Nov. 12, 1940. R. A. NIELSEN 2,221,601

IONIZING WIRE SUPPORT, ESPECIALLY FOR ELECTRICAL PRECIPITATORS

Filed July 26, 1939 2 Sheets-Sheet 1

Fig. 1.

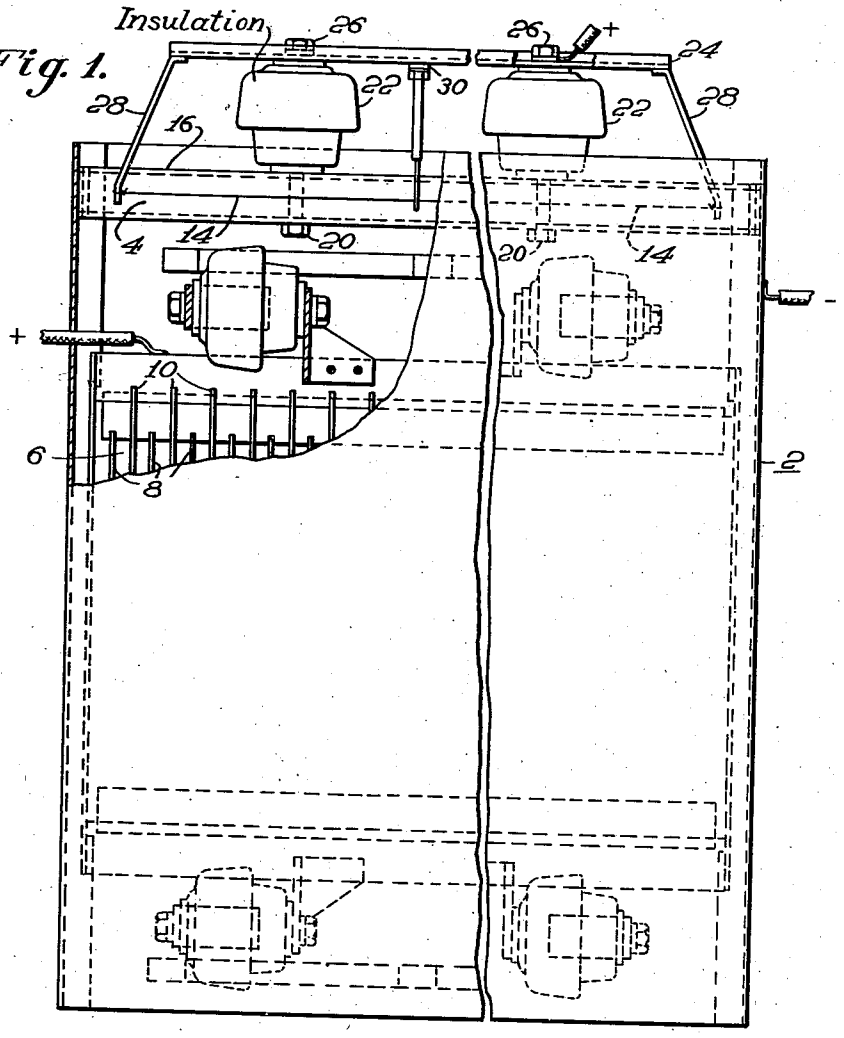


Fig. 2.

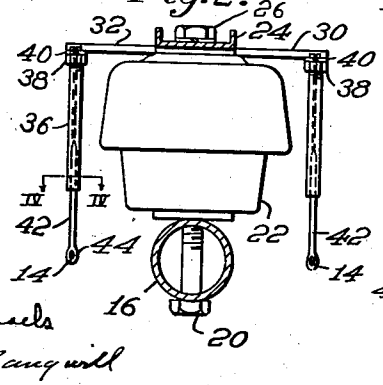


Fig. 3.

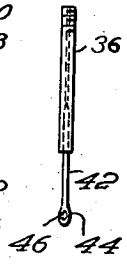


Fig. 5.

