Dec. 22, 1936. C. B. THORNE 2,064,960

METHOD OF AND APPARATUS FOR CLEANING GASES

Filed March 5, 1932 3 Sheets-Sheet 1

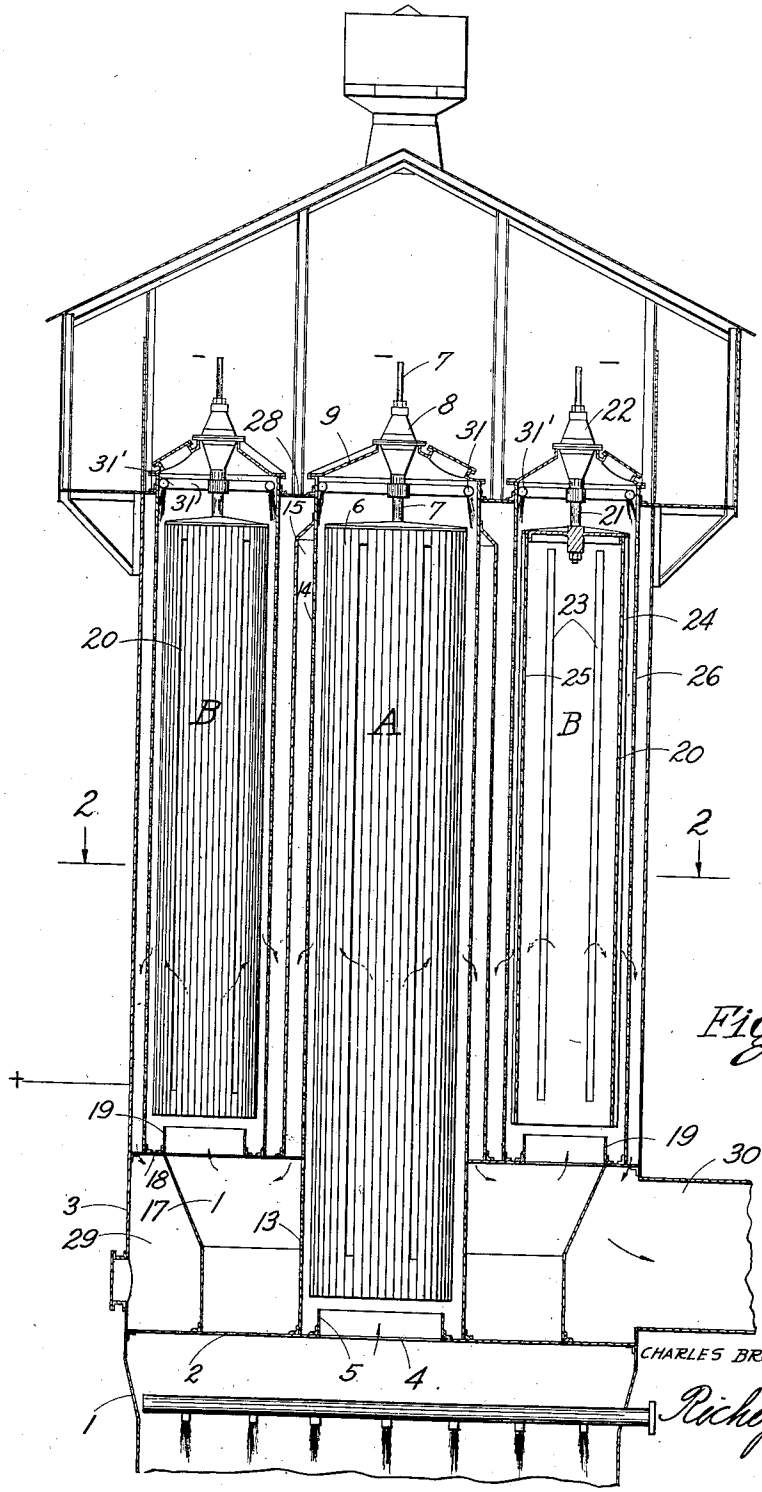

Fig. 1

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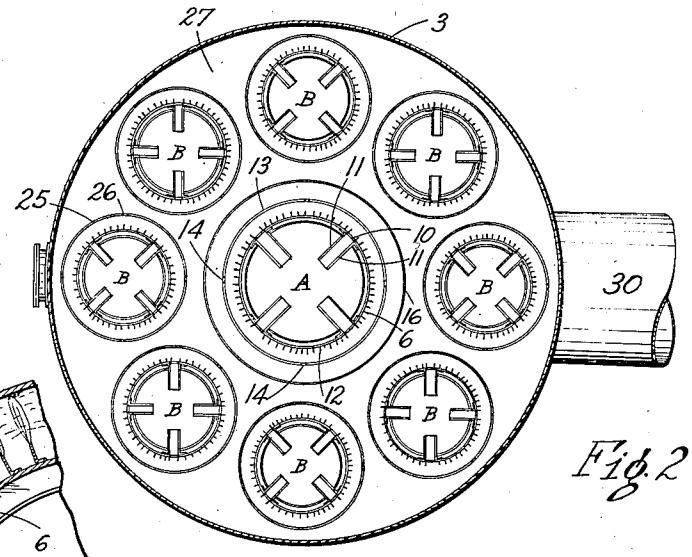

