrodes, generally grounded, and designated as ground electrodes, at a suitable potential with respect to the wires for creating an ionized electrostatic field of low power consumption and negligible generation of ozone or oxides of nitrogen, extending in the regions between the wires and ground electrodes.

Since the ionizing wire is at a high potential relative to the ground electrodes, the wires must necessarily be insulated from the electrodes; and, moreover, since a supporting structure must be provided for the ionizing means, the ground electrodes are generally part of, or electrically-connected to, the supporting structure which may be in the form of a metal casing. This means that the ionizing wires must also be electrically insulated from this casing, and for this purpose, the wires are secured between end supports spaced and insulated from the proximate sides of the casing, or box, or whatever form the supporting means may take or be called.

This space between the wire end supports, or the end of a wire, and the casing end sides, is a region in which, in prior structures, the ionizing current is inadequate, that is, the dust carried by the air or gas passing through the region is not sufficiently electrically charged for subsequent efficient precipitation of the dust. This region of inadequate ionization is enlarged right at the end supports for the wires which introduce dark, or shielded spots of little or inadequate ionization often extending a half-inch or more from the support.

In large precipitating apparatus having long ionizing wires, transverse to the gas flow, the total regions of inadequate, or less-than-sufficient, ionization are small compared to the total regions of adequate, or sufficient, ionization to charge the dust particles for precipitation, and the total overall cleaning efficiency of the apparatus is little affected by the dark regions. Thus, for example, in an apparatus in which nine-tenths of the air is sufficiently well ionized to yield a cleaning efficiency of 95%, and the remaining one-tenth is inadequately ionized so that its cleaning efficiency is, only, say 50%, then the total efficiency would be 90.5%. If the length of the wires goes down, the portion of the former regions to the latter increases with a manifest further adverse effect on efficiency. While even 90.5% efficiency represents a high degree of air cleaning possible only with electrical precipitators of the type described and ample for practically all cleaning purposes, nevertheless, it is an object of this invention to devise a means to further increase the efficiency of precipitating apparatus by increasing the ionization in the regions previously inadequately ionized.

It is an object of our invention, therefore, to provide a means for assuring adequate ionization of all the air or gas passing through the end spaces of an electrical precipitator of the type described, and more particularly to assure ionization of the gas passing through the regions which previously had been dark spots, without interfering with the flow of the air or gas to any appreciable extent. The means may take the form of added ionizing wires properly disposed to create an ionized field in the path of the gas flow.

It is an object of our invention to so arrange ionizing wires at the end spaces of the casing

in the regions of inadequate ionization so that utilizable adequate ionization is created therein about the support and in the aforesaid end space between the end supports and the casing.

It is a further object of our invention to make the aforesaid arrangement with a minimum of expense, and which involves little change in the practical forms of precipitating apparatus or ionizing units, such as, for example, that disclosed in patent application of Edward H. R. Pegg, Serial No. 286,577, filed July 26, 1939, which has matured into Patent No. 2,215,298, granted September 17, 1940, and assigned to the Westinghouse Electric & Manufacturing Company, and the apparatus described in the aforesaid Penney patent.

In achieving the objects of our invention, rather than terminating the normal ionizing wires when they reach the end supports, as have been done in prior constructions, we continue the wires onward in one or more directions chosen to ionize the regions previously inadequately ionized. To this end, in certain embodiments of our invention, the end supports are slightly altered and provided with additional wire-supporting arms for supporting additional lengths of ionizing wire which ionize the region through which the gas or air to be cleaned must pass, which regions, in prior constructions, constituted the aforesaid inadequately-ionized spaces and dark spots.

With the foregoing and other objects in view, our invention consists of the features, elements, combinations and apparatus hereinafter more particularly described and claimed, and illustrated in the accompanying drawings, in which:

Figure 1 is a perspective view of part of the ionizing portion of a precipitating apparatus, which might follow the construction described in the aforesaid Penney patent, for depicting the principles underlying one embodiment of our invention.

Fig. 2 is a view similar to Fig. 1, but showing an additional embodiment.

Fig. 3 is a top plan view of a structure similar to that of Fig. 2 but employing another form of corner baffle.

