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APPARATUS FOR SEPARATING SUSPENDED MATERIAL FROM GASES

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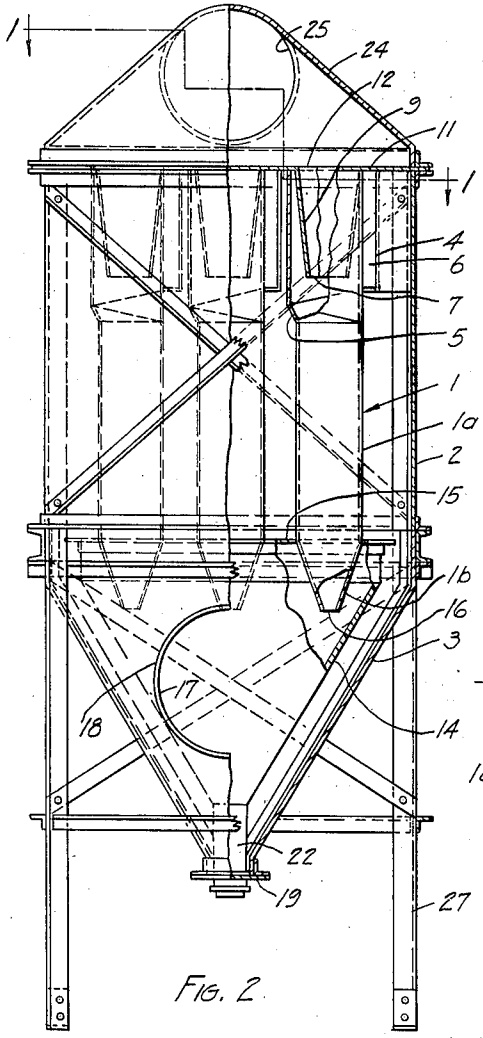

