April 14, 1953 H. A. WINTERMUTE 2,634,818

GAS CLEANING APPARATUS

Filed Dec. 6, 1949 2 SHEETS—SHEET 1

Fig. 1.

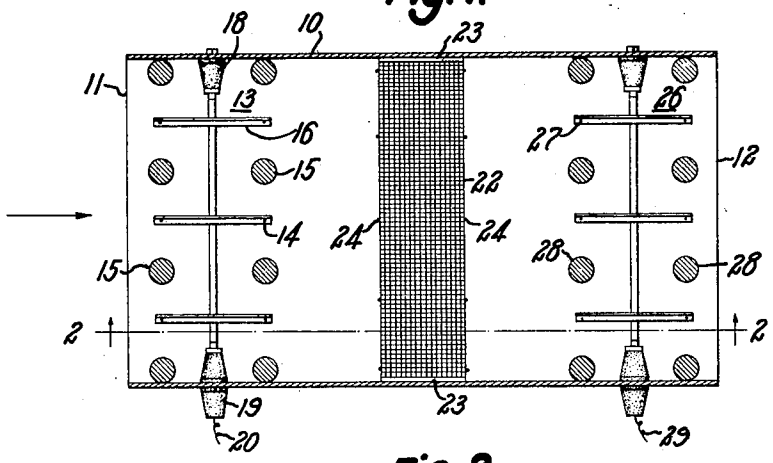

Fig. 2.

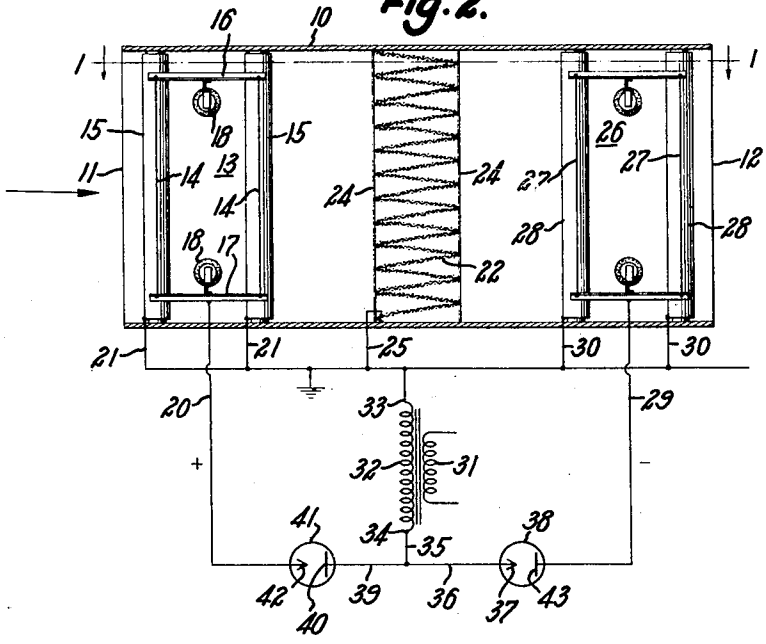

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Fig. 3.

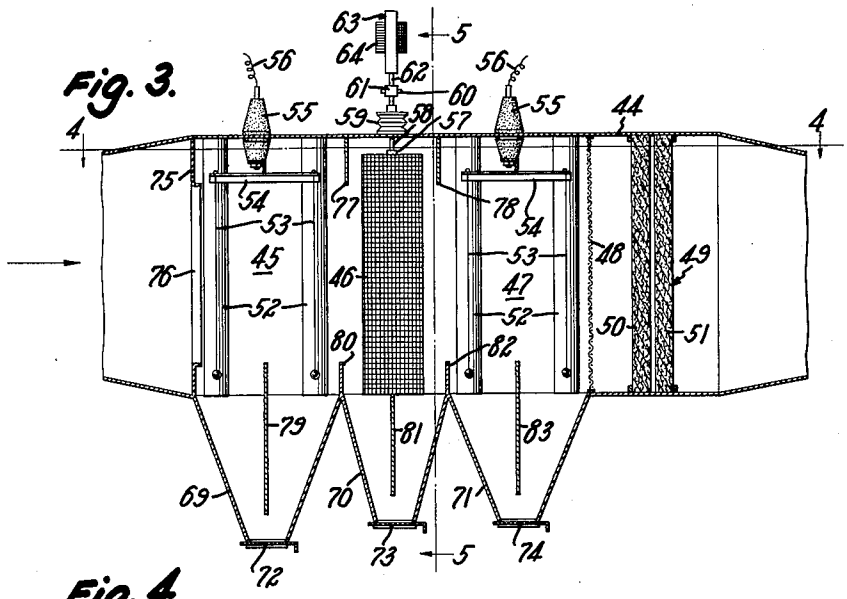


Fig. 4.