Fig. 2

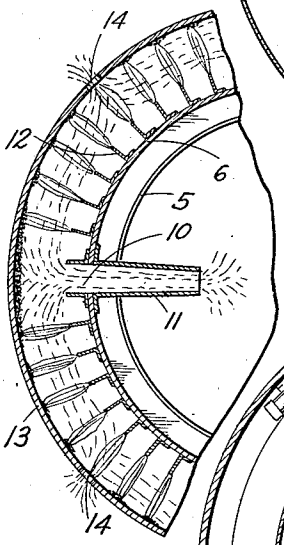

Fig. 3

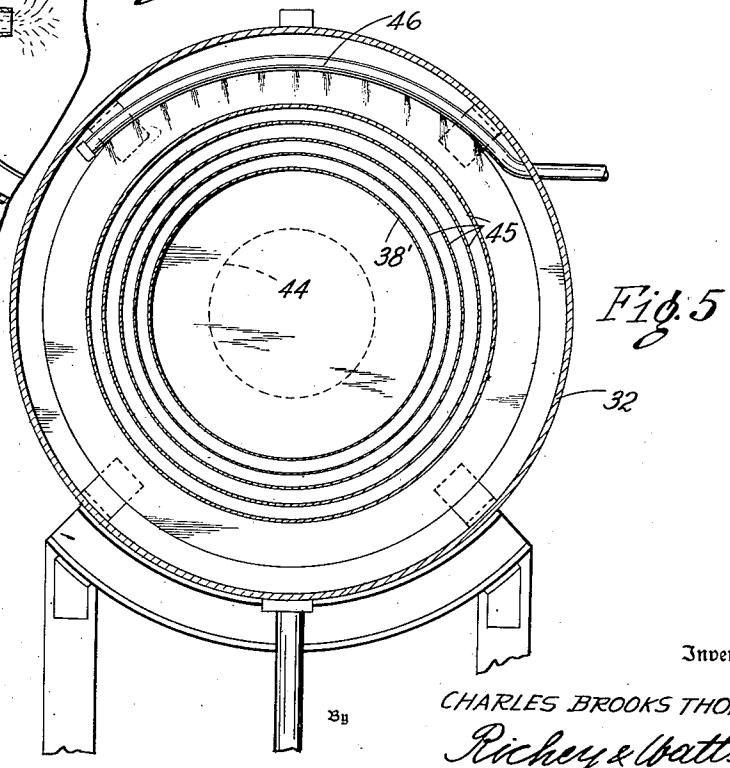

Fig. 5

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METHOD OF AND APPARATUS FOR CLEANING GASES

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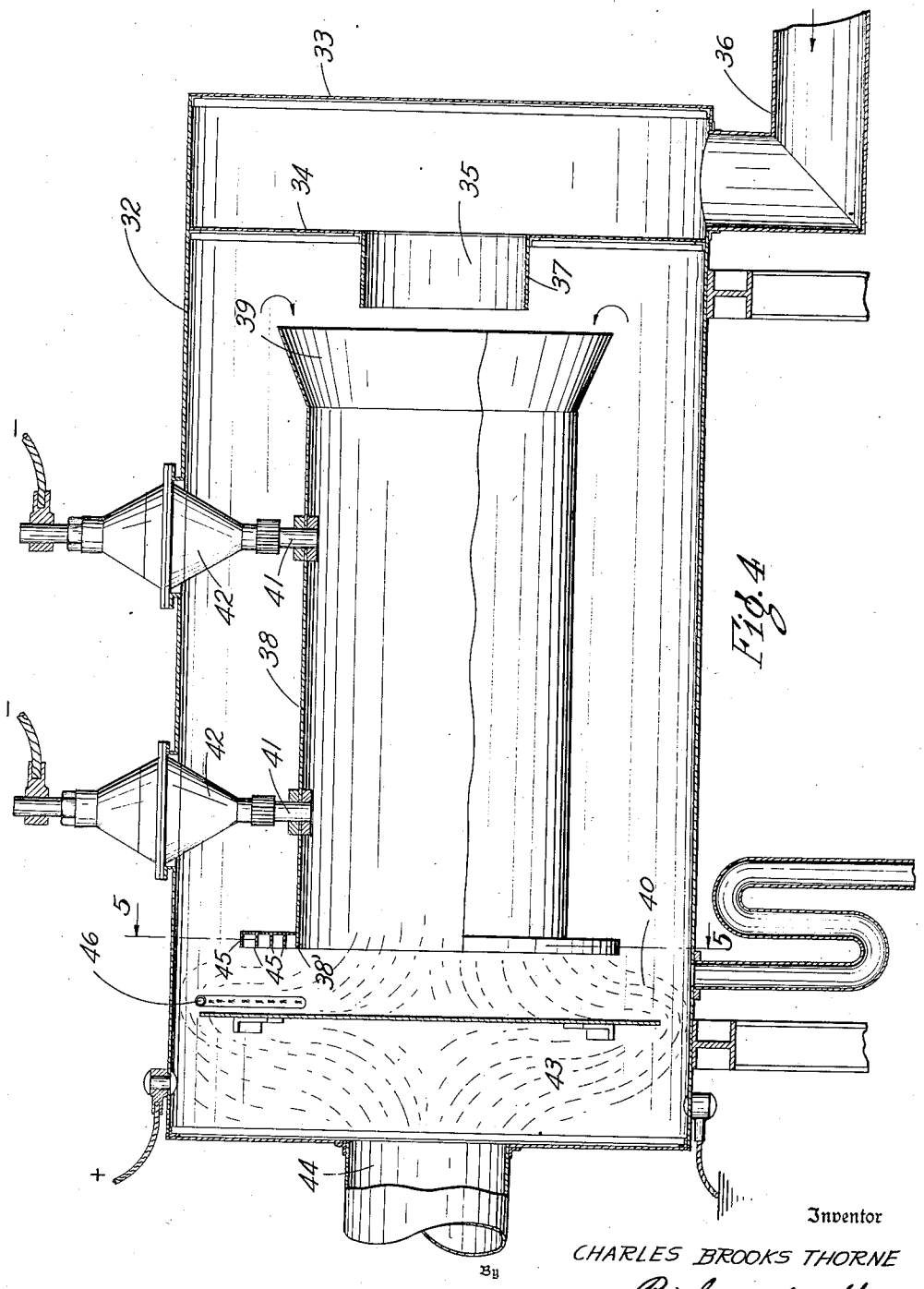

