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ELECTRICAL PRECIPITATORS

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2 Sheets-Sheet 1

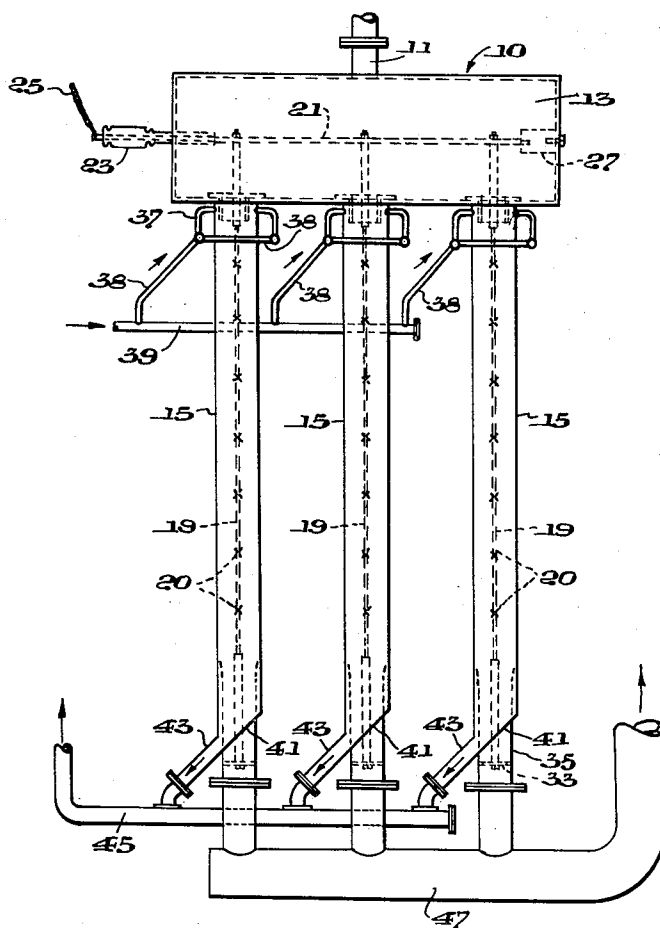


Fig. 1.

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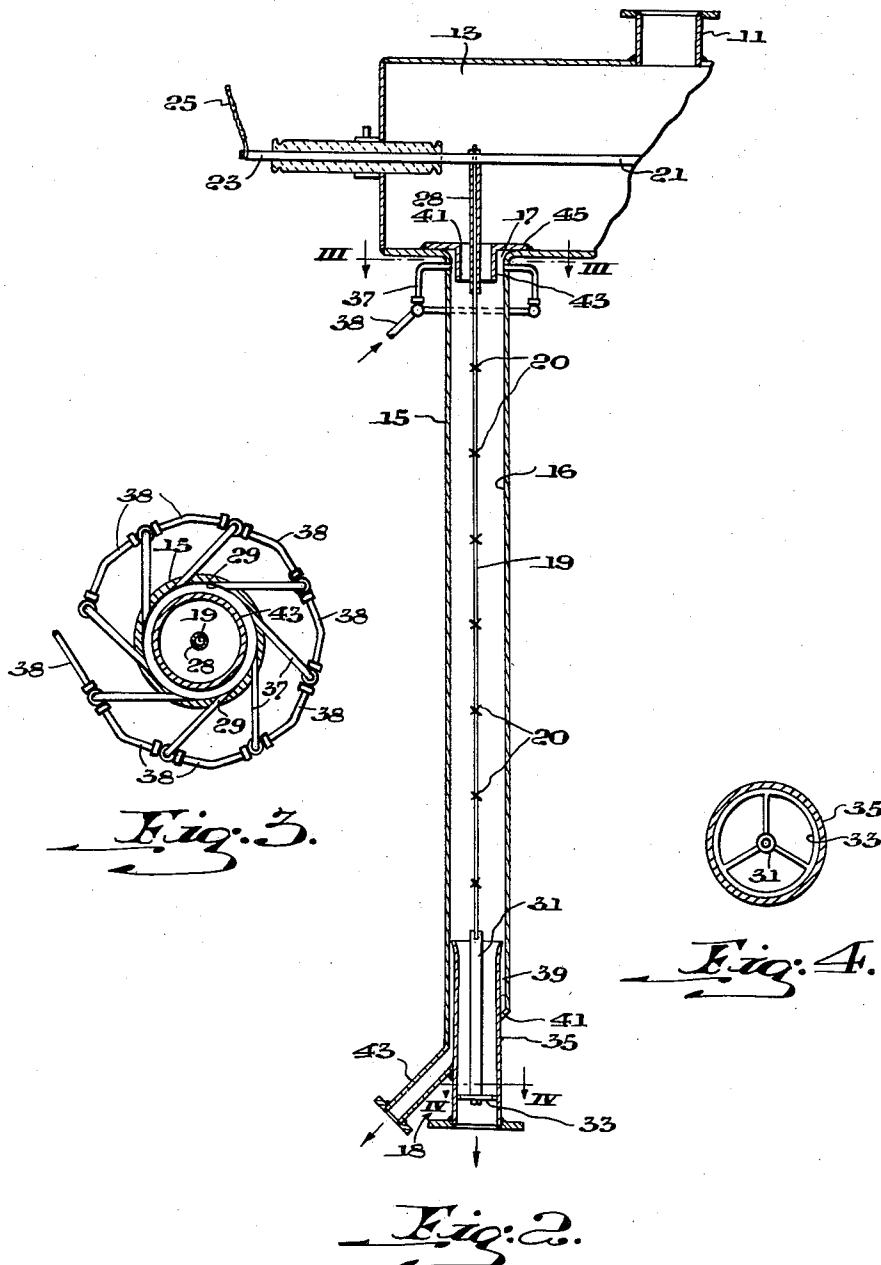
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ELECTRICAL PRECIPITATORS

