My invention relates broadly to means for removing foreign particulate matter from air or other gas by first causing the gas to whirl at sufficiently high velocities to force the particulate matter outwards in the whirling gas, and then separating a particle-laden outer layer from the rest of the gas. More specifically, my invention relates to that type of gas-cleaning means which comprises two concentric tubes forming a gas-passage therebetween in which the gas moves in the general axial direction while whirling about the inner tube.

It is an object of my invention to provide an efficient, compact, rugged and simple gas-cleaning means of the character described which will yield exceptionally good gas-cleaning with tubes of comparatively short axial length. The gas cleaning means including improved limited-size means for directing the clean gas to points of utilization for the gas, so that the gas-cleaning means can be installed in places where only limited space is available, such as, for example, a locomotive.

A further feature of my invention resides in providing gas-cleaning means of the type described in which the entering gas need not be in a direction conducive to producing a whirl in the gas passage. A whirl is positively and forcibly established by means of a propeller at the entrance end of the gas-cleaning means. In the preferred embodiment, the propeller also forces the gas through the gas-cleaning equipment. Suitable stationary vanes may be provided immediately below the rotating propeller to give the gas leaving the propeller a more pronounced whirl. Consequently, the gas is caused to reach a high velocity whirl very shortly after it has entered the gas-cleaning means so that particulate matter in the gas is quickly and effectively driven to the outside portion of the gas stream in a gas-passage of comparatively short length.

By quickly imparting a high rotational movement to the gas-flow as it enters one end of the gas-cleaning equipment and moving the gas forcibly, it can be withdrawn from the opposite end of the gas-cleaning means, without passing the gas in a reverse direction through the inner tube. Improved means are provided for reducing the swirl of the cleaned gas taken from this opposite end of the equipment, and straightening out the flow of the gas so that the gas can be conveniently directed into a straight distributing duct.

Objects, features, innovations and combinations of my invention, in addition to the foregoing, will be discernible from the following description of the important features of a preferred form of the same. This description is to be taken in conjunction with the accompanying drawings, in which:

Figure 1 is a vertical sectional view of apparatus embodying the teachings of my invention;

Fig. 2 is a horizontal sectional view substantially along the line II—II of Fig. 1; and

Fig. 3 is a vertical sectional view substantially along the line III—III of Fig. 3.

Referring to the drawings, gas-cleaning equipment in accordance with my invention comprises an inner member and an outer member providing spaced facing wall-surfaces. These wall-mem bers are indicated in their entirety by the reference numerals 2 and 4, respectively. The wall-mem bers are radially spaced, or nested, in order to provide an elongated gas-passage 8 which is generally annular in cross-section. In the preferred embodiment the wall-mem bers are generally circular in transverse cross-section, and are vertically arranged over a base plate or floor 8, with their axes substantially perpendicular to the floor.

The inner wall-member 2 comprises a stationary vertical cylindrical tube or tubular member 10 comprising a long lower tube-section 12 and a short upper tube-section 14. A rotatable hub is immediately above the upper tube-section 14 and comprises a short cylindrical tube-section 16 and a rounded cap 18 which, in effect, constitutes a closure for the upper end of the tube 16. The tube 10 rests on the floor 8, thereby closing the lower end of the tube.

The outer wall-member 4 comprises a cylindrical tube-section 20, an elongated slightly upwardly tapered section 22 extending downwardly from the tube-section 20, and a sharply flared throat tube-section 24 extending upwardly from the top of the tube-section 20. The tube-section 20 is about and substantially coextensive with the upper tube-sections 14 and 16 of the inner wall-member 2.