Fig. 4

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2,064,960

METHOD OF AND APPARATUS FOR CLEANING GASES

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Application March 5, 1932, Serial No. 596,943

21 Claims. (Cl. 183—7)

This invention relates to electrical precipitators and particularly to an improved method of and apparatus for precipitating out particles of solid and liquid material from a gas in which they are suspended or entrained.

In electrical precipitators of the type generally used at present dust and/or moisture laden gas is passed through tubes which act as collecting electrodes. A relatively small rod or wire is passed through the center of each of the tubular collecting electrodes and serves as a discharge electrode. When a high potential unidirectional current is applied to the electrodes of a precipitator so constructed with the negative polarity connected to the central discharge electrode and the positive to the grounded tubular collecting electrode, a silent discharge or corona is established between the negative rod or wire and the positive tube which surrounds it. The dust or moisture particles carried in the gas which passes through the tubes are swept out by the action of the corona and deposited upon the inside of the tubular collecting electrode. This corona action is well known and is a combination of electro-static action and physical entrainment by the corona windage. Other types of electrical precipitators which have been proposed include the use of the flat plates as collecting electrodes with rods, wires or wire netting discharge electrodes suspended between the plates.

It is among the objects of my invention to provide an improved method of and apparatus for separating out particles of solid and/or liquid material from gases in which the usual separating effects of an electrical nature are combined with separating effects of a mechanical nature, thus intensifying the cleaning action.

Other objects of my invention are: the provision of an electrical precipitator which occupies a minimum of space for any given capacity; the provision of a compact and efficient unit for removing particles of solid and/or liquid material from gas which is particularly adapted for the treatment of blast furnace gas after it has been passed through a preliminary washer or scrubber of any one of the well known types; the provision of an electrical precipitator unit in which the velocity of the gas as it passes through and is subjected to the action of the corona discharge, may be maintained at a relatively low value without increasing the dimension of the precipitator; the provision of a precipitator unit in which the distribution of the gas under treatment in the unit can be easily and effectively controlled and thus prevent the gases under treatment from channeling through certain parts of the unit to the serious detriment of its cleaning efficiency; the provision of an electrical precipitator unit composed of a plurality of sub-units arranged so that one or more of the sub-units may be shut down to permit cleaning or repairs without interfering with the continuous operation of the unit as a whole. Another object is the provision of an electrical precipitator having a treating chamber so arranged that flushing water connections of practical dimensions may be installed within the treating chamber without abnormal increase in the size of the unit; the provision of an electrical precipitator composed of a plurality of treating elements adapted to be connected in series or in parallel within a single shell without complicated piping and without adding to the height of the apparatus over that of a single treating unit.

The above and other objects of my invention will appear from the following description of several embodiments thereof, reference being had to the accompanying drawings, in which:

Fig. 1 is a vertical cross section of an installation of a group of my improved precipitator units, mounted on the top of a blast furnace gas scrubber.

Fig. 2 is a section taken on line 2—2 of Fig. 1.