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2 Claims. (Cl. 183—7)

This invention relates to apparatus for the separation of suspended particles from gases and more particularly to an improved electrical precipitator.

A primary problem in prior electrical precipitators has been the tendency for the suspended foreign particles in the gases to accumulate on the walls of the collector electrode such that the efficiency of the precipitator is materially reduced. One mode of removing this accumulation from the collector electrode is to flow a film of water over the electrodes so as to wash the accumulation therefrom. As practiced heretofore, the water is applied so as to flow countercurrent to the flow of the gases. Usually, the rate of flow of the water to form a film sufficient to wash the particles from the electrode walls is controlled by weirs located adjacent the top of the plate.

This prior system for removing the accumulation has not been completely satisfactory because such countercurrent flow of the gas relatively to the water flow creates a turbulence causing the water containing the suspended particles to separate from the wall and mingle with the gases flowing through the precipitator chamber. In the absence of such a continuous film and entrainment of the water and suspended particles within the gas stream, arcing and short circuiting oftentimes occurs. Such arcing reduces the operating efficiency of the precipitator. In order to minimize the arcing in these prior precipitators, the rate of flow of the gas through the precipitator is maintained at relatively low velocities, as for example, between the rates of 3 to 6 feet per second such that the liquid remains on the collecting electrode surface and the power input to the discharge electrodes is maintained at a relatively low level as for example 20 kv. Under these operating conditions, the residence time of exposure of the gases within the precipitator chamber must be prolonged to obtain an efficient removal of the particles from the gas. Accordingly, the equipment for carrying out the precipitation of the suspended particles from the gases by these prior apparatus are of large dimensions and expensive to construct.

It is an object of the present invention to provide an improved electrical precipitator utilizing a liquid which washes the accumulated particles from collecting electrodes in a manner such that the difficulties encountered heretofore are overcome.

It is a further object to provide an improved electrical precipitator incorporating therein a novel arrangement for introducing a liquid on the electrode plates such that it forms a film thereon and flows co-current with the flow of gas. With the liquid flow arranged to flow co-current with the gases, it has been found that it is possible to increase the velocity of the gases through the precipitator and maintain the power input to the discharge electrode at levels such that the size of the precipitator unit may be maintained at a minimum.