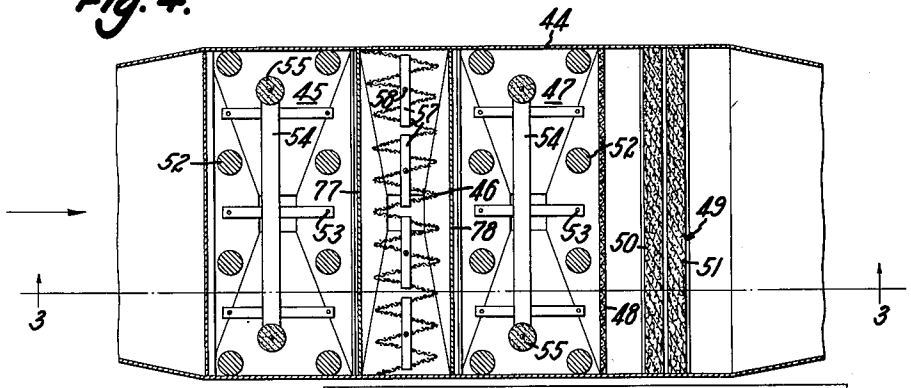
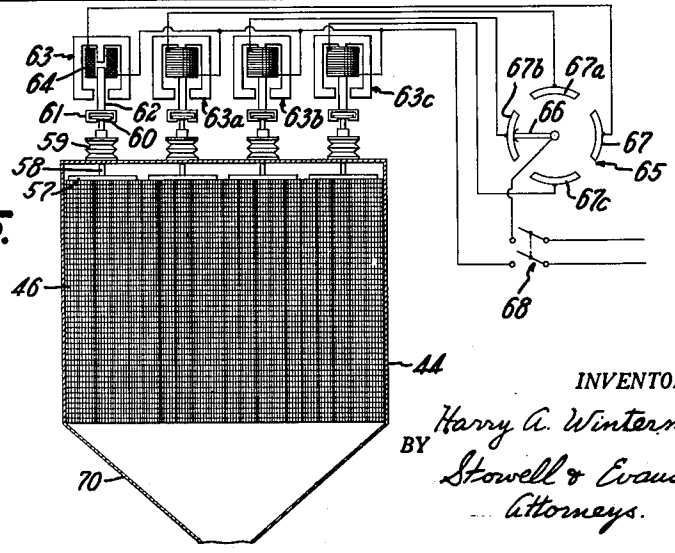


Fig. 5.



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UNITED STATES PATENT OFFICE

2,634,818

GAS CLEANING APPARATUS

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Application December 6, 1949, Serial No. 131,301

9 Claims. (Cl. 183—7)

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This invention relates to gas cleaning apparatus and more particularly to apparatus whereby suspended particles contained in air or other gases may be successively charged, flocculated and collected.

An object of the invention is to provide an improved gas cleaning device which is particularly effective in removing from a stream of gas flowing therethrough extremely fine suspended particulate matter such as gas black, smoke, carbon black, mist and the like. The efficiency of removal of extremely fine particles is high and the device of the invention is capable of cleaning gases that ordinary mechanical cleaning devices cannot handle at all and that other electrical gas cleaning apparatus cannot treat as effectively. Although the device of the present invention is especially suitable for cleaning gas bearing very fine particles, it also may be used to advantage in the treatment of gases for the removal of larger particles.

Another object is to provide gas cleaning apparatus of relatively simple construction which can be cheaply built and economically operated, which is simple to operate and which requires a minimum of attention and maintenance.

Another object is to provide gas cleaning apparatus including electrical precipitators having simple and rugged electrode charging means.

Another object is to provide gas cleaning apparatus including a particle flocculating device that is highly effective in enhancing the collection efficiency of the apparatus.

Gas cleaning apparatus in accordance with the invention includes a casing providing a conduit for the flow of gas therethrough. Within the casing there are disposed successively in the direction of gas flow, an electrical precipitator providing particle charging means, a particle agglomerating means providing an electrically conductive surface of low electrical resistance such as a metallic screen, and a second electrical precipitator for collecting particles from the gas stream. The particle agglomerating means may be in the form of a zig-zag woven metallic screen, this form providing relatively large gas contact surface for a given cross-sectional area.