Although each of the different tube-sections 20, 22 and 24 of the wall-member 4 and each of the tube-sections 12, 14 and 16 of the wall-member 2 may be said to comprise a tube or tubular member for the equipment, for convenience and limited to the following description of the apparatus, combinations of two or more of the tube-sections of each group are also referred to as a tube or tubular member. Accordingly, the apparatus has an inner tube and an outer tube, the tubes being coaxial. The circular bottom edge 26 of the outer tube is considerably above the floor 8. At the upper end of the concentric tubes,
the flared throat tube-section 24 and the cap 18 form an annular inlet or entrance 28 for the gas-passage 8. The floor 10, which is lower end of the tapered tube-section 22, and the cap 8 form an annular inlet or entrance 28 for the gas-passage 8. The tubular member 16 forming the hub at the top of the inner tube 18, is also part of a propeller 30 having a plurality of airfoil blades 32 circumferentially spaced in the gas-passage 8, at the entrance 28 of the gas-passage. The propeller 30 is of the axial-flow type, with the blades 32 arranged and shaped to force the gas in the gas-passage 8 to flow, in effect, generally axially downward but around the inner tube 10. To this end the blades 32 are at an angle to the plane of rotation of the propeller. The whirl about the tube 16 is increased by stationary airfoil deflector vanes or blades 24 fixed to the section 14 of the tube 16 and extending substantially across the gas-passage 8, near the propeller 30 on the downstream side thereof. The blades 24 cause the flowing gas to make a greater number of turns around the inner tube 10 while the gas is travelling lengthwise, or axially, along the gas-passage 8 from the entrance 28 to a point near the bottom edge 26 of the tapered section 22 of the outer tube. The blades 24 are also at an angle with respect to a horizontal plane. The angles of the different blades 24 and 32 are not critical, and a wide range will produce results. About 35° to the horizontal, but in opposite directions, has given satisfactory operation.

The propeller 30 is driven by any suitable power-supplying means, which in the preferred embodiment comprises an electric motor 40. These are the only continuously moving parts of the gas-cleaning equipment described. Since the inner tube 10 is completely closed against gas-flow through it, the propeller-driving motor 40 can be advantageously and conveniently supported inside the tube, being carried on brackets 42 secured to the upper tube-section 14 of the tube.

The propeller 30, its driving motor and the blades 32 comprise a draft-inducing means which causes the gas through the gas-passage by imparting motion to the gas in a manner illustrated by the arrows A and B which represent the approximate direction of the flow of gas leaving the blades 32 and blades 34, respectively. However, my invention is not limited to the particular draft-inducing means described; and my application Serial No. 369,010 filed concurrently herewith describes a further gas-cleaning means which can be said to be related, in a sense, to that of the instant application.

As the gas moves downwardly while whirling around the inner tube 10, particulate matter in the gas is driven outwardly toward the tube-section 22 so that, after a short time, an outer portion of the flowing gas is considerably heavier laden with particulate matter than a relatively inner portion. If an outermost layer of the gas is separated out of the gas-flow, the remaining gas is comparatively clean and can be utilized for such purposes as ventilation of electrical equipment on locomotives or any other suitable purpose.

In order to skim off an outer portion of the dirt-carrying gas, a vertical cylindrical skimmer or partition wall 44 is provided having an upper portion which is inwardly radially spaced from, and overlaps, the lower end of the tapered tube-section 22 of the outer tube so as to form an outer particle- or dirt-receiving passage 46 into which the outer layer of gas, carrying the most dirt, flows. Specifically, the wall 44 has an upper circular edge 48 which is slightly upstream of the bottom edge 26 of the tapered tube-section 22. The wall 44 extends downwardly between the edge 26 to a horizontal wall 50 which is above the edge 26 and has an opening for receiving the gas.

The outside of the wall 44, the horizontal wall 50 and outer walls 52 and 54 form an annular-like compartment or duct 66 for the skimming-off of dirt-laden gas. The bottom portion of the wall 52 is provided with a plurality of openings 58 through which the dirt-laden gas in the duct 58 discharges to the atmosphere about the gas-cleaning equipment, the skimmed-off gas acting as a scavenging gas for carrying the dirt out of the compartment 66. A sloping deflector 69 may be provided in the compartment 56 for more effective removal of the dirt.