FIG. 2

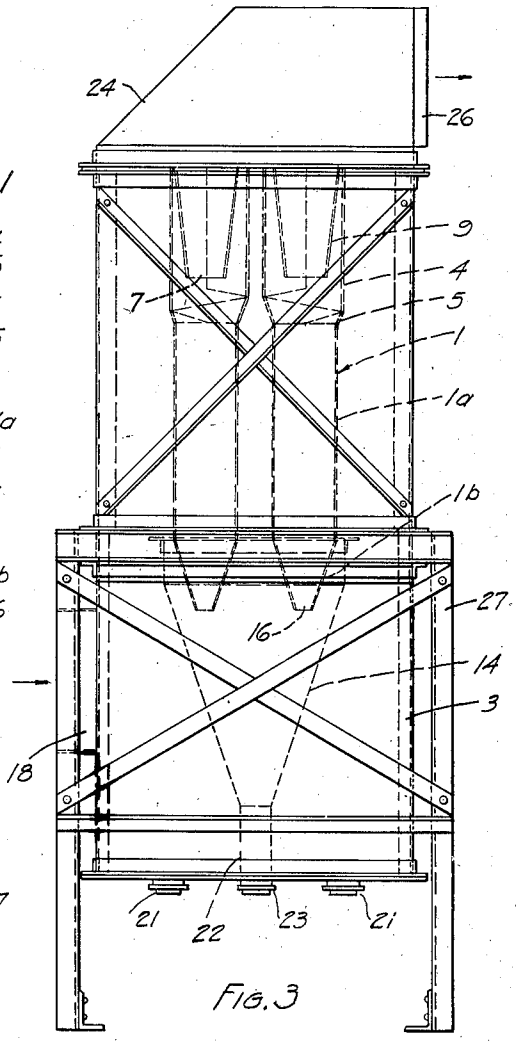

FIG. 3

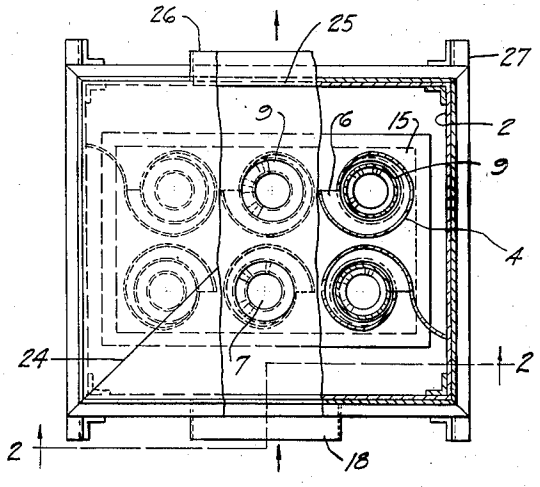

FIG. 1

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APPARATUS FOR SEPARATING SUSPENDED MATERIAL FROM GASES

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6 Claims. (Cl. 183—83)

This invention relates to the treatment of gases or vapors for the purpose of removing suspended material therefrom, and more particularly to apparatus for effecting such removal of suspended material by means of cyclonic or vortical action in the gases or vapors being treated.

This application is a division of our application Ser. No. 403,003 filed October 28, 1929.

An important object of the invention is to provide an apparatus which is adapted to effect a highly efficient separation of suspended material from gases by centrifugal action, and which is provided with improved means for maintaining the walls of the separating apparatus at substantially the same temperature as the gas passed therethrough.

A particular object of the invention is to provide an apparatus in which heat contained in the gases delivered to the apparatus is utilized to maintain the walls of the separating apparatus at a temperature higher than that of the surrounding atmosphere.

A further object of the invention is to provide a centrifugal gas cleaning apparatus having a plurality of centrifugal separating elements and provided with novel and advantageous gas inlet and gas outlet means for effecting passage of gas through all of said elements in parallel.

The invention is particularly applicable to a type of centrifugal gas cleaning apparatus having one or more of axially elongated tubular separating elements of circular cross-section, each of which separating elements communicates at one end with an inlet chamber common to all of said elements and is provided at that end with inlet means adapted to deliver gas into said element in a substantially tangential direction or with a whirling motion, and is also provided at the same end with centrally disposed gas outlet means, and is further provided at the other end with a restricted central outlet opening for separated material communicating with an enlarged receiving chamber common to all of the elements. In the operation of such apparatus the gas carrying suspended material is kept in active whirling or vortical motion throughout its passage through each separating element, while at the same time moving in a compound vortical motion from the inlet means to the outlet means. In such compound vortical motion the gas passes first in an outer vortex moving in a general direction from the inlet means toward the separated material outlet, and passes gradually inwardly into an inner vortex moving in the reverse direction toward the gas outlet means. By the vortical motion of the gas, the particles of suspended material contained therein are forced outwardly by centrifugal action, and accumulate adjacent the walls of the separating elements. The velocity of gas flow through the apparatus is preferably maintained sufficiently high to cause the downward whirling motion of the external vortex to persist throughout the length of each separating element and at the restricted central outlet opening for separated material at the end opposite the inlet means. The separated particles are thus carried downwardly by the frictional effect of the downwardly moving gas, and also by gravity, and are finally discharged through the restricted outlet openings into the common enlarged receiving chamber.

While the maintenance of active whirling motion in the gas at these restricted dust outlet openings is ordinarily effective in insuring the discharge of all separated particles into said receiving chamber and preventing accumulation thereof on the walls of the separating elements, it has been found that, in the removal of certain types of suspended materials from gases there is a tendency for the separated material to stick together and to the walls of the separating elements, particularly at the portions of said walls adjacent the dust outlet openings. Said sticking is found to occur most commonly in the cleaning of gases which enter the apparatus at a temperature above atmospheric temperature and which are of sufficiently high relative humidity so that, if the walls of the separating elements are subjected to cooling by the atmosphere, these walls and the gas coming in contact therewith are cooled sufficiently to cause condensation of moisture to occur within the separating elements. This condensation of moisture tends to moisten or wet the separated solid particles and cause the same to stick to one another and to the walls of the separating elements. This is particularly true with certain classes of solid materials, such as powdered milk or powdered products derived from milk, which have a great tendency to become sticky in the presence of even a small amount of condensed moisture.