The foregoing and other aims, objects and advantages of the invention will be in part apparent and in part pointed out in the following detailed description of exemplary forms of the invention as shown in the accompanying drawings in which:

Fig. 1 is a horizontal sectional view of one form of gas cleaning apparatus in accordance with the invention taken along the line 1—1 of Fig. 2;

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Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a vertical sectional view of another form of gas cleaning apparatus in accordance with the invention taken along the line 3—3 of Fig. 4;

Fig. 4 is a horizontal sectional view taken along the line 4—4 of Fig. 3; and

Fig. 5 is a vertical transverse sectional view taken along the line 5—5 of Fig. 3.

Referring to the drawings, particularly to Figs. 1 and 2 thereof, the gas cleaning apparatus shown includes a casing 10 having a gas inlet 11 and a gas outlet 12, the direction of gas flow being from left to right in the direction of the large arrow as seen in these figures.

In passing through the apparatus the gas or air to be cleaned first encounters an electrical precipitator generally designated 13. This precipitator includes two transverse banks of complementary electrodes, the high tension or discharge electrodes being shown at 14 and the extended surface electrodes being shown at 15. High tension electrode spiders 16 and 17 provide upper and lower supports for the discharge electrode wires and the spiders are supported upon the sides of the casing 10 by insulators 18 and insulating bushing 19, the bushing providing access to the spider for the high tension cable 20 which is electrically connected to the spider and, through the latter, to the high tension electrodes 14. The extended surface electrodes 15 may be grounded to the housing 10 if the latter is of metal construction, or they may be grounded, as shown in Fig. 2 through conductors 21.

The gas contacting or agglomerating means shown takes the form of a zig-zag woven wire screen 22 extending transversely of the casing and supported by end members 23. Additional support for the screen is provided by vertical wires 24 soldered or otherwise affixed to the angles of the screen and spaced apart laterally thereof. The screen may be grounded through conductor 25, or it may be connected to the housing if the latter is grounded. The zig-zag construction of the screen increases the surface area available for contact with the gas stream and serves to deflect the flowing gas in its passage through the meshes; such factors improve the efficiency of the screen. Some collection of gas-suspended particles may take place at the screen, and screen-rapping or cleaning devices may be employed for dislodging matter that adheres to the screen.

Reference numeral 26 designates the particle-collecting means which is an electrical precipita-

tor similar in construction to the particle-charging means 13 described hereinbefore. It has high tension or discharge electrodes 27 and extended surface electrodes 28, the former being connected to high potential lead 29 and the latter being grounded through conductors 30.

The power supply for the precipitators includes a transformer having a primary winding 31 supplied with alternating current and a secondary winding 32 one end 33 of which is grounded. The other or ungrounded end 34 of the secondary winding is connected through conductors 35 and 36 to the cathode 37 of a rectifier tube 38 and through conductors 35 and 39 to the anode 40 of a second rectifier tube 41. The cathode 42 of rectifier tube 41 is connected to the high tension electrode system of precipitator 13 through cable 20 and the anode 43 of rectifier tube 38 is connected to the high tension electrode system of the precipitator 26 through the cable 29. It will be seen that this power supply energizes the high tension electrodes of precipitator 13 with a positive polarity from half-waves of transformer secondary current and energizes the high tension electrodes of precipitator 26 with a negative polarity with alternate half-waves of transformer secondary current. Of course, the polarity of the voltages applied to the high tension electrodes of the two precipitators may be readily reversed by simply interchanging connections with the power supply.

In operation of the apparatus of Figs. 1 and 2, gas containing suspended matter to be removed is passed through the housing 10 from left to right. Charging of suspended particles and some precipitation thereof occurs in precipitator 13; flocculation of the charged particles and some collection thereof takes place at the grounded screen 22; and final precipitation and collection is accomplished in the second precipitator 26.

The gas cleaning apparatus shown in Figs. 3, 4, and 5 is similar in principle to that described with reference to Figs. 1 and 2. The apparatus has a casing or housing 44 through which gas bearing suspended matter is passed in the direction of the large arrow. Within the casing is a first precipitator 45, an agglomerating screen 46 and a second precipitator 47. This apparatus includes in addition a final clean-up section having an agglomerating screen 48 following the second precipitator and a mechanical gas filter 49 positioned behind the screen 48 in the direction of gas flow. The filter 49 may consist, as shown, of two filter elements 50 and 51 formed of matted glass wool coated with oil or other sticky substance.