Fig. 3 is an enlarged fragmentary cross sectional view illustrating the orifice through which the gas passes out of the discharge electrode and impinges against the collecting electrode in the central precipitator unit shown in Figs. 1 and 2. This figure also illustrates the path of the gases in the particular portion of the apparatus illustrated.

Fig. 4 is a vertical section of a modification of my precipitator, and

Fig. 5 is a section taken on line 4—4 of Fig. 3.

I have found that, by directing a stream of the gas to be treated through a tubular discharge electrode and against a collecting electrode in such a manner that its velocity is relatively high as it passes out of the discharge electrode and relatively low as it spreads out over the collecting electrode, I can add two more powerful dust and moisture separating forces to the usual electro-static and corona windage forces. These forces are, first, the inertia of the moving solid and/or liquid particles tending to carry them across the gap between the discharge and collecting electrodes and causing them to impinge upon the collecting electrode, and sec-

ond, the action of centrifugal force upon the particles as the stream of gas changes its direction when it strikes the collecting electrode. As will be seen from the following description and explanation of the operation of my apparatus, the action of the corona force upon the particles tends to carry them against the collecting electrode and it will be seen by those skilled in the art that both of the above noted forces materially assist the corona discharge in causing the foreign material to be deposited upon the collecting electrode.

Referring now to the drawings, Fig. 1, the upper part of the housing of a common type of blast furnace gas scrubber is indicated at 1. The blast furnace gas which has entered the lower part of this scrubber passes upwardly therethrough until it reaches the baffle plate 2 which extends across the shell 3 of the precipitator unit and is provided at its center with an opening 4. An annular flange 5 extends upwardly upon this opening 4 and forms a short nozzle which directs the gas as it passes from the scrubber unit into the center precipitator unit which may be generally indicated by the reference character A.

The precipitator unit A includes an inner open bottomed tubular discharge electrode member 6. The upper end of the discharge electrode 6 is closed by a suitable cover plate to which is secured the supporting conductor 7 which extends up through the insulator 8. The insulator 8 is mounted in the closed top 9 of the unit A and serves to support the conductor 7 and the electrode 6. The upper end of the conductor 7 may be connected to the negative side of any suitable source of high potential electrical current (not shown).

The tubular electrode 6 is formed with a plurality of elongated slot shaped openings 10. On the inside of the electrode 6, adjacent the slots 10, are inwardly extending flanges 11 which define a discharge orifice. The functions of these flanges 11 will be described later. The outside surface of the discharge electrode 6 is provided with a plurality of radially outwardly extending fins or knife edges 12 which extend substantially the full length of the electrode and assist in equalizing and distributing the corona discharge from the electrode 6 in well known manner.

The collecting electrode 13 is a tubular shell which surrounds and is co-axial with the discharge electrode 6. This collecting electrode 13 is supported at its lower end on the plate 2 and at its upper end it in turn supports the cover 9, the insulator 8, the conductor 7 and electrode 6. It will be noted that the collecting electrode 13 is connected directly to the frame of the apparatus and through this frame to the ground. A suitable connection between the shell 3 of the apparatus and the positive side of the high potential current may be made in any suitable manner.

The collecting electrode 13 is provided with vertically extending rows of holes 14. In the apparatus indicated it will be noted that the discharge electrode is provided with four vertically extending discharge slots 10 spaced 90° apart about the circumference of the electrode. The rows of holes 14 in the collecting electrode, in the illustrated construction, are also four in number, are spaced 90° apart about the circumference of the collecting electrode and are disposed so that a row of holes 14 lies half way between each of the discharge slots 10 in the discharge electrode. It will be understood that more or less than four slots 10 or rows of holes 14 may be used in some cases. Also that elongated slots may be formed in the collecting electrode 13 in place of the rows of holes 14.

Gas which passes through the row of holes 14 in the collecting electrode 13 enters an elongated annular chamber 15 between the collecting electrode 13 and the enclosing shell 16. This enclosing shell 16 is a tubular member which tapers inwardly at its upper end and is secured to the collecting electrode 13 at a point above the top of the rows of holes 14. The chamber 15 opens into the enlarged annular chamber 17 which surrounds the lower portion of the central precipitator unit A.

A plurality of additional precipitator units B are disposed about the central unit A. In the installation illustrated there are eight of these units B and they are symmetrically arranged about the central unit.

After the gas is passed through the central unit A it is directed into the annular chamber 17 from which it passes through suitable apertures in the plate 18 into the units B. Each of these apertures is provided with an upwardly extending flange 19 which corresponds in function to the flange 5 and serves to direct the gas upwardly into the inside of the tubular discharge electrodes 20 of the units B.