According to the present invention the common inlet chamber through which the gas is introduced to all of the separating elements is formed as a housing surrounding the separating elements, preferably throughout the entire length thereof, and the incoming gas is delivered to said housing at a position adjacent the dust outlet ends of said elements and remote from the gas inlet ends of said elements, so that this incoming gas is caused to pass around and in contact with the external walls of said elements before entering the interiors thereof, thus causing the walls

of said elements to be maintained at substantially the same temperature as the gas, and preventing cooling thereof by the surrounding atmosphere. In this manner condensation of moisture within the separating elements is substantially prevented and the tendency to sticking of the separated material is eliminated.

The centrally disposed gas outlet means of the several separating elements may open directly to the atmosphere, or may communicate with a common gas outlet means extending over the ends of said elements.

The accompanying drawing illustrates a form of separating apparatus according to this invention, and referring thereto:

Fig. 1 is a partly sectional plan view of such apparatus, on line 1—1 in Fig. 2.

Fig. 2 is a partly sectional front elevation thereof on line 2—2 in Fig. 1, with parts broken away.

Fig. 3 is a side elevation, taken from the right side of Fig. 2.

The separating elements of the apparatus may be disposed in any desired direction, either vertically, horizontally, or at any suitable angle. However, one of the simplest forms of construction is obtained by placing these separating elements in vertical or upright position, as shown in the drawing, and the following description will therefore be directed to an apparatus in which the separating elements are so disposed. When so disposed, the gas inlet means for the respective separating elements and the central gas outlet openings thereof are preferably provided at the upper ends of said elements, and the restricted dust outlet openings at the lower ends thereof. However, as above stated this particular disposition is not essential and it will be understood that reference herein to the upper ends of the separating elements refer in general to the ends of the separating elements at which the gas inlet and gas outlet openings of the respective elements are located, and references to the lower ends of said separating elements refer in general to the ends of the respective elements at which the restricted dust outlet openings are located.

The apparatus is shown as comprising a plurality of axially elongated tubular separating elements 1 of circular cross-section disposed vertically within a casing 2 having a tapering or hopper-shaped bottom portion 3. Each of said separating elements preferably comprises, as shown, a cylindrical portion 1*a* extending throughout the major portion of the height thereof, and a conical or inwardly tapering bottom portion 1*b* below said cylindrical portion. Each of said separating elements is also provided at its upper end with inlet means adapted to deliver gas thereto in a substantially tangential direction or with a whirling motion. Said inlet means is shown as comprising a substantially involute-shaped wall portion 4 disposed above the cylindrical portion 1*a* and connected thereto by a suitably shaped sloping shoulder portion 5. The wall portion 4 is shown as extending through one complete revolution, the inner end thereof being substantially tangent to the prolongation of the cylindrical portion 1*a*, and the outer end thereof being spaced radially outward from said inner end so as to provide an opening 6 therebetween. Each separating element is also provided with a centrally disposed gas outlet opening 7 adjacent the upper end thereof, said gas outlet opening being preferably provided at the lower end of a frusto-conical outlet pipe 9 disposed within the wall portion 6 and coaxial with respect to the separating element 1. The outlet opening 7 is preferably at approximately the same level as the lower end of the inlet opening 6. A top plate 11 extends over the upper ends of all of the separating elements and serves to close the upper end of the common inlet chamber provided by casing 2 and also to close the upper ends of the spaces between the involute-shaped wall portions 6 and the central outlet pipes 9. Said plate 11, however, is provided with openings 12 disposed over the upper ends of the respective outlet pipes 9 so as to permit outflow of gas therethrough.