Fig. 4 is a vertical sectional view through a precipitator cell such as shown and described in the aforesaid Pegg application, but altered to incorporate an embodiment of our invention.

Fig. 5 is a plan view of the structure of Fig. 4 with parts omitted for the purpose of clarity, and

Fig. 6 is a perspective view of part of the ionizing structure of the apparatus of Figs. 4 and 5.

In the form of the precipitating apparatus shown in Fig. 1, an outer metallic casing 1 carries an ionizing means comprising spaced, parallel ground electrodes 2, 3 and 4 terminating at the end sides of the casing, and ionizing wires 5 and 6 disposed centrally between the ground electrodes in their axial plane. The ionizing wires are supported in proper relation by end supports 7 and 8 at each side of the casing, the end supports being suitably insulatedly spaced from the ground electrodes and the end sides of the casing.

The structure thus far described may be representative of conventional ionizing units of the type described and an ionized field exists between the ionizing wires 5 and 6 and the ground electrodes 2, 3 and 4. However, with this structure there is no adequate ionization in the space 9 between the end supports 7 and 8 and an end side 10 of the casing 1, and in the shielded or dark spots in proximity to the points at which the ionizing wires contact their respective end supports. Accordingly, confined solely to the structure thus far described the gas flowing through the ionizing means would have a major portion adequately ionized, while the portion of the gas flowing through the spaces 9 at each end of the casing and the dark spots at the end supports might be inadequately ionized.

It is a primary purpose of our invention to provide means for adequately ionizing the latter portion of the gas flow. To this end we extend the supports 7 and 8 slightly above the ground electrodes 2, 3 and 4 and toward the casing sides as far as is consistent with the voltages employed, so that the end supports will be closer to the casing sides but nevertheless sufficiently spaced from them for satisfactory insulation. Between the tops of these end supports an additional ionizing wire 11 is secured, and it may be at once perceived that this wire is transverse to the direction of gas flow represented by the arrows and is also transverse to the previously described ionizing means embracing the ground electrodes 2, 3 and 4 and the ionizing wires 5 and 6.

The ionizing wire 11 has cooperating therewith additional ground electrode 12 in the form of a semi-cylinder secured to the end side 10, the axis of the electrode being horizontally aligned with the ionizing wire 11. Accordingly, an ionized field will exist in the space between the ionizing means 11 and 12, and to some extent on the other side of the ionizing wire 11 in cooperation with the other ground parts of the unit.

Since this additional ionizing field is substantially coextensive with the end space 9 and the dark regions about the supports 7 and 8, it is apparent that the gas, and the dust it contains, flowing through the casing will now be substantially adequately ionized or charged.

In some embodiments, the ground electrode 12 may be omitted in which case the current from the ionizing wire 11 flows directly to the end side 10 of the casing.

Fig. 2 represents another form of our invention adapted to a unit such as shown in Fig. 1. In this embodiment the casing 20 has sides 21 and 22 and end sides 23. Carried by the casing 20 are ground electrodes 24 and 25 between which is disposed an ionizing wire 26 maintained taut between end supports 27. However, each end support 27 continues upward beyond the ionizing wire 26 and has a curved member 28 thereon between the extremities of which is secured an ionizing wire 29 vertically disposed with respect to the horizontal disposition of the wire 26. The wire 29 is also suitably spaced from the end side 23 of the casing and creates an ionized field about it for adequately ionizing any gas that flows through this field in order to assure substantially complete charging of the gas borne dust flowing through the end space and dark regions.

The structure of Fig. 2, however, does not quite adequately ionize the corner spaces of the casing, but this area is quite small and may be ignored. Nevertheless, if it be desired to avoid the flow of gas through these corner spaces, triangular baffle inserts 30 may be employed secured inside the corners of the casing for baffling the incoming air or gas toward adequately-ionized regions.

If desired, the vertical corners of the casing may be closed to air flow, as shown in Fig. 3, by a baffle 31 of an extent slightly longer than the ionizing wire 29 and paralleling it. The baffle 31 has a semi-cylindrical outer surface 32 of a radius of approximately equal to that of the distance from the ionizing wire 26 to either of the elec-

trodes 24, 25. In Fig. 3, the fine broken lines indicate the electrostatic field between the electrodes 24, 25 and the wire 26 on the one hand, and the baffle 31 and wire 29 on the other.