As each of the units B are identical it will be unnecessary to describe them all. The construction of these units B is substantially the same as that of the unit A and they each include a central discharge electrode 20 supported by a conductor 21, which in turn is mounted in and supported by an insulator 22. The conductors 21 are connected to the negative side of a suitable source of high potential current in the same manner as above described for the conductor 7. Elongated slots 23 are formed in the discharge electrodes 20 and the fins or knife-edges 24 on their outer surfaces are similar to and serve the same purpose as the fins on the discharge electrode 6 of the central unit A. The collecting electrodes 25 of the units B surround the discharge electrodes 20 and are provided with rows of holes 26 which are disposed midway between the slots 23 in the discharge electrodes 20.

After the gas being treated has passed upwardly into the electrodes 20 and out through the slots 23, it passes through the rows of holes 26 in the collecting electrodes 25 into the space generally indicated by reference numeral 27 within the outer shell 3. This space 27 is bounded on its sides by the shell 3 and at its top by a suitable baffle wall 28. From this space the gas is discharged downwardly through openings in the supporting plate 18 into the annular chamber 29 which surrounds the annular chamber 17. A discharge pipe 30 leads from the chamber 29 and is adapted to conduct the cleaned gas to any desired place.

To remove the matter which is separated from the gas stream and which collects on the inner surfaces of the collecting electrode 13 of the center unit A and the collecting electrodes 25 of the units B, I employ the circular flushing water supply pipes 31 and 31'. These pipes are provided with a plurality of spray holes or nozzles and are located within and adjacent the tops of the collecting electrodes 13 and 25 respectively. The spray holes or nozzles are so disposed that they will spray water against the

inner surfaces of the collecting electrodes and the pipes 31 and 31' may be connected in any suitable manner to a source of supply of flushing liquid. The inner surfaces of the collecting electrodes may be flushed continuously or intermittently as desired and the flushing liquid will run down over the collecting electrode surfaces and carry away the foreign material deposited thereon. Suitable outlets (not shown) may be provided at the bottoms of the precipitator units to carry away the flushing liquid and solid matter from the electrodes.

In operation of the apparatus illustrated in Figs. 1 and 2 and described above, the gas to be treated passes upwardly through the opening 4 in the plate 2. The flange 5 forms a nozzle which directs the gas into the interior of the tubular discharge electrode 6. The diameter of the opening 4 is smaller than the inside diameter of the electrode 6 and the upwardly extending flange 5 causes an injector action to take place which tends to draw any stray gas from the space between the discharge electrode 6 and the collecting electrode 13 adjacent the bottom end of the discharge electrode back into the interior of the discharge electrode. The gas to be cleaned passes up into the discharge electrode and escapes therefrom through the four elongated slots 10 in the walls thereof. As noted above these slots are provided with inwardly extending flanges which are closed at their bottom end. These flanges act as baffles and insure even distribution of the gas within the interior of the electrode 6. They also serve to equalize the discharge through the slots 10 so that approximately the same quantity of gas escapes through the upper portions of these slots as through the lower portions.

When the high potential current is applied to the electrodes through the connections above described a silent or corona discharge will take place from each of the outwardly extending fins 12 to the inner wall of the collecting electrode 13. As the gas passes out through the slots 10 it must travel circumferentially, through the space between the electrode 6 and the electrode 13, until it reaches one of the rows of holes 14 in the collecting electrode 13. Thus each part of the gas being treated must pass through a corona zone equal in length to at least one-eighth of the circumference of the electrodes. As the slots 10 are restricted the velocity of the gas as it passes therethrough is relatively high but as it enters into the annular chamber between the electrodes its volume is increased and consequently its velocity is reduced. Thus, as gas passes through the corona zone it is traveling at a relatively low velocity and ample time is provided to permit the corona to act to carry the particles of solid and liquid material to the inner wall of the collecting electrode 13. An additional separating effect is created due to the fact that the direction of flow of the gas which passes out of the slots 10 is changed approximately 90° when it strikes the inner surface of the collecting electrode 13. This abrupt change in direction, due to the action of centrifugal force, tends to cause any solid or liquid particles in the gas to be thrown against the collecting electrode 13 and assists in a cleaning of the gas. Additional cleaning action is obtained due to the inertia of the particles which pass through the slots 10 at relatively high velocity. These particles tend to keep going in a straight line when the path of the gas is deflected by the collecting electrode walls and this causes at least a part of the particles to impinge against the wall of the collecting electrodes at points substantially opposite the slots 10.

Figure 3 illustrated in dotted lines the path of the gas as it leaves the slot 10 and strikes the collecting electrode 13. This figure also shows at C the corona discharge from the fins 12. The deposits of solid particles are indicated at D.

After the gas passes through the rows of holes 14 in the electrode 13 it enters the annular chamber 15 from which it passes, as shown by the arrows in Fig. 1 of the drawings, downwardly into the chamber 17. The chamber 17 is annular in shape and from this chamber the gas passes upwardly through the upwardly extending flanges 19 into the interior of the discharge electrodes 20 of the precipitator units B.

It will be understood by those skilled in the art that although I have illustrated a precipitator arrangement in which the central unit is arranged in series with a plurality of surrounding units, which surrounding units are in parallel arrangement, other combinations and arrangements of units might be employed without departing from the spirit of my invention.