The space between the wall 44 and the lower tube-section 12 of the inner tube 16 provides an annular gas-passage or compartment 72 for cleaned gas, the gas-passage 62 being, in effect, an extension of the gas-passage 8. A plurality of circumferentially spaced curved vanes 64 are fixed in the gas-passage 62 for removing the whirl of the clean gas leaving the compartment 72 and horizontally straight downward into a compartment 66 which is below the wall 44 and the dirt-receiving duct 56. The compartment 56 is provided with a plurality of different sets of curved vanes about the bottom portion of the tube-section 12 of the inner tube 10, for deflecting the gas into an outlet duct 68 from which a supply of cleaned gas may be taken for use wherever desired. The aforesaid sets of vanes comprise a set of vanes 70 which acts on the gas from the half of the gas-passage 52 which is nearest the outlet duct 56, and deflects such gas directly longitudinally into a central duct-pair 72 of outlet duct 56, and oppositely directed sets of vanes 74 which acts on the other half of the cleaned gas, deflecting such gas horizontally outwardly in both directions toward sets of vanes 78 which are curved for deflecting the gas longitudinally into the outlet duct 68 on both sides of the duct-pair 72. Consequently, the motion of the cleaned gas is changed from the downwardly whirling motion in the gas-passage 6 to substantially rectilinear motion in the outlet duct 68.

From the foregoing, it is apparent that I have provided means for conveniently removing the means of the cyclone type through which the gas need move in a substantially longitudinal direction only. If desired, the gas-passage 62 can be extended beyond the vanes 64, and cleaned gas taken directly from the extended part of the gas-passage, because the vanes 64 straighten the gas-flow.

The propeller 30 supplies sufficient drive to force the gas through the gas-cleaning means, but the draft may, if desired, be augmented by a suction in the outlet duct 68.

While I have described my invention with reference to a particular embodiment, it will be obvious that the teachings of my invention have broader scope and can form the basis of other embodiments; and that even the particular embodiment described can be widely modified without departing from the scope of my invention.

I claim as my invention:

1. A gas-cleaning means comprising, in combination, upstanding nested walls forming a gas-passage having a gas inlet at one end, said nested walls comprising an inner tubular member and an outer tubular member bounding said gas-passage; draft-inducing means comprising vanes and a propeller for establishing a draft through...
said gas-passage with the gas whirling about said inner tubular member; a gas-divider intermediate upstanding tubular wall inside of but spaced from an end of said outer tubular member; a horizontal wall having an opening receiving said intermediate wall end extending outwardly therefrom; additional walls cooperating with said horizontal wall, said intermediate wall, and said end of said outer tubular member for providing a dirt-receiving duct; a second horizontal wall below the said first horizontal wall; said inner tubular member extending downwardly to said second horizontal wall; said first and said second horizontal walls cooperating with further walls to form an outlet duct extending outwardly from said intermediate wall and said inner tubular member; vanes between said inner tubular member and said intermediate wall for reducing the whirl of gas flowing therebetween; and vane means and divider-wall means in the space between said first and said second horizontal walls for directing gas leaving said vanes longitudinally into said outlet duct.

2. In gas-cleaning apparatus of a type described, in combination, a pair of upstanding spaced inner and outer members providing a gas-passage therebetween, the inner member having a lower wall-portion extending below the outer member; curved whirl-reducing vanes in the space directly between said spaced members; walls, including horizontal walls, forming an outwardly-directed duct below said outer member, said duct being wider than said outer member; said gas-passage opening into said duct; wall means inside said duct, cooperating with said lower wall-portion, providing a distinct outwardly directed duct-section in said duct which is in communication with said gas-passage; deflecting vanes disposed in said duct-section and below said gas-passage so as to receive a portion of the gas leaving said whirl-reducing vanes, said deflecting vanes being curved to direct such gas rectilinearly into said duct-section; and additional deflector vanes disposed in said duct below said gas-passage so as to receive another portion of the gas from said whirl-reducing vanes, said additional deflector vanes being curved to direct such gas rectilinearly in said duct along a side of said duct-section.

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