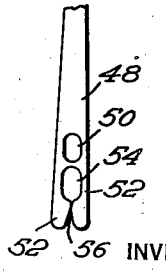
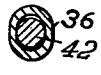


Fig. 4.



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Fig. 6.

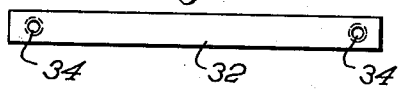


Fig. 7.

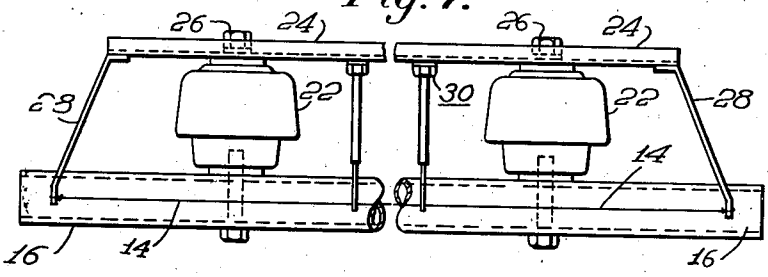


Fig. 8.

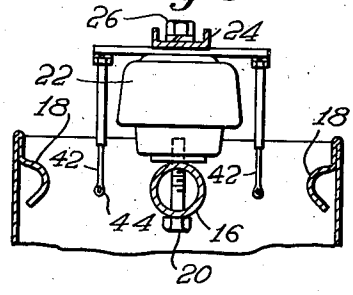
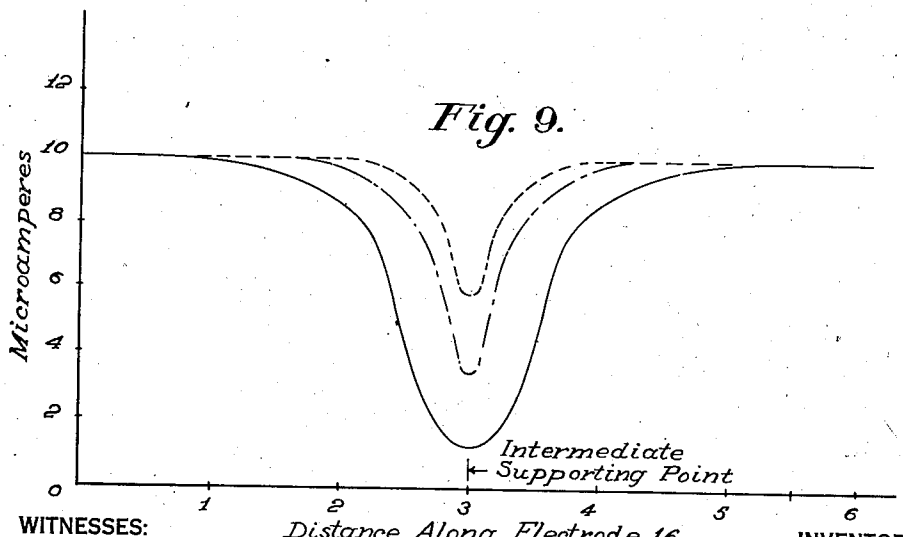


Fig. 9.



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Patented Nov. 12, 1940 2,221,601

UNITED STATES PATENT OFFICE

2,221,601

IONIZING WIRE SUPPORT, ESPECIALLY FOR ELECTRICAL PRECIPITATORS

Russell A. Nielsen, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 26, 1939, Serial No. 286,589

11 Claims. (Cl. 183—7)

My invention relates to electrical precipitators employed to electrically precipitate from air, or other gaseous medium, any contained, or suspended, dust particles, or fogs, or other particulate matter, and which, for convenience, is hereinafter generically referred to as dust.