The path of the gas through the precipitator units B is exactly the same as that above described in reference to unit A and it will be sufficient to point out that when the gas passes out through the vertical rows of holes 26 in the collecting electrodes 25 it enters the space 27 within the shell 3. From this space 27 the gas passes downwardly into the annular chamber 29 and from here may be carried away through the discharge pipe 30.

To secure the most effective operation of my precipitator units I prefer to so proportion the various gas passages through the apparatus that uniform distribution of the gas and the desired velocity and pressure at each part of the apparatus will be secured. To accomplish the desired results the opening 4 (in this explanation reference will be had only to the central precipitator unit as the same remarks apply to each individual unit) will be made of a size to give the desired gas velocity into the interior of the discharge electrode 6. As the discharge electrode is closed at its upper end the velocity head of the gas passing through the opening 4 is converted into static or pressure head within the tubular discharge electrode shell. The total combined area of all of the outlet passages 10 of the discharge electrode will be made such that a somewhat higher pressure will be developed within the discharge electrode and the flow of gas therefrom will be restrained, thus tending to evenly distribute the gas in its passage through the slotted openings 10. The cross sectional area of the gas passage between the discharge electrode 6 and the collecting electrode 13 is greater than one half of the area of one of the passages 10 and therefore the velocity of gas will be reduced as it flows through the corona zone. Moreover, the total area of the outlet openings 14 in the collecting electrode 13 will be preferably somewhat smaller than the total area of the outlet openings 10 of the discharge electrode. Thus, a certain back pressure will be created within the corona zone and the flow of gas therethrough will be made more uniform and stratification will be prevented. Of course, when the gas passes out of the openings 14 into the space surrounding the

collecting electrode the velocity will be further reduced although at this point the gas has been cleaned and the velocity thereof does not assume the importance that it does in the other portions of the apparatus. By thus properly adjusting the areas of the passages which control the flow of gas and taking advantage of the conversion of the velocity head of the gas entering the discharge electrode into static or pressure head, I am enabled to maintain the gas under a slight restraint which tends to evenly distribute the gas through the apparatus and secure the most effective results.

From the above description it will be seen that the electrical precipitator installation just described provides a maximum length of corona path through which all of the gases must pass. In addition to the length of the corona path which is obtained with my construction, advantageous results are obtained due to the fact that the gas is traveling at a relatively low velocity when it passes through the corona discharge. Moreover, the added separating effects of centrifugal force and inertia are added to the electro-static and windage action of the corona and the result is an extremely efficient apparatus.

It will be understood by those skilled in the art that if desired one or more of the units B may be shut down for cleaning or repairing without rendering the entire apparatus inoperative.

In the above described embodiment of my invention a specific arrangement of the discharge zones is disclosed. Other possible arrangements will appear to those skilled in the art and I do not therefore wish to be limited to the specific features of my apparatus as shown and described herein.

In Figs. 4 and 5 I have illustrated a modified type of apparatus which is adapted to carry out my improved gas cleaning method. This apparatus performs the same functions as the apparatus illustrated in Figs. 1, 2, and 3, but is somewhat different in form. A tubular shaped casing **32**, preferably cylindrical, is adapted to house this form of my apparatus. One end of the casing **32** is closed by a plate **33**. A plate **34**, provided with a central opening **35**, extends across the housing **32** and the gas inlet pipe **36** is adapted to direct the gas into the space between the end wall **33** and the plate **34**. A cylindrical nozzle or flange **37** is secured to the wall **34**. The discharge electrode consists of a tubular member **38**, open at both ends. The end which the gas enters is preferably flared slightly outwardly as indicated at **39** so that an injector effect will be created by the passage of the gas through the nozzle or orifice **37** into the electrode **38**. This injector action will tend to cause any gas which may escape into the space within the shell **32** but outside of the electrode **38** to be recirculated through the electrode **38**.

In this type of apparatus the collecting electrode consists of a flat plate **40**, somewhat smaller than the cross sectional area of the outer shell **32** and supported therein by suitable brackets so that it is spaced from the outer shell **32** to provide a passage for gas between its outer edge and the housing **32**. The discharge electrode **38** is supported by the conductors **41**, which in turn pass through and are supported by the insulators **42**, which are mounted in the shell **32**. The negative side of a high potential current supply is applied to the suspended discharge electrode **38**. The collecting electrode **40** is connected to the positive side of the current supply through a suitable connection and to the ground through the supporting framework of the apparatus. When the current is applied a corona discharge will be formed between the end **38'** of the discharge electrode and the flat collecting electrode **40**. The corona will be substantially cylindrical in form. It will be seen that all gas which passes through the electrode **38** must pass through the corona wall before it can escape around the periphery of the electrode plate **40** into the chamber **43** and out of the discharge pipe **44**.