While the descriptions of the apparatus shown in Figs. 1, 2 and 3 have been largely confined to one end of the casing, it is, of course, to be understood that the other end of the casing has like provisions for adequately ionizing the inner spaces in proximity to that particular end side of the casing.

The embodiment shown in Figs. 4, 5 and 6 shows ar application of our invention to a more recent type of precipitating cell described in greater detail in the aforesaid Pegg application. Briefly, such a unit comprises a casing 50, open at its top and bottom, having opposed side walls 51 and 52, and opposed end walls 53 and 54. Air flows into the top of the casing as indicated by the arrows, and passes first through the ionizing zone or chamber 55 where the dust and the air are charged or ionized and then through a precipitating zone or chamber 56 where the dust may be precipitated or agglomerated.

The ionizing zone or chamber comprises a plurality of ionizing units disposed transversely with respect to the air flow. Structurally it may take the form of a plurality of spaced, horizontal, curved electrodes 57, 58 and 59 between which are suitably supported ionizing wires 60 and 61. The electrodes 57 and 58 may be semi-cylindrical and integral with the sides 51 and 52, respectively, of the casing, while the electrode 59 is preferably round.

The precipitating chamber comprises a relatively large number of alternately insulated and non-insulated plates 62 and 63 parallel to the direction of air flow. The insulated plates 62 are supported on notched bars 64 suitably carried by one end of insulators 65, the other ends of which are supported by bars 66 extending between and carried by the sides 51 and 52 of the casing.

In the specific structure shown in Figs. 4 through 6 the ionizing means includes a single structural item for economical manufacture, and this item is built about the electrode 59 which is provided at each end with means for securing it in its proper place in the casing 50, this means comprising a pin 67 at one end of the electrode which fits the protruding portions of the pin-fitting hook 68 secured to the casing while the other end of the electrode is provided with a threaded plug for the reception of a bolt 69 extending through an end side of the casing so that the electrode can be given a rigid three-point suspension in the casing. Intermediate the ends of the electrode 59 are a pair of spaced apertures through which extend bolts 70 screwing into the bottom ends of insulators 71, across the other ends of which is fastened a metallic bar 72 by means of bolts 73. The metallic bar 72 parallels the electrode 59, but is somewhat shorter, and has secured to its extremities end supports 74 and 75, each provided, in this instance, with four arms as shown in Fig. 6.

The main ionizing portions of the ionizing wires 60 and 61 extend, respectively, between two arms 76 and 76' and two arms 77 and 77' on the end supports. Each of the end supports are further provided with additional arms 78 and 79 for the end support 74, and 78' and 79' for the end support 75 which are approximately in the same plane as the bar 72 but project outwardly therefrom to terminate substantially directly above the ends of the arms 76, 76', 77 or 77', as the case may be.

The end supports 74 and 75 and the bar 72 constitute supporting means for the ionizing wires and are therefore so proportioned that they are suitably spaced from any of the grounded parts of the precipitator apparatus. Accordingly, there is a space 80 between the end side 53 of the casing and the end support 74 and the second space 81 between the other end side 54 of the casing and the other end support 75.

In order to ionize these spaces as well as to provide an adequately ionized field in the path of the flow of gas through spaces 80 and 81, and for gas flowing through the dark regions at the extremities of the arms of the end supports 74 and 75, a combination of the horizontal ionizing means and the vertical ionizing means of Figs. 1 and 2, respectively, is employed. To this end, ionizing wires are strung between the extremities of the pairs of arms 76 and 78, and 77 and 79 of end support 74, and between the extremities of the pairs of arms 76' and 78', and 79' and 77' of the end support 75, to provide vertical ionizing wire portions 82, and an ionizing wire portion is strung between the extremities of the arms 78 and 79, and 78' and 79' to provide horizontal ionizing wire portions 83 above the plane of the main ionizing field as determined by the axes of the ground electrodes. Accordingly, an ionizing field is created at each end of the casing to assure adequate ionization of the dust in the gas-flow portion which flows along the ends of the casing and in proximity to the end supports, the vertical ionizing wires 82 creating vertical fields which extend somewhat beyond the dark spaces at the supporting points of the ionizing wires 60 and 61, and also toward the end sides of the casing, and the horizontal ionizing wires 83 further augmenting these fields.