The present invention is an improvement over the gas purifying precipitator comprising the subject matter of Patent No. 2,129,783 issued to G. 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 separate precipitator chamber, a significant feature of the precipitator being that the ionizing wire is of such small diameter that practically utilizable ionization of the suspended particles of dust may be obtained at a wire-charging voltage producing ionizing currents at which negligible ozone generation occurs, and 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 aforesaid Penney patent, the wire is much finer than this upper limit, and is frequently as little as 5 mils in diameter or even less. The ionizing wire is usually maintained in some degree of tension, although this is not so essential.

In order to minimize breakage and to facilitate handling of the equipment, the end supports between which the wire is strung must be fairly rigid and strong. If the wire is longer than about a foot, it is preferable that it be supported or confined at frequent intervals along its length, say about every 8 inches, in order to protect it against vibration and breakage, or in remote cases, against excessive shock. The prior supports introduced dark spots along the wire extending from about one-half to three-quarters of an inch, or somewhat more, on either side of the supports, defining regions at which the ionizing current is inadequate so that the dust carried by the air or gas passing through these regions is not sufficiently electrically charged, thus reducing the efficiency of the precipitator. It is an object of my invention to avoid the foregoing defects.

It is a further object of my invention to provide intermediate supports for an ionizing wire of an electrical precipitator which will have utilizable ionization in the aforesaid dark regions, thereby raising the cleaning efficiency of the system.

It is a further object of my invention to provide an intermediate support for ionizing wires which is easy to assemble, and inexpensive to manufacture.

To accomplish the foregoing object of my invention, I provide some or all of the wire supports with means which do not seriously or appreciably shield the wire and thereby cut down the ionization. In other words, the dark regions are shrunk. I have found that I may employ a needle through the eye of which the wire can be strung, and that such a support or confining means does not seriously affect the ionization of such supporting or confining points.

Generally, I have found that the supporting means for the wire first, should have no sharp points and secondly, should be relatively thin for some extent from the wire.

By avoiding the use of points, concentrated electrostatic fields are eliminated, and I thereby avoid visible or audible point discharges. While points might yield satisfactory ionization, they are entirely too erratic in operation, and it has been found that such points may become the source of objectionable ozone generation even though when originally installed, the apparatus appeared to function properly. When using thin, rounded supports for the wire as I do, the ionization near the supports can be more readily controlled and is consistent through long periods of operation.

The other desired property of the support, namely, that it be relatively thin, minimizes the shielding effect of it and I have found that the thinner the support, the smaller the area of shielding, the only limitation to the thinness of the support being the necessary strength to permit it to perform its function as a supporting or confining means without danger of breaking or bending.

With the foregoing and other objects in view, my invention consists in the features, elements, and apparatus hereinafter described and claimed, and illustrated in the accompanying drawings on varying scales, wherein:

Figure 1 is a view, partly in elevation and partly in section, of a precipitator cell unit having separate ionizing and precipitating chambers, and embodying my invention;

Fig. 2 is a sectional view of part of the ionizing chamber of the cell unit of Fig. 1, showing intermediate supporting means for the ionizing

wire which, in this case, comprises an assembled U-shaped bracket whose arms terminate in needles;

Fig. 3 is an elevational view of one of the arms of the ionizing wire supporting bracket of Fig. 2 but including a somewhat modified needle;

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 2;

Fig. 5 is an elevational view of the eye portion of a self-threading needle adapted to be used in place of the ordinary needles shown in Figs. 2 and 3;

Fig. 6 is a plan view of the cross bar or bridge between the arms of the ionizing supporting bracket of Fig. 2;

Fig. 7 is an elevational view of part of the ionizing unit, being broken away to indicate extra length and showing two intermediate supporting brackets;

Fig. 8 is a sectional view similar to Fig. 2 but showing additionally the relation of the ionizing unit of Fig. 2 to the sides of the precipitator casing; and

Fig. 9 shows curves representing the ionizing current along the ionizing wire for different types of intermediate supports.