To increase the effectiveness of the action of the corona a plurality of annular rings **45** may be provided. These rings are supported concentrically with and are electrically connected to the discharge end **38'** of the electrode **38**. When such rings are used a plurality of rings of corona discharge will be formed and the gas must pass through and be acted on by several separate corona fields before it can be discharged from the apparatus. The dotted lines in Fig. 4 indicate generally the path of the gas as it leaves the tubular discharge electrode **38** and strikes the plate collecting electrode. As the collecting electrode is preferably continuously or intermittently flushed with water or other suitable liquid by jets from the flushing liquid supply pipe **46**, the particles of solid material and/or liquid which are carried against the surface of the electrode **40** will adhere thereto and be removed from the gas stream. As the direction of the flow of the gas is changed 90° when it strikes the plate **40** the action of centrifugal force upon the particles will be quite pronounced and will tend to assist in directing the particles against the surface of the connecting plate **40**. This apparatus also illustrates the way in which the particles, due to their inertia, tend to resist change in the direction of their movement when the gas strikes the plate **40**. As above explained this action assists in causing the particles to strike the electrode **40** and be removed from the gas stream.

The above described modified form of my apparatus is adapted to carry out the steps of my method of cleaning gas and it will be seen by those skilled in the art that other types of apparatus may be used to carry out my method. I do not, therefore, wish to be limited to the exact forms of my invention, shown and described, but claim as my invention all embodiments thereof coming within the scope of the appended claims.

I claim:

1. The method of removing finely divided foreign material from a gas which includes the steps of moving the gas toward a positively charged collecting electrode within a space defined by a corona discharge, abruptly changing the direction of movement and reducing the velocity of the gas, passing the gas through the corona discharge and then recirculating at least a portion of the gas which has passed through the corona discharge back into the untreated gas moving toward said collecting electrode.

2. In an electrical precipitator, a tubular discharge electrode open at both its ends means for directing a stream of gas into one end of said tubular electrode, a collecting electrode plate disposed across the path of the gas emerging from the opposite end of the discharge electrode and means for flushing precipitated material from said collecting electrode.

3. In an electrical precipitator, a tubular discharge electrode open at both its ends, means fo.

directing a stream of gas into one end and out the other end of said tubular electrode, a collecting electrode plate disposed across the path of the gas emerging from the outlet end of the discharge electrode, said collecting electrode having a surface area greater than the area of said open outlet end of the discharge electrode and adapted to act as a baffle to change the direction of flow of gas from the discharge electrode, and means for creating a plurality of concentric bands of corona discharge between the outlet end of the tubular discharge electrode and the collecting electrode plate whereby gas discharged from the discharge electrode will be acted upon by a plurality of bands of corona.

4. In an electrical precipitator, a tubular discharge electrode closed at one end and having a longitudinally extending outlet opening in its side wall, flanges extending inwardly from and outlining said opening, a nozzle spaced from the open end of said electrode and adapted to direct gas thereinto, and a tubular collecting electrode surrounding and spaced from said discharge electrode.

5. An electrical precipitator comprising an outer shell, a central precipitator unit comprising a pair of oppositely charged tubular electrodes arranged in spaced relation, one within the other and having passages whereby gas can flow therebetween, said precipitator unit being centrally located in said shell, a plurality of additional precipitator units, each having a pair of oppositely charged tubular electrodes arranged in spaced relation one within the other and having passages whereby gas can flow therebetween, said additional precipitator units being disposed within said shell about said central unit, and gas conducting means for directing gas into and through said central unit and from said central unit into and through said additional units and then to a point removed from said shell.

6. In an electrical precipitator of the type described, a tubular discharge electrode closed at one end and having a longitudinally extending outlet slot in its side wall, a plurality of longitudinally extending fins secured to and projecting radially outwardly from the side wall of the electrode and flanges extending inwardly from and defining said outlet slot.

7. In an electrical precipitator, a tubular discharge electrode having a plurality of spaced gas outlet openings and a tubular collecting electrode surrounding and spaced from said discharge electrode, said collecting electrode having a plurality of spaced gas outlet openings disposed substantially midway between pairs of adjacent outlet openings of said discharge electrode.

8. In an electrical precipitator, a tubular discharge electrode closed at one end and open at its opposite end, said discharge electrode having a gas outlet opening extending lengthwise of the tube and a plurality of discharge fins spaced about and extending outwardly from the outer surface of said tube, means for directing a stream of gas into the open end of said discharge electrode, a tubular collecting electrode surrounding the tubular discharge electrode and spaced therefrom, said collecting electrode having a gas outlet opening peripherally staggered from said outlet opening in said discharge electrode.

9. In an electrical precipitator, a tubular discharge electrode closed at one end and open at its opposite end, said discharge electrode having a gas outlet opening extending lengthwise of the tube and a plurality of discharge fins spaced about and extending outwardly from the outer surface of said tube, means for directing a stream of gas into the open end of said discharge electrode, a tubular collecting electrode surrounding the tubular discharge electrode and spaced therefrom, said collecting electrode having a gas outlet opening peripherally staggered from said outlet opening in said discharge electrode and means for creating corona discharge zones between said discharge fins and said collecting electrode.

