United States Patent [19]

Robertson

[11] **3,785,118**

[45] **Jan. 15, 1974**

[54] **APPARATUS AND METHOD FOR ELECTRICAL PRECIPITATION**

[75] Inventor: **John A. Robertson,** Chillicothe, Ohio

[73] Assignee: **The Mead Corporation,** Dayton, Ohio

[22] Filed: **Mar. 22, 1972**

[21] Appl. No.: **236,851**

[52] **U.S. Cl.** **55/5,** 55/10, 55/13, 55/107, 55/118, 55/122, 55/130, 55/152, 55/154

[51] **Int. Cl.** **B03c 3/16**

[58] **Field of Search** 55/5, 10, 13, 107, 55/118, 120, 122, 130, 154, 152

[56] **References Cited**

UNITED STATES PATENTS

1,132,124	3/1915	Schmidt et al.	55/130
1,342,651	6/1920	Squires	55/118

FOREIGN PATENTS OR APPLICATIONS

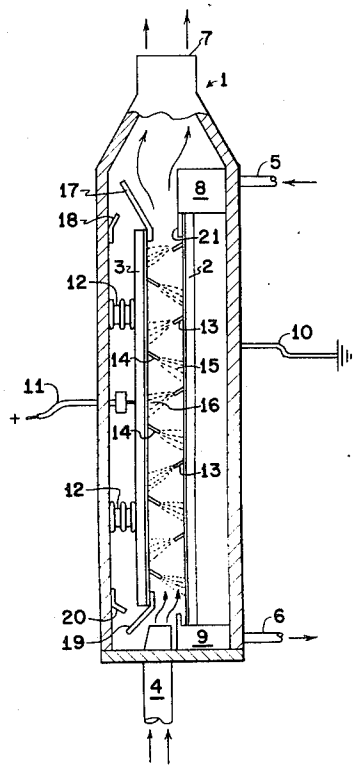
538,294	7/1941	Great Britain	55/152
1,184,389	3/1970	Great Britain	55/107
770,619	7/1934	France	55/107

Primary Examiner—Dennis E. Talbert, Jr.
Attorney—John W. Donahue

[57] **ABSTRACT**

A liquid spraying electrical precipitator comprising a pair of electrically conductive walls and a plurality of spouts on each wall. A cleaning liquid such as water is applied to one of the walls, as by drippers at the top thereof, and flows downwardly to the spouts thereon. The liquid is caused to transit the gap between the walls by application of a strong electrical field. Preferably the wall of initial application is grounded, and the other wall is connected to a source of high positive potential. The electrical field so created causes negatively charged drops to be sprayed from the spouts on the first wall, and to follow a somewhat downwardly directed trajectory until they impinge upon the second wall. Water impinging on the second wall runs downwardly to spouts thereon, and is resprayed as positively charged drops across the gap to the first wall. This process is continually repeated until the water finally exits at the bottom of the precipitator. A stream of dirty gas flows upwardly through the precipitator, and is cleansed by the action of the positively and negatively charged drops continually spraying and respraying back and forth between the walls.