Precipitators 45 and 47 are substantially identical in construction and each includes spaced cylindrical extended surface electrodes 52 that are grounded to the casing 44. Complementary discharge electrodes 53, in the form of fine wires, are suspended from a framework or spider 54, the spiders being suspended from insulating bushings 55 through which current is carried to the discharge electrodes by conductor cables 56.

The zig-zag wire screen 46 is oriented with its flat panelled surfaces extending in the vertical direction so that dust that is caught on the screen will fall freely between the screen panels when it is dislodged. The screen is suspended from a plurality of short horizontal bars 57, to the underside of which the folds of the screen are attached as by brazing. The screen supporting bars extend transversely of the casing and each bar is attached to the bottom of a vibration transmitting

rod 58 extending through a hole in the top of the casing 44. The rods 58 are supported in sealing bellows 59 mounted on the top of the casing and the tops of the rods terminate in disc-shaped anvil members 60. It will be seen that movement or vibration of the anvil members 60 will be transmitted to the flocculating screen 46 through the rods 58 and support bars 57.

Means for vibrating the anvil members 60 includes, for each anvil, a striker or stirrup 61, the arms of which embrace the anvil, and which is suspended from an armature piece 62 of a solenoid 63. The solenoid coil 64 is periodically energized to move the striker 61 and to vibrate that portion of the screen under its control.

As best seen in Fig. 5, the four solenoids 63, 63*a*, 63*b*, and 63*c* are energized in rotation by a system having a distributing switch 65 including a rotary contact arm 66 and circularly arranged cooperating fixed contact shoes 67, 67*a*, 67*b*, and 67*c*. The arm 66 is connected to one side of the line through switch 68 and the contact shoes 67 are connected respectively to one end of each of the solenoid coils 64, the other ends of the solenoid coils being connected to the other side of the line. It will be apparent that upon rotation of the distributing switch arm 66, the coils 64 will be successively energized to vibrate the respective portions of the agglomerating screen 46.

Hoppers 69, 70, and 71 are positioned respectively beneath the first precipitator 45, the agglomerating screen 46 and the second precipitator 47, to receive precipitated dust from these collecting members. It will be understood that conventional electrode cleaning devices may be provided for the precipitators 45 and 47. The hoppers have gates 72, 73, and 74 for the removal of dust.

A system of baffles directs the stream of gas to be cleaned through the cleansing elements of the apparatus. The end partition 75 has gas inlet opening 76 that gives initial direction to the gas stream. Transverse baffles 77 and 78 at the top of the casing prevent gas from flowing over the tops of the collecting elements 45, 46, and 47. Transverse baffles 79, 80, 81, 82, and 83 at the bottom of the casing and in the hoppers substantially eliminate undesired gas flow beneath the collecting elements.

The gas cleaning apparatus of Figs. 3, 4, and 5 is electrically energized in the same manner as the apparatus of Figs. 1 and 2, the high tension electrodes of the precipitators being charged with voltages of opposite sign and the collecting electrodes as well as the agglomerating screen being grounded.

In operation, the precipitators are energized and the screen vibrating system is set in motion. Gas bearing suspended particles of matter to be removed is passed through the apparatus in the direction of the arrow of Figs. 3 and 4. In the precipitator 45, the particles are charged, for example negatively, and are in part precipitated upon the electrodes 52 of the first precipitator. A substantial portion of the charged particles escape from the first precipitator and are brought into contact with the agglomerating screen 46. The screen 46 substantially discharges the particles and some of them collect upon the screen. The remainder of the agglomerated particles are carried by the gas stream into the second precipitator 47 wherein they are charged with electricity of sign opposite to that applied in the first precipitator and are in large measure collected on the cylindrical electrodes 52 of the second pre-

cipitator. That small portion of the particles not collected in the precipitator 47 is carried through the second agglomerating screen 48, where discharge and flocculation of the particles occurs, and thence to the filters 50 and 51, which remove substantially all of the residual suspended matter from the gas stream.

Whereas, the illustrative embodiments of the invention herein shown and described each have a single casing in which are disposed the three gas treating elements, it will be apparent that a unitary casing is not essential, provided suitable means is employed for constraining a mass of gas to be treated to flow in a stream through the three principal treating zones hereinbefore described. It will also be apparent that the casing need not be made of electrically conducting material, as described, but may be made of non-conducting material, in which case the necessary electrical connections to the apparatus elements can be made by conductors passing into or through the casing and directly connected to the elements. Moreover, the intermediate gas contacting means need not be made of metal as long as its gas contacting surfaces are sufficiently conducting to be maintained at a preselected potential under the conditions of operation.

The intermediate gas contacting means located in the flocculating zone may comprise a plurality of wire screens or the like extending across the gas stream and spaced apart in the direction of gas flow to provide additional gas contact surface.