In a practical form of construction, it is possible to use a single wire for all of the ionizing portions of the ionizing means. Thus, an end of the wire may be first secured to point A at the extremity of one of the arms 77', and be continued tautly to the point B of the arm 77 on the same side of the ground electrode 59. From the point B the wire may be continued up to the point C of the arm 79, then horizontally across to the point D of the arm 78, then downwardly to the point E at the extremity of the arm 76. From point E the wire may be horizontally strung to the point F at the end of the arm 76', then upwardly to the end G of the arm 78', horizontally across to the point H at the end of the arm 79', and then vertically downward back to its starting point A. Any suitable expedient may be employed to secure the wire at the different turning points.

It is to be understood, of course, that suitable unidirectional energy is supplied to the precipitator apparatus, and this is represented in the various embodiments by the grounding of the casing which automatically grounds the ground electrodes and the un-insulated plates carried in direct conductive contact with the casing. The positive terminals of the unidirectional voltage is indicated by the (+) signs attached to the ionizing wire supports and to the spacing bar of the insulated plates. Accordingly, the embodiment described is operative with what is known as positive ionization on the wires. Obviously negative ionization and other methods of energizing the electrodes may be employed.

While we have described our invention in the

preferred form of embodiment, it is to be distinctly understood that many equivalents and modifications may be employed following the teachings of our invention.

We claim as our invention:

1. In a device of the class described generally having an ionized zone and a precipitating zone successively in the path of a gas-flow for the cleaning of particulate matter from the gas, an outer metallic casing generally rectangular in cross-section transverse to the gas-flow thereby presenting pairs of opposed sides in the direction of gas-flow, ionizing means comprising wire means insulatedly spaced from said casing sides, said wire means comprising ionizing wire portions transverse to the gas-flow paralleling a pair of said opposed sides, and ionizing end wire portions in proximity to the second pair of said opposed sides, said end wire portions being taut and having one directional component in the direction of gas-flow and another perpendicular to the gas-flow but transverse to the first said wire portions.

2. The structure of claim 1 characterized by the first said wire portions and said end wire portions being continuous wire.

3. In a device of the class described generally having an ionized zone and a precipitating zone successively in the path of a gas-flow for the cleaning of particulate matter from the gas, an outer metallic casing generally rectangular in cross-section transverse to the gas-flow thereby presenting pairs of opposed sides in the direction of gas-flow, ionizing means comprising wire portions transverse to said gas-flow paralleling a pair of said opposed sides but spaced from the other pair of said opposed sides, thereby leaving spaces therewith, said ionizing means further comprising an additional ionizing wire for creating an ionized field in the direction of one side of said other pair of opposed sides for charging dust in the associated one of said spaces, said additional wire being of an extent to create an adequately ionized field in the last said one space, said field extending substantially between the first said pair of opposed sides.

4. In a device of the class described generally having an ionizing zone and a precipitating zone successively in the path of a gas-flow for the cleaning of particulate matter from the gas; an outer metallic casing having pairs of opposite sides; ionizing means comprising a taut ionizing wire parallel to and spaced from a said pair of opposed sides, said wire being transverse to the gas-flow, and ground electrodes paralleling said wire, end supports for said wire supported so that said supports and said wire are spaced from another pair of said pairs of opposed sides thereby leaving spaces therewith, said ionizing means including an additional taut ionizing wire means supported by said supports for insuring copious ionization of the portion of the gas which flows past the vicinity of said supports, and the portion of the gas which flows through said spaces.

5. In a device of the class described generally having an ionizing zone and a precipitating zone successively in the path of a gas-flow for the cleaning of particulate matter from the gas; an outer metallic casing having pairs of opposite sides; ionizing means comprising a taut ionizing wire parallel to and spaced from a said pair of opposed sides, and ground electrodes paralleling said wire, supporting means for said wire, and additional ionizing means at one or more of said supporting means comprising an ionizing wire having a directional component perpendicular to the direction of the first said wire, the second said wire having both ends contacting and positioned by the last said supporting means.