10 Claims, 2 Drawing Figures



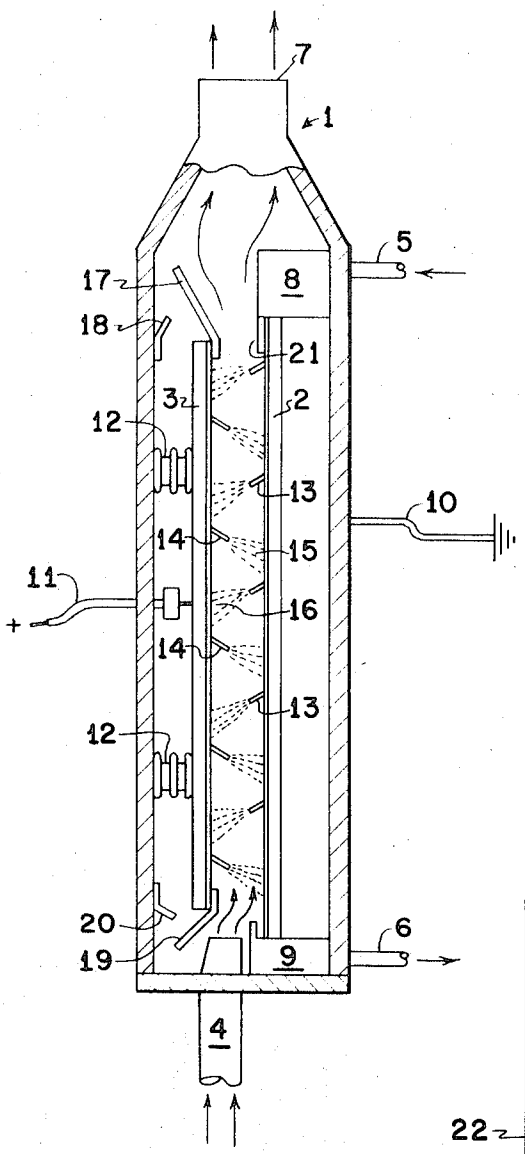

7
1
5
8
17
18
21
3
2
12
13
10
14
15
11
16
14
13
12
20
6
19
9
4

FIG. 1

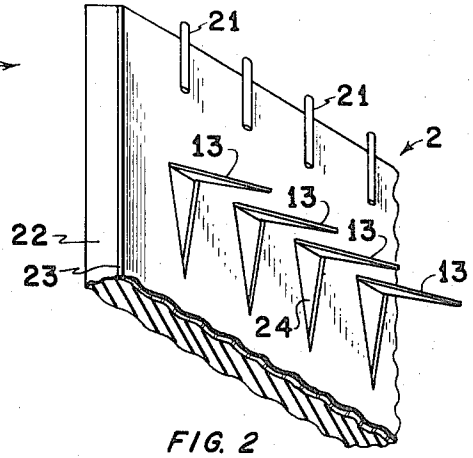

21
21
2
13
13
13
22
13
23
24

FIG. 2

APPARATUS AND METHOD FOR ELECTRICAL PRECIPITATION

BACKGROUND OF THE INVENTION

This invention relates to electrical precipitation of particles or droplets of contaminating matter from a flowing gas stream. More particularly it relates to precipitators of the type wherein contaminated gas is caused to flow through a strong electrical field, and wherein the precipitating action of the electrical field is aided by water particles. Examples of such a prior art device are disclosed in Marks U. S. Pat. No. 3,503,704 and Wintermute U. S. Pat. No. 2,245,516. Most commonly, however, prior art precipitators are characterized by either electrical field precipitation or charged particle precipitation, but not both. For instance, Darrah U. S. Pat. No. 1,958,406 and Romell U. S. Pat. No. 3,440,799 disclose devices employing charged liquid particles for precipitation of gas particulates, but the gas does not flow through a strong electrical field. Alternatively, there are dry electrostatic precipitators such as those disclosed in Hahn U. S. Pat. No. 1,980,521, Thompson U. S. Pat. No. 1,992,974 and Shively et al. U. S. Pat. No. 2,195,431 wherein particulate matter is precipitated by an electrostatic field, but without any charged liquid particles in the precipitation region.

A common problem with dry electrostatic precipitators has been the accumulation of precipitated matter on the collection electrodes. This has necessitated periodic shutdown for flushing. In some devices, however, the accumulation problem has been solved by arrangements whereby the collection electrode is grounded and continuously flushed by a cleansing liquid. A typical example of continuous flushing of the collection electrode is shown in DeSeversky U. S. Pat. No. 3,238,702. Wintermute U. S. Pat. No. 1,959,752 discloses continuous flushing of discharge electrodes. It will be appreciated that in such liquid flushing systems, the flushing liquid cleans only the electrodes and not the contaminated gas.

SUMMARY OF THE INVENTION

This invention provides for simultaneous precipitation of gas contaminates by an electrical field and by liquid particles in a compact, efficient, and mutually compatible manner. The liquid particles are introduced directly into the electrical field and transit continually back and forth across the field for efficient utilization of cleansing liquid and continuous cleansing of the field creating electrodes.