A cell unit for an electrical dust precipitator is represented somewhat schematically in Figure 1, and, except for the features of my invention, may be constructed in accordance with the teachings disclosed and claimed in patent application Serial No. 286,577, of E. H. R. Pegg, filed concurrently herewith, and assigned to the Westinghouse Electric & Manufacturing Company. Such a cell unit comprises an outer casing 2 having a dust-ionizing zone or chamber 4 and a dust-precipitator or dust-collecting zone or chamber 6.

The casing itself is preferably rectangular in cross section, and has secured therein for the precipitator zone, collector plates 8 which may be grounded, alternating with insulated collector plates 10. Air to be treated is drawn or forced through the top of the unit past the ionizing zone 4 where the dust is suitably charged electrically, and is then drawn downwardly through the precipitating zone 6 where the electrically charged dust is attracted to the collector plates, the air passing outwardly from the bottom of the casing from where it may be led away by any suitable means in any suitable manner.

The ionizing zone usually comprises a plurality of ionizing wires disposed transversely with respect to the direction of a gas-flow, each ionizing wire being disposed intermediate two relatively large grounded electrodes with curved peripheries in cross section so as to present curved surfaces toward the ionizing wire. In the instant construction and referring to Figs. 1, 2, 7 and 8, ionizing wires 14 are disposed between a central, tubular ground electrode 16 and semi-cylindrical electrodes 18 forming part of the casing 2. The ground electrode 16 extends the length of the casing 2 and has suitable means at each end whereby it may be secured to opposed sides of the casing.

The construction of the ionizing unit is described in greater detail in the aforesaid application of E. H. R. Pegg and generally comprises a removable unit built about the electrode 16.

The unit comprises a plurality of bolts 20 extending through the electrode 16 and spaced along its length, the bolts securing one end of insulators 22 to the electrode. To the other end of the insulators 22 is secured an elongated bar 24 in the form of a low channel. Bolt means 26 cooperating with the other ends of the insulators 22 maintain the channel bar 24 parallel to the ground electrode 16. The bar 24 is somewhat shorter than the ground electrode 16 and has its ends symmetrically spaced with respect to the ends of the ground electrode.

End brackets 28 are welded or otherwise secured to the ends of the bar 24, and serve as a means for securing an end of the ionizing wire 14 on each side of the electrode 16. The extremities of the arms of the brackets 28 are provided with notches, and the end of the ionizing wires may be turned once or twice about the extremities of the arms of the brackets 28 with portions lying in these notches, after which ends of the wires may then be given a turn or two about the stretched part of the wire lying between the two opposed arms of the brackets 28. In terminating the wires, it is preferable to dispose the extreme cut-off ends as close to the arms of the brackets 28 as conveniently suitable so that the sharp ends of the wire will be within the shielded area of the extreme portions of the arms of the brackets.

The construction thus described results in the ionizing wire being suspended, preferably in tension, between the end supporting brackets 28 carried by frame work supported on the ground electrode 16 so that the entire structure comprises a single unit. However, for extra long units it is usually necessary to support or confine each wire at one or more intermediate points also, and to this end I have devised a novel intermediate support, indicated in its entirety by the reference character 30, which will not adversely affect the efficiency of the precipitator to any objectionable degree. The number of such intermediate supports will, of course, depend upon the length of the ionizer unit, and in Fig. 1, one support 30 is shown, while in Fig. 7, two such supports are shown.

Each intermediate support is U shaped in final form and comprises a metal bar 32 welded or otherwise secured at its center transversely to the metal bar 24. The bar 32 is provided with two threaded holes 34, the distance between these two apertures being approximately equal to the spacing between the two ionizing wires 14.