From the foregoing description it will be seen that there has been provided an efficient, simple and very satisfactory air cleaning apparatus. Since modifications will be obvious to those skilled in the art in the light of the disclosure, the invention is not limited to the specific embodiments herein shown and described except as defined by the claims.

This application is a continuation-in-part of my copending application Serial No. 669,917, filed May 15, 1946, now Patent 2,593,377 dated April 15, 1952, entitled "Gas Cleaning Apparatus."

I claim:

1. Gas cleaning apparatus comprising a first electrical precipitator including grounded extended surface electrodes and complementary discharge electrodes, means providing a grounded extended metallic surface, a second electrical precipitator including grounded extended surface electrodes and complementary discharge electrodes, means for conducting a stream of gas to be cleaned successively through said first precipitator, thereafter into substantial contact with said metallic surface providing means, and through said second precipitator, said metallic surface providing means extending substantially across the gas stream and being positioned at a location substantially removed from the influence of an opposing charged electrode, and means for charging the discharge electrodes of said precipitators with potentials of opposite polarity comprising a power transformer having one end of the secondary winding grounded, two rectifier tubes, conductor means connecting the ungrounded end of the secondary winding of the transformer to the anode of one of said tubes and to the cathode of the other of said tubes, and conductor means connecting the free electrodes of said rectifier tubes each to the discharge electrodes of one of said precipitators.

2. An electrical precipitator as defined in claim 1 wherein said metallic surface providing means comprises a zig-zag metallic screen member.

3. An electrical precipitator as defined in claim 2 including means for rapping the metallic screen member.

4. Gas cleaning apparatus comprising a first electrical precipitator including grounded extended surface electrodes and complementary discharge electrodes, means providing a grounded extended metallic surface, a second electrical precipitator including grounded extended surface electrodes and complementary discharge electrodes, means for conducting a stream of gas to be cleaned successively through said first precipitator, thereafter into substantial contact with said metallic surface providing means, and through said second precipitator, said metallic surface providing means extending substantially across the gas stream and being positioned at a location substantially removed from the influence of an opposing charged electrode, and means for charging the discharge electrodes of said precipitators with potentials of opposite polarity comprising a power transformer having one end of the secondary winding grounded, two rectifier means, conductor means connecting the ungrounded end of the secondary winding of the transformer to the anode of one of said means and to the cathode of the other of said means, and conductor means connecting the free electrodes of said rectifier means each to the discharge electrodes of one of said precipitators.

5. Gas cleaning apparatus comprising a casing providing a conduit for the flow of gas therethrough, said casing having disposed therein successively in the direction of gas flow particle-charging means, comprising complementary discharge and extended surface electrodes, means for contacting the gas stream with an extended grounded metallic surface, electrical precipitator means for collecting particles from the gas stream comprising complementary discharge and extended surface electrodes, and means for energizing the discharge electrodes of the particle-charging means, and said electrical precipitator means with potentials of opposite polarity comprising a transformer having one end of the secondary winding grounded, two rectifier means, and conductor means connecting the ungrounded end of the secondary winding connected to the anode of one and the cathode of the other of the rectifier means and conductor means connecting the free terminals of said rectifier means each to the discharge electrodes of the particle-charging means, and the electrical precipitator means.

6. A gas cleaning apparatus as defined in claim 5 including a mechanical gas filter following the electrical precipitator means.

7. A gas cleaning apparatus as defined in claim 5 including means for rapping the metallic surface.

8. Gas cleaning apparatus comprising a casing providing a conduit for the flow of gas therethrough, said casing having disposed therein successively in the direction of gas flow a first electrical precipitator means, a metallic screen member extending transversely of the casing, a second electrical precipitator means, said first and second electrical precipitator means including complementary discharge and extended surface electrodes, means for passing a stream of gas to be cleaned successively through said electrical precipitators and the metallic screen, energizing means for energizing the discharge electrodes of the first and second precipitator means with po-

tentials of opposite polarity and maintaining the metallic screen at a potential midway between that of the discharge electrodes, comprising a transformer having one end of the secondary winding connected to the metallic screen, two rectifier means, and conductor means connecting the other end of the secondary winding connected to the anode of one and the cathode of the other of the rectifier means and conductor means connecting the free terminals of said rectifier means each to the discharge electrodes of the first and second electrical precipitator means.

9. A gas cleaning apparatus as defined in claim 8 wherein the metallic screen member is in a transverse zig-zag form to provide substantial contact with the gas to be treated.

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