10. In an electrical precipitator, a tubular discharge electrode having a plurality of discharge fins extending outwardly from its outer periphery and having a gas outlet opening in the side wall thereof, means for directing a stream of gas into said discharge electrode and a collecting electrode surrounding said discharge electrode and spaced therefrom, said collecting electrode having an outlet opening in its side wall, said opening being disposed out of alignment with said outlet opening in the discharge electrode.

11. In an electrical precipitator, a pair of coaxially arranged oppositely charged tubular electrodes, one of said electrodes being negatively charged and disposed within and spaced from the other positively charged electrode and having a plurality of discharge fins projecting outwardly toward said positively charged electrode, each of said electrodes having a gas outlet opening, said outlet openings being arranged relative to each other to cause gas flowing through the precipitator to move in a tortuous path.

12. In an electrical precipitator, a pair of coaxially arranged oppositely charged tubular electrodes, one of said electrodes being negatively charged and disposed within and spaced from the other positively charged electrode and having a plurality of discharge fins projecting outwardly toward said positively charged electrode, each of said electrodes having a gas outlet opening, said outlet openings being arranged relative to each other to cause gas flowing through the precipitator to move in a tortuous path, and means for directing gas into said negatively charged tubular electrode.

13. In an electrical precipitator, a pair of coaxially arranged oppositely charged tubular electrodes, one of said electrodes being negatively charged and disposed within and spaced from the other positively charged electrode and having a plurality of discharge fins projecting outwardly toward said positively charged electrode, each of said electrodes having a gas outlet, said outlet openings being arranged relative to each other to cause gas flowing through the precipitator to move in a tortuous path, means for directing gas into said negatively charged tubular electrode, and means for creating a corona discharge between said fins and said positively charged electrode.

14. In an electrical precipitator, a tubular discharge electrode closed at one end and having an outlet opening in its side wall, circumferentially spaced discharge fins secured to said discharge electrode and extending longitudinally thereof and flanges extending radially inwardly from said outlet opening.

15. In an electrical precipitator, a tubular discharge electrode closed at one end and having an outlet opening in its side wall, circumferen-

tially spaced discharge fins secured to said discharge electrode and extending longitudinally thereof, flanges extending radially inwardly from said outlet opening, and a tubular collecting electrode surrounding and spaced from said discharge electrode.

16. In an electrical precipitator, a tubular discharge electrode having a gas outlet opening in the side wall thereof, a tubular collecting electrode surrounding and spaced from said discharge electrode, said collecting electrode having a pair of spaced outlet openings in its side wall, said outlet openings being substantially equi-distant from the outlet opening in said discharge electrode whereby gas flowing from said discharge electrode outlet opening will divide into substantially equal portions and travel in opposite directions to said outlet openings in said collecting electrode.

17. In an electrical precipitator, a tubular discharge electrode having a gas outlet opening, means for directing gas into said tubular discharge electrode, a tubular collecting electrode surrounding and spaced from said discharge electrode, said collecting electrode having an outlet opening arranged out of alignment with said outlet opening of said discharge electrode, said collecting electrode outlet opening being of smaller area than said discharge electrode outlet opening.

18. An electrical precipitator comprising an outer shell, a central precipitator unit comprising a pair of oppositely charged tubular electrodes arranged in spaced relation one within the other and having passages whereby gas can flow therebetween, said precipitator unit being centrally located in said shell, a plurality of additional precipitator units each having a pair of oppositely charged tubular electrodes arranged in spaced relation one within the other and having passages whereby gas can flow therebetween, said additional precipitator units being disposed within said shell about said central unit and gas conducting means for directing gas into said precipitator units.

19. The method of treating gas which includes moving the gas in a cylindrical stream, causing at least a portion of said gas to move radially outwardly of said cylindrical stream, causing said radially outwardly moving body of gas to move circumferentially around said cylindrical stream and through a zone of corona discharge extending transversely of the direction of flow of said circumferentially moving body of gas and then again moving the gas radially outwardly of said cylindrical stream.

20. The method of treating gas which includes moving the gas into a tubular enclosure, permitting said gas to flow radially outwardly from said enclosure, directing said radially flowing gas around the periphery of said enclosure and through a corona discharge zone extending transversely of the direction of flow of the gas and then again directing said peripherally flowing gas radially outwardly of said enclosure.

21. The method of treating gas which includes moving the gas in a stream, converting the velocity head of said moving stream of gas into static head, permitting gas to leave said stream in a direction radially outwardly thereof, maintaining said radially moving gas out of contact with said stream and changing the direction of flow of said radially moving gas so that it moves peripherally around said stream, causing said peripherally moving gas to pass through a zone of corona discharge and then again directing it radially outwardly of said stream.

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