Each arm of the support 30 comprises a metal tube 36 having a fine bore therethrough and threaded at one end so that it may be secured in one of the said holes 34, a lock nut 38 and lock washer 40 serving to more securely hold the tube 36 in place, although it is obvious that the tube 36 may be secured to the bar 32 by any other suitable means, either removably or fixedly. The tube 36 is approximately two-thirds the distance between the bar 24 and the center of the ground electrode 16, and each arm is provided with a metal needle 42 occupying the remainder of the distance. The needle has its point inserted in the bore of the tube 36, and the tube can then be swaged sufficiently out of round as shown in Fig. 4 for holding the needle securely in the tube. The bore, of course, should be large enough to permit the needle to be inserted therein, but preferably, small enough to provide a snug fit originally. The eye 44 of the needle is preferably aligned with the ionizing wire 14 so that the wire may be threaded through it, but a slight tolerance may be permitted with respect to the alignment of the eye 44. The needle itself either supports the wire 14 or confines it so that any vibration of the wire will be damped, and it is to be understood that I employed the term "sup-

porting the wire" for either, or both, of these purposes.

The needles of Figs. 2 and 8 are of the ordinary type having an eye which requires threading of the wire through the eye, but in Figs. 3 and 5 I show other types of needles which may be satisfactorily employed, and which are of the self-threading type.

The needle of Fig. 3 is similar in all respects to that in Fig. 2, but has been provided with a cut slot 46 so that it is self-threading, the slot being wide enough to permit the ionizing wire to be slipped through it and is preferably disposed at an angle to the horizontal.

Fig. 5 shows the eye portion of a common type of self-threading needle 48 provided with a completely enclosed eye 50 and two separable jaws 52 on each side of an eye 54. The ends of the jaws 52 are rounded to provide a notch 56 so that the needle may be threaded into the eye 54 by simply slipping the wire into the notch and forcing it through the jaws.

The heads of the needles commonly obtainable are usually rounded and this type of needle is always preferred in constructing the supporting member 30. In fact, even the self-threading types of needle have the extremities of their jaws rounded, and it has been found that this is almost invariably the case in needles commercially available.

I have found that by employing supporting elements in the form of needles at the intermediate supporting points of the ionizing wires, I substantially eliminated to a large extent the shielded ionizing region about the intermediate supporting point.

Fig. 9 is a curve indicating the improved results I obtained using 13.5 kilovolts between an ionizing wire and the ground electrode, the ionizing wire being 4.5 mils and the ground electrodes having an outside radius of curvature of about $\frac{5}{8}$", and a length of 14", with the axes of two adjacent ground electrodes spaced $3\frac{3}{4}$". The top of the needle holder or tube 36 was approximately $1\frac{1}{4}$" from the wire.

The solid line curve of Fig. 9 represents the ionizing current along the ground electrode on both sides of an arm, such as a tube 36 of about $\frac{3}{16}$" diameter, or a bar $\frac{1}{8}$" by $\frac{3}{16}$" extending the full distance between the wire and bar 32, the wire being secured to the top of the arm. It may be observed that there is a large region extending somewhat over one-half inch through which there is very little ionization, and that the region through which there is less than normal ionization is spread out. The dot-dash line represents a curve obtained using a self-threading needle of the type shown in Fig. 5 having a diameter of 34 mils while the dash line represents the ionizing current for a similar needle but having a diameter of 24 mils. The value of current represents that flowing to a $\frac{1}{4}$" conducting band insulated from but firmly wrapped around electrode 16 at different distances from the support.

I have found that the smaller the diameter of the needle the greater the ionization current obtained in the region about the supports, and as may be observed from Fig. 9, the use of the 24 mil self-threading needle results in utilizable ionization across the whole region. Additionally, I have found it best to dispose the wire as close to the tip of the needle as possible. These, of course, are factors in the consideration of the type of needle to be used. There are, however, two factors limiting the fineness of the needles that may be used, and these are; first, that the needle may become so fine that its tip approaches a point so that erratic point discharge might occur, and second; too fine a needle may result in too flimsy a support, one which is subject to bending, and perhaps breakage.

It is preferable to use a long needle since I have found that if the tube 36 is too close to the ionizing wire, the minima shown in Fig. 9 tend to fall lower and lower until finally the solid line is approached. A long thin needle supported with its eye about $1\frac{1}{4}$" from the tube 36 gave satisfactory results and the size of the needle, that is, its thickness and length, is limited only by the factors of strength required for a practical application of my invention.