The apparatus for practicing this invention comprises a pair of parallel electrode surfaces and a plurality of liquid collecting spouts on each surface. The two electrodes are oppositely charged to set up an electrical field therebetween, and a flow of cleansing liquid is supplied to at least one of the electrode surfaces. The liquid then sprays continually back and forth between the electrodes by collection upon the spouts and electrical attraction therefrom. Concomitantly ions of opposite electrical polarity are generated at the two sets of spouts and cooperate with the electrical field and the criss-crossing water spray to produce a novel combined cleansing action.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a somewhat schematic vertical crossection of a precipitator made in accordance with this invention.

FIG. 2 is an exploded view of a portion of one electrode plate.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of a precipitator built in accordance with this invention is shown in FIG. 1. As illustrated therein a contaminated gas enters precipitator 1 through an inlet pipe 4 and exits through a discharge port 7. During its passage through precipitator 1 the gas passes between a pair of walls 2 and 3 equipped with spouts 13 and 14 respectively. Walls 2 and 3 are similar in construction, and preferably contain a large number of spouts arranged in rows as shown more particularly in FIG. 2.

An electrically conductive cleansing liquid such as water is admitted to precipitator 1 via an inlet pipe 5 for distribution by manifold 8. The water leaves manifold 8 by means of a row of small tubes 21 attached thereto and trickles down to spouts 13. The water flow rate through tubes 21 may be adjusted by adjustment of the fluid level within manifold 8, or alternatively, by filling manifold 8 completely and adjusting the inlet flow rate at pipe 5.

The water reaching the first row of spouts 13 flows downwardly to the tips thereof, and is pulled therefrom by a strong electrical field. This field is created by grounding wall 2 as by line 10 and raising the surface of wall 3 to a high positive potential as by line 11. This causes the water on spouts 13 to become negatively charged and to be sprayed across the inter-electrode space to wall 3. The negatively charged water particles scrub the flowing gas during this transit.

After reaching the surface of wall 3, the water flows downwardly to spouts 14. Upon reaching the tips of spouts 14, the water is sprayed back to the surface of wall 2 as positively charged droplets. Upon reaching wall 2, the water gives up its positive charge, flows down wall 2 to the next row of spouts 13, and flows downwardly therealong for respraying to the surface of wall 3. The process continues with the water traversing a downwardly directed zigzag path characterized by positively charged sprays 15 and negatively charged sprays 16. It is apparent that the flowing gas is continually scrubbed by the alternate sprays, and that the continued reuse of the cleansing water results in a great water economy. The waste water, with contaminating matter entrained therein, eventually flows into waste collection trough 9, and leaves precipitator 1 via waste outlet pipe 6.

It will be appreciated that the electric field concentration at the spout tips not only sprays water as above described, but also causes ionization of the passing gas. Ions of both positive and negative polarity are created; positive ions in the vicinity of spouts 14 and negative ions in the vicinity of spouts 13. Thus the contaminated gas is cleaned by both scrubbing and precipitation.

The charged wall 3 is electrically isolated from ground by means of insulators 12. Deflector plates 17, 18, 19, and 20 are provided to prevent migration of water particles to the region behind wall 3. Precipitator 1 is preferably closed out at the ends thereof by dielectric walls, not shown.

As shown more particularly in FIG. 2, wall 2 comprises a backing board 22 and a conductive faceplate

23. Backing board 22 may be made of any convenient conductive or nonconductive material, but the corresponding backing board in wall 3 preferably should be nonconductive. Plate 23 may be an aluminum plate of about 25 mils thickness and must be in electrical communication with ground line 10. Spouts 13 (and likewise spouts 14) may be made by a simple metal stamping and bending process, and preferably should be bent upwardly about 60° from apertures 24. The spouts thus make an angle of about 30° from the horizontal, and function effectively with a wall spacing of about 2-¾ inches and a potential of about +20,000 volts on wall 3. It has been found that the precipitator operates most effectively with a large number of spouts arranged in rows as illustrated. One particularly effective configuration has a spout row spacing of about 3 inches and a center-to-center spacing of about three-sixteenths inch between spouts in a row. In this configuration the spouts are about three thirty-seconds inch wide at their base and are about ¾ inch long. The gas flow rate ideally should be about 10 to 12 feet per second. The arrangement may be made as wide as desired to accommodate any gas flow requirement. Parallel plate operation is also possible. Furthermore, any desired collection efficiency may be obtained by serial cleansing in a stack of such precipitators.