This increase of velocity of the gases and high power input is accomplished by a novel arrangement for introducing the liquid on the collecting electrodes adjacent

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the gas inlet end so as to form a continuous uniform film which flows along the length of the collecting electrode toward the gas outlet end thereof.

Briefly, the novel arrangement comprises a tubular precipitating chamber having a gas inlet and an outlet; liquid inlet means adjacent said inlet arranged so as to introduce a thin continuous film on the inner walls of the cylinder; and a discharge electrode mounted axially within the chamber.

It is another object to provide a novel precipitating chamber constructed in a manner such that the liquid on the wall containing the foreign particles separated from the gas stream does not re-entrain with the cleaned gas stream at the outlet thereof.

It is a further object to provide an improved arrangement for introducing the liquid into the precipitating chamber such that a minimum amount of water is required to achieve a continuous uniform film on the collecting wall thereof such that it will be economically feasible to dispose of liquid containing the suspended particles as waste rather than treating the liquid to remove the particles and recycle the liquid. In instances where the solid particles are of economic value, it may still be desirable to recover them from the liquid.

More particularly, the present invention provides an electrical precipitator having a substantially vertically disposed cylindrical chamber of substantially uniform cross-section and having an upper gas inlet and a lower outlet. Adjacent the upper gas inlet, there is provided a liquid port means arranged so as to introduce a thin continuous film tangentially on the inner walls of said cylinder. In this manner, with the port means located adjacent the upper end, the liquid forms a continuous film on the inner wall surface of the chamber such that the film flows downwardly co-currently with the gases flowing therethrough. Mounted axially within the precipitator chamber for charging the particles in the gas stream such that the particles are concentrated on the inner wall of the cylinder, is an axially extending electrode adapted to be connected to a suitable source of power. The suspended particles are concentrated toward the collecting electrode wall of the chamber and the liquor flowing as a continuous film downwardly toward the outlet carries the particles concentrated thereon toward the outlet which is provided with a means for discharging the liquid containing the particles separately from the cleaned gas.

Further objects and features will hereinafter appear.

Reference will now be made to the accompanying drawings which illustrate and exemplify one embodiment of the invention in a preferred form of construction.

Fig. 1 represents a front elevational view of an electrical precipitator embodying the present invention.

Fig. 2 represents fragmentary front elevational view of the precipitator of Fig. 1 showing one of the precipitator chambers with parts cut away to show underlying details.

Fig. 3 is a view taken along the lines 3—3 of Fig. 2, showing details of the liquid introducing means.

Fig. 4 is a view taken along the lines 4—4 of Fig. 2, showing the spider for attaching the lower end of the electrode to the precipitator chamber wall.

Referring now to the drawings, there is disclosed a precipitator 10 having a main gas inlet 11 communicating with a plenum chamber 13. Equally spaced and connected to the lower wall of the plenum chamber 13 are a plurality of elongate vertically disposed tubular precipitating chambers 15, the wall 16 of which serves as a collecting electrode. In the preferred form as shown, the chambers 15 are of uniform circular cross-section. Each of the chambers is provided with a gas inlet 17 communicating with the plenum chamber 13 and an outlet 18.

Disposed axially within each of the chambers through

the gas inlet 17 is a discharge electrode 19. The discharge electrode 19 is connected at its upper end to a conducting rod 21 extending horizontally through the plenum chamber 15. One end of the rod 21 projects through an insulator 23 mounted on the plenum chamber side wall. Connected to the terminal end of the rod 21 is a lead 25 extending from a suitable source of power (not shown). The other end of the rod 21 is attached to the opposite side wall by way of an insulator 27. The upper end of the electrode 19 is encompassed by an insulating shield 28 of a suitable ceramic material which extends into the precipitating chamber 15 below the liquid ports 29 located adjacent the inlet 17. The lower end of the electrode 19 is supported by way of an insulating rod 31 on an open webbed spider 33, Fig. 4, mounted in a clean gas exhaust tube 35 located at the outlet 18. While any suitable discharge electrode may be used in the preferred form, the electrode 19 as shown is of the type having barbs 20 equally spaced along the length thereof.