As a result of my invention, the amount of ionization is increased and the extent of the formerly shielded dark regions decreased about the intermediate supports of the ionizing wires 14. When I refer to shielded or dark regions, I mean the effect of massive wire-supporting arms not provided with the means for reducing the shielding effect.

Where sharp points are utilized at the intermediate supports, erratic behavior is usually the result.

A positive point discharge might occur which behaves as follows: As the electrostatic field around the point is increased, a short brush visible in a dark room is first observed accompanied by a hissing sound. This brush discharge causes a generation of ozone, but at slightly higher voltages the brush disappears and only a faint blue dot at the point is visible and the ozone generation drops off. No sound is audible; nevertheless it is discharging more current than before. At still higher voltages a larger brush extending toward the other electrode will form and increases in size and noisiness until an arc occurs. When a point is discharging as a brush, ozone is generated in amounts much greater than when it is quiet and shows only a blue dot.

However, a point discharge having low ozone generation and utilizable ionization is hard to control and will break into an ozone-generating discharge upon the slightest provocation, as for example, altering the conditions of humidity or changing the carbon dioxide content even slightly. Moreover, the field about a point is more highly concentrated than that about a curved surface so that the brush discharge will start at lower voltages than required to cause a similar discharge from the rounded extremities of a needle. Accordingly, I may operate an ionizing unit constructed in accordance with my invention at somewhat higher voltages than would be the case if the intermediate wire supports contained points in proximity to the ionizing wire.

Another important feature of my invention lies in the practicability of my novel intermediate support. The ionizing wire can be threaded and unthreaded into the eye 54 of the needle without disturbing the rest of the structure. Moreover, inasmuch as the arms of the intermediate brackets are removably secured to the bar 32, it is possible to change the arms in the event they become bent or otherwise defective. It is even possible to interchange different types of arms with other arms having different construction and functional characteristics.

While I have described my invention in the preferred forms of embodiments, and have suggested limits in accordance with my best understanding of the same at the present time, I de-

sire it to be distinctly understood that I am not altogether limited to these limits or understandings, or to the forms of embodiments shown in the drawings since the equivalent of a needle can be readily manufactured, the needle being preferred at present because of the ease with which it can be procured and because of its relatively small cost.

I claim as my invention:

1. A device of the class described generally having an ionizing chamber and a precipitating chamber successively in the path of a gas-flow; said ionizing chamber having ionizing means disposed transverse to the gas-flow, said ionizing means comprising ground electrode means, an ionizing wire, and supporting means to support said wire insulated from and in spaced relation to said ground electrode means, said supporting means comprising a supporting element contacting said wire and having rounded exterior surfaces thereby to avoid point discharges.

2. An item for an electrical precipitator which removes dust from gases by providing an ionizing zone through which the gas flows so that the dust therein may be ionized, comprising an elongated, relatively large electrode, a plurality of insulators, means to secure one end of said insulators and said electrode together with the insulators spaced along said electrode, armed brackets supported by the other end of said insulators, a relatively fine ionizing wire, the arms of said brackets forming supports for supporting said wire in spaced and insulated relation to said electrode, one of said arms comprising a needle having its point away from said wire, and an eye through which said wire passes.

3. A device of the class described generally having an ionizing zone and a precipitating zone successively in the path of a gas-flow; said ionizing changer having ionizing means disposed transverse to the gas-flow, said ionizing means comprising ground electrode means, an ionizing wire, and supporting means to support said wire insulated from and in spaced relation to said ground electrode means, said supporting means comprising a member having a needle protruding therefrom with its eye away from said member, said wire passing through said eye.