6. In a device of the class described generally having an ionizing zone and a precipitating zone successively in the path of a gas-flow for the cleaning of particulate matter from the gas; an outer metallic casing having pairs of opposite sides; ionizing means comprising a taut ionizing wire parallel to and spaced from a said pair of opposed sides, and ground electrodes paralleling said wire, end supports for said wire supported so that said supports and said wire are spaced from another pair of said pairs of opposed sides thereby leaving spaces therewith, said ionizing means including an additional taut ionizing wire at one of said spaces for ionizing said one space, said last wire being spaced from said first wire in a gas-flow direction and disposed substantially transverse to the gas-flow and to the first said wire.

7. An item for an electrical precipitator which removes particulate matter from gases by providing an ionizing zone through which the gas flows so that the particulate matter may be charged, comprising a pair of end supports secured in spaced relation, and a taut ionizing wire, said end supports having arms to which said wire may be secured starting at one arm of one support and extending to a similar arm of the second support, the wire thereafter extending and fastened to other arms of said second support with component directions perpendicular to the line of the wire between the first two said arms.

8. An item for an electrical precipitator which removes particulate matter from gases by providing an ionized zone through which the gas flows so that the particulate matter may be charged, comprising a pair of end supports secured in spaced relation, and a taut ionizing wire, said end supports having arms to which said wire may be secured starting at one arm of a first support and extending to a similar arm of the second support, the wire thereafter extending and fastened to other arms of said second support with component directions perpendicular to the line of the wire between the first two said arms, the wire thereafter extending back to the said first support in spaced relation to said line.

9. An item for an electrical precipitator which removes particulate matter from gases by providing an ionized zone through which the gas flows so that the particulate matter may be charged, comprising a pair of end supports secured in spaced relation, and a taut ionizing wire, said end supports having arms to which said wire may be secured starting at one arm of a first support and extending to a similar arm of the second support, the wire thereafter extending and fastened to other arms of said second support with component directions perpendicular to the line of the wire between the first two said arms, the wire thereafter extending back to the said first support in spaced relation to said line, and then fastened to other arms of said first support with component directions perpendicular to said line.

10. A device of the class described generally having an ionizing zone and a precipitating zone in the path of a gas-flow for the cleaning of particulate matter from the gas, comprising a metallic casing, ionizing means for establishing said ionizing zone, said ionizing means including an ionizing wire, end supports for said wire, means for securing said end supports in spaced relation,

and insulated from said casing, each of said end supports having a plurality of arms, the arms of each support having end portions spaced from each other, said ionizing means comprising additional ionizing electrode means extending between and positioned by said end portions of said arms.

11. A device of the class described generally having an ionizing zone and a precipitating zone in the path of a gas-stream for the cleaning of particulate matter from the gas, comprising conduit means defining the transverse boundary of said gas-stream, ionizing means for establishing said ionizing zone, said ionizing means including a discharging electrode means, and a cooperating field-establishing electrode means associated with said discharging electrode means, said field-establishing electrode means including curved non-discharging electrodes around said conduit means along the boundary of said gas-stream, said discharging electrode means including a plurality of ionizing electrodes substantially paralleling said non-discharging electrodes, said ionizing electrodes being in said gas-stream inward of said non-discharging electrodes and having portions in spaced relation, said field-establishing electrode means comprising an additional non-discharging electrode between the said spaced portions of said ionizing electrodes.

12. In a device of the class described generally having an ionizing zone and a precipitating zone successively in the path of a gas-flow for the cleaning of particulate matter from the gas; an outer metallic casing having pairs of opposed sides; ionizing means comprising a taut ionizing wire parallel to and spaced from a said pair of opposed sides, and curved ground electrodes paralleling said wire, end supports for said wire, means for supporting said end supports so that said supports and said wire are spaced from another pair of said pairs of opposed sides thereby leaving spaces therewith, said ionizing means including an additional taut ionizing wire for ionizing one of said spaces, said last wire being spaced from said first wire in a gas-flow direction and disposed transverse to the gas-flow and the first said wire, the last said pair of opposed sides having a curved ground electrode substantially parallel to said additional ionizing wire for establishing an ionized electrostatic field therewith.

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