The liquid ports 29 serve to introduce liquid into the precipitating chamber so as to form a thin uniform continuous film along the walls thereof and wash the particles collected and concentrated adjacent the walls toward the outlet 18. As shown in Fig. 3, the inlet ports 29 are equally spaced to provide adequate wetting and film formation on the inner wall of the cylindrical precipitating chamber. Entering each of the ports 29 and arranged tangentially to the inner wall of the chamber 15, is one end of a tube 37 connected at its other end by way of pipes 38 to a main line 39 which is connected to a suitable source of liquid (not shown).

The precipitating chamber 15 adjacent the inlet 17 is provided with a shielding member 41 having a downwardly depending flange 43 spaced from the inner wall of the chamber 15 and extends below the liquid ports 29 and a horizontal flange 45 which is connected to the lower wall of the plenum chamber as by welding or the like. The flange 43 serves to shield the ports 29 from the gas turbulence which is normally present when the latter enters the precipitating chambers. In this manner, the tendency of the liquid to spray and enter the gas stream is substantially eliminated and the flow of liquid is initiated such that a smooth continuous film forms on the inner particle collecting wall 16 of the chamber 15. Furthermore, the angular arrangement of the horizontal and downwardly depending flanges 43 and 45 prevents the accumulation of particles which tend to form at the entrance of the chamber.

Each of the precipitating chambers 15 at its lower outlet 18 is provided with a means for conducting and discharging the cleaned gases substantially free of suspended particles separately from the liquid containing the suspended particles from the precipitating chamber.

As shown, this is accomplished by positioning the clean gas discharge tube 35 so as to project upwardly and coaxially into the outlet of the precipitator chamber 15. The outer wall of the tube is spaced from the inner wall of the precipitating chamber 15 such that a liquid passage 39 is formed through which the liquid carrying the suspended particles precipitate from the gas stream flows. The bottom 41 of the passage 39 is formed by an inclined base plate secured to the lower edge of the chamber 15 and is provided with a central opening on the edges of which the clean gas discharge tube 35 is secured as by welding. In order to reduce the turbulence of the clean gas as it flows from the precipitating chamber 15 into the clean gas discharge tube 35, the upper portion of the tube 35 is tapered outwardly toward the inner precipitator chamber wall. By reducing this turbulence of the clean gas at this location, the tendency for such turbulence to disrupt the liquid film on the precipitator chamber such that it becomes entrained within the gas is substantially prevented.

Communicating with the liquid passage 39 adjacent the

lower end of the inclined bottom 41 is a fluid discharge conduit 43 which communicates with a manifold 45 which collects the liquid for disposal. The clean gas discharge tubes 35 each communicate with a collecting manifold 47 which carries the gas to a header or storage tank for future use for its heating value or may pass through to a stack to be expelled to the atmosphere.

In a typical operation of the invention, the gases are introduced into the precipitator 10 through the inlet 11 into the plenum chamber 15. Advantageously, the gases are introduced at velocities as high as 20-60 feet per second, since such velocities permit large velocities of gas to be cleaned. These gases, depending on their origin, may contain suspended particles of fly ash, iron oxide, silica, dolomite or other dust particles having various characteristics with respect to their pH, resistivity and etc.

The gases containing the suspended particles flow into each of the precipitating chambers 15 past the shielding member 41 at the gas inlet 17 which, as pointed out above, serves to prevent the accumulation of particles.

The liquid is supplied to the ports 29 by way of the pipes 39 from the main line 39. The liquid is tangentially introduced onto the walls adjacent the upper end of the precipitating chamber 15. By the present invention, the number of ports and spacing thereof is arranged such that the total flow requirements of the liquid is maintained at a minimum. By maintaining the flow of liquid at a minimum, it is not essential that the liquid be recovered so as to remove the particles therefrom and recycle the former for future use. That is to say, the liquid containing the foreign particles may be disposed of as waste. Advantageously, there is supplied to each of the chambers 15, 0.5 to 5 gallons of liquid per 1000 cubic feet of gas flowing through each of the chambers. The exact quantity of water used will be determined to some extent by the particle content and characteristics thereof suspended in the gas. By introducing the water tangentially on the walls at equally spaced points, it has been found that a continuous film is more readily formed than has been possible by the structures used heretofore.