4. An item for an electrical precipitator which removes dust from gases by providing an ionizing zone through which the gas flows so that the dust therein may be ionized, comprising, an elongated substantially-straight tubular electrode, a plurality of insulators, means to support an end of each of said insulators on said electrode intermediate the ends thereof, a bar secured across the other ends of said insulators and extending substantially parallel to said electrode but of lesser length with the ends of the bar within the ends of the electrode, a plurality of spaced U-shaped brackets secured to said bar with their arms straddling said electrode, and in spaced relation thereto, said brackets comprising a second bar transverse to said first bar, said arms being removably secured to and extending from the said second bar, each said arm including an end portion comprised of a needle with its eye away from said bar.

5. In an electrical precipitator which removes dust from gases by providing an ionizing zone through which the gases pass so that the dust therein may be ionized, the combination with a relatively fine ionizing wire, said gases passing near said wire whereby the dust in the said gases is charged, and means for supporting said wire at each of its ends, of means for confining said wire intermediate its ends comprising a bracket having a bar, and an arm extending therefrom, said arm comprising a relatively rigid, thin metallic rod for reducing the shielding effect of said rod on ionizing current, said rod having a free end with rounded edges, said free end being provided with an opening through which said wire passes.

6. In an electrical precipitator which removes dust from gases by providing an ionizing zone through which the gases pass so that the dust therein may be ionized, the combination with a relatively fine ionizing wire for ionizing said zone for charging the dust in the said gases, of means for supporting said wire in said zone, comprising a thin metallic rod having a free end with rounded edges to reduce possible discharges from said edges, said free end being provided with an opening through which said wire passes, said rod being of a relatively small size whereby the shielding effect of said rod on the ionizing current from said wire near said rod is limited.

7. In an electrical precipitator which removes dust from gases by providing an ionizing zone through which the gases pass so that the dust therein may be ionized, the combination with a relatively fine ionizing wire, and insulating means, of means to confinedly support said wires from said insulating means, the said supporting means comprising an elongated bar, an arm removably secured to each end of said bar, and a needle for each arm, each of said needles being secured to its corresponding arm with its eye outward, the said wires passing through said eyes.

8. In an electrical precipitator which removes dust from gases by providing an ionizing zone through which the gases pass so that the dust therein may be ionized, the combination with a relatively fine ionizing wire, and insulating means, of means to confinedly support said wires from said insulating means, the said supporting means comprising an elongated bar, an arm removably secured to each end of said bar, and a needle for each arm, each of said arms having a small bore therein into which the pointed end of the corresponding needles extend, the arm and its corresponding needle being swaged with the eye of the needle extending outward, the said wires passing through said eyes.

9. In a device of the class described generally having an ionizing chamber and a precipitating chamber successively in the path of a gas-flow; said ionizing chamber having ionizing means disposed transverse to the gas-flow, said ionizing means comprising relatively large ground electrode means, a relatively fine ionizing wire, and supporting means to support said wire insulated from and in spaced relation to said ground electrode means, said supporting means comprising a relatively small supporting element contacting said wire and having rounded exterior surfaces thereby to avoid point discharges.

10. An electrical precipitator for cleaning dust from a flowing gas, said precipitator comprising, an ionizing wire, means for supporting said wire comprising end supports and intermediate confining means, said gas flowing near said wire and confining means whereby the dust in the gas may be charged, said confining means comprising a relatively thin metallic rod having a free end with rounded edges, said free end being provided with an eye, said rod being transverse to said wire,

said wire passing through said eye, and said eye being of the self-threading type.

11. An electrical precipitator for cleaning dust from a flowing gas, said precipitator comprising an ionizing wire having a diameter of less than 32 mils, and of such fineness that substantially utilizable ionization is obtained with negligible ozone generation, and supporting means for supporting said wire, said supporting means comprising end supports and intermediate confining means in the path of the gas-flow, said confining means comprising a thin rod having a free end provided with a small opening through which said wire passes, whereby vibration of said wire is reduced, said rod being of a relatively small cross-sectional area whereby any shielding effect on the ionizing current from said wire near said rod is limited.

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