It has been observed that proper adjustment of the water flow rate has an important bearing on the efficiency of precipitators made in accordance with this invention. In particular for a unit built as above described with electrode walls 36 inches high by 36 inches wide, a flow rate of about 150 cc per minute has been found to be about optimum. The preferred mode of operating such a unit is to adjust the water flow to a proper rate and then gradually raise the operating voltage on wall 3 until electrical arcing is observed. Thereafter the voltage is reduced to a level just below arcing and the system is ready for operation. As stated above the usual operating voltage is about +20,000 volts. This precipitator has been found to be very efficient at removing contaminating matter from gas streams, and has been unexpectedly effective in removing small particles having a diameter of 1 micron or less.

It is apparent that spouts 13 and 14 need not be arranged in spaced rows as described above, but this arrangement is preferred because it allows for placement of a large number of spouts in a small area with little interference between positively charged sprays 15 and negatively charged sprays 16. Avoidance of such interference is desirable so as to prevent collisions between positively and negatively charged water particles with concomitant loss of momentum and charge. Particles which do collide have a tendency to coalesce and fall directly downward into the flowing gas stream.

There is another preference to be observed in the arrangement of spouts in spaced rows. That is that there be one or more rows of spouts 14 at a level lower than the lower row of spouts 13. This eliminates the need for a waste trough below wall 3.

Instead of the spout configuration shown in FIG. 2, one may employ any other configuration adapted to collect water and carry it to a point of high electrical field strength. Also, tubes 21 may be replaced by any other means adapted to distribute a film of cleansing liquid along the upper surface of plate 23. In another embodiment cleansing liquid may be supplied to a dripper device and dripped upon deflector plate 17.

What is claimed is:

1. Apparatus for cleansing a contaminated gas comprising:
   1. a first wall member provided with an electrically conductive surface,
   2. a second wall member mounted in substantially parallel relation to said first wall member and provided with an electrically conductive surface facing the conductive surface of the first wall member,
   3. a first series of protuberances mounted on the first wall member and extending toward the second wall member,
   4. a second series of protuberances mounted on the second wall member and extending toward the first wall member,
   5. means for supplying a gas cleansing liquid to at least some of the protuberances in said first series,
   6. means for causing said contaminated gas to flow through the space between said wall members, and
   7. means for establishing an electrical field between said wall members whereby said cleansing fluid is induced to spray back and forth between said conductive surfaces and said protuberances and concomitantly clean the flowing gas.

2. Apparatus according to claim 1, said first and second wall members being upstanding, said protuberances being downwardly directed spouts, and said means for supplying a gas cleansing liquid comprising means for flowing said liquid downwardly over the conductive surface of said first wall member to be collected by the spouts mounted thereon and sprayed as aforesaid.

3. Apparatus according to claim 2, the conductive surfaces of said wall members being of planar configuration.

4. Apparatus according to claim 3, said spouts being arranged in spaced horizontal rows, the rows of spouts on said second wall member being vertically displaced relative to the rows of spouts on said first wall member.

5. Apparatus according to claim 3, further comprising means to catch and carry off used cleansing fluid and a pair of dielectric end walls closing out the ends of said first and second wall members.

6. Apparatus according to claim 2, said means for causing gas flow being operative to produce flow in an upward direction.

7. Apparatus according to claim 2, said means for establishing an electric field comprising a D.C. voltage source connected to the conductive surface on said second wall member and means for grounding the conductive surface on said first wall member.

8. Apparatus according to claim 7, said D.C. voltage source being of adjustable positive potential relative to ground.

9. Method of cleansing a contaminated gas comprising the steps of:
   1. passing said gas between a pair of substantially parallel electrode surfaces each provided with a series of projections extending inward toward the other plate,
   2. supplying an electrically conductive cleansing liquid to the projections on at least one of said plates,
   3. establishing an electrical field between said electrodes, and

4. adjusting the strength of said field to a magnitude great enough for production of continuous liquid spraying back and forth between said electrodes but low enough to avoid substantial arcing between the electrodes.

10. Method according to claim **9,** the strength of said electrical field being adjusted to a magnitude just slightly below that at which electrical arcing commences.

* * * * *