In the preferred form of carrying out the invention, ordinary tap water may be used as the liquid. However, under some circumstances, process water, black liquor, oil or the like may also be used. In this connection, if the liquid is of the type having value for future use in the particular installation in which the precipitator is to be employed, it is, of course, to be understood that it may be necessary to treat the liquid containing the dust particles to remove the latter therefrom such that the liquid may be recycled for reuse. It has also been found that if the characteristics of the dust particles collected on the wall are of a corrosive nature, additives may be added to the liquid to neutralize such corrosive action. Similarly, additives may be added to the liquid to increase or decrease the conductivity in the event that the suspended dust particles are of high or low resistivity.

As pointed out above, as the gases flow into the inlet 17 past the downwardly depending flange 43, the ports 29 are shielded such that the turbulence of the gases at the high velocities under which the precipitator is operated does not cause a spraying of the liquid away from the inner walls of the chamber 15. This feature of the invention is of significance since such spraying of the liquid onto the gas stream tends to cause a sparkover or accumulation between the discharge electrode and the inner wall of the chamber 15 such that the efficiency of the precipitator is reduced. By preventing such spraying, it is possible to apply higher power to the discharge electrode such that greater precipitation occurs within a shorter precipitating chamber. In the typical operation of the precipitator unit, a voltage between 25-75 kv., preferably 50 kv. is supplied. Further assisting and preventing the arcing in the vicinity of the inlet 17, the portion of the electrode adjacent the ports 29 is covered with the

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insulating shield 28. In this connection, it is to be noted that the insulating shield 28 projects below the lower edge of flange 43 such that arcing does not occur between the discharge electrode 19 and the flange 43.

The suspended particles in the gases are concentrated on and adjacent to the inner wall 16 of the chamber 15. Whereupon these particles are then washed downwardly by the liquid film flowing downwardly on the inner walls of the chamber 15. This flow of the liquid and the particles contained therein is co-current with the flow of gas toward the outlet 18. Hence, as the gases approach the outlet 18, there is formed a central zone of substantially clean gas and a liquid zone adjacent the wall containing the suspended particles. The clean gas flows through the clean gas discharge tube 35 to the manifold 45, while the liquid containing the suspended particles pass downwardly in the liquid passage 39 onto the inclined bottom 41 and into the liquid discharge conduit 43 to the manifold 45.

What is claimed is:

1. An electrical precipitator for separating suspended particles from a gas stream comprising a substantially vertically disposed cylindrical precipitating chamber of substantially uniform cross-section and having an upper gas inlet and a lower outlet, means located adjacent said upper gas inlet for distributing a thin continuous liquid film on the inner wall of said chamber, an annular plate mounted over said liquid film distributing means, a cylindrical flange projecting from said annular plate extending coaxially into said chamber and overlying said liquid film distributing means, and an electrode axially mounted in said chamber for charging said particles in said gas stream so that said particles are concentrated on the inner wall of said chamber within said liquid film.

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2. An electrical precipitator for separating suspended particles from a gas stream comprising a substantially vertically disposed cylindrical precipitating chamber of substantially uniform cross-section and having an upper gas inlet and a lower outlet, means located adjacent said upper gas inlet for distributing a thin continuous liquid film on the inner wall of said chamber, an annular plate mounted over said liquid film distributing means, a cylindrical flange projecting from said annular plate extending coaxially into said chamber and overlying said liquid film distributing means, an electrode axially mounted in said chamber for charging said particles in said gas stream so that said particles are concentrated on the inner wall of said chamber within said liquid film, and a clean gas discharge tube coaxially disposed into said outlet and having its innermost end tapered toward said chamber wall whereby the liquid film containing said particles passes between said discharge tube and said chamber wall and is separated from said clean gas which passes through the discharge tube.

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