Within and spaced from the hopper-shaped bottom portion 3 of housing 2, there is provided a hopper-shaped dust-receiving chamber 14 provided with a cover plate 15. The conical portions 1*b* of the respective separating elements are shown as extending through said cover plate 15 and projecting into the dust-receiving chamber 14, and are provided at their lower ends with restricted dust outlet openings 16. The hopper-shaped bottom portion 3 of housing 2 is provided at one end with an inlet opening 17 having a collar 18 for connection to a flue or conduit through which the gases to be cleaned are delivered to the apparatus. The bottom of this hopper-shaped portion is closed by a plate 19 which may be provided with one or more discharge doors 21 for removal of any material which may settle or deposit therein. The dust-receiving hopper 14 is provided at its lower end with a dust discharge tube or pipe 22 extending downwardly through plate 19 and provided with a discharge gate or valve 23.

An outlet header 24 is shown as disposed above the top plate 11 and communicating with the outlet pipes 9 of all of the separating elements, through the openings 12 in said top plate. Said outlet header is provided at one end with an outlet opening 25 having a collar 26 or other suitable means for connection to a flue or conduit through which the cleaned gas is conducted from the apparatus.

The entire structure is shown as mounted on a suitable supporting frame indicated at 27, although it will be understood that any desired form of supporting means may be provided.

In the operation of the above-described apparatus, the gas containing dust or other suspended material is delivered through inlet opening 17 into the hopper-shaped bottom portion 3 of casing 2 and passes upwardly around dust-receiving chamber 14 and around the several separating elements 1 to the individual inlet openings 6 of the several separating elements. The casing 2 with its hopper-shaped bottom portion 3 thus constitutes a common inlet chamber for delivering gas substantially uniformly to the inlet openings of all the separating elements, and said common inlet chamber is seen to surround the separating elements throughout substantially the entire length thereof and also to surround the dust-receiving chamber 14.

The gas then passes through the respective separating elements in the manner above described, and the clean gas is delivered through outlet pipes 9 to the outlet header 24, while the dust or other suspended material separating from the gas by centrifugal force due to the vortical motion of the gas within the separating elements is discharged through the restricted openings 16 into the receiving chamber 14. The velocity of gas flow through the apparatus is preferably maintained sufficiently high to cause the active whirling mo-

tion of the descending outer vortex to continue throughout the length of the separating elements and at the discharge openings 16, thus promoting the discharge of separated material through said openings. The material collected in said receiving chamber may be discharged therefrom through discharge means 23. Also, any material settling from the gas by gravity within the inlet chamber 2 accumulates at the bottom of the hopper portion 3 and may be discharged therefrom through discharge means 21.

As above stated, the apparatus is particularly adapted for use on gases above atmospheric temperature and having a high relative humidity, particularly when the suspended material to be removed from such gases is of such a nature as to become sticky in the presence of moisture. Under these conditions, the passage of the incoming gas around the receiving chamber 14 and the separating elements 1 causes the walls thereof to be maintained at substantially the same temperature as the gas, so that substantially no cooling of the gas occurs within the separating elements. This prevents condensation of moisture within said elements or upon the separated particles therein. The separated particles, therefore, remain in substantially dry condition and pass readily down along the walls of the separating elements and through the outlet openings 16. The tendency of such material to become sticky and adhere to the walls is eliminated, and such walls are kept in substantially clean condition. This not only prevents clogging of the outlet openings 16 which would seriously interfere with the proper operation of the apparatus, but also prevents injury to the collected material which might occur if it were permitted to accumulate at this point instead of being removed from the apparatus. The condensation of moisture within the receiving chamber 14 is also substantially prevented, so that the material collected therein is also kept in substantially dry condition so as to prevent caking thereof and facilitate the removal thereof through discharge means 23.

We claim:

1. An apparatus for separating suspended material from gases comprising a plurality of elongated tubular separating elements of circular cross-section each provided with inlet means at one end adapted to deliver gas thereto with a whirling motion, each of said separating elements being further provided with centrally disposed gas outlet means adjacent the same end as said inlet means and with a restricted central outlet opening for separated material at the other end thereof, and a common gas inlet chamber formed as a casing surrounding all of said separating elements and communicating with said inlet means of all of said separating elements and provided with an inlet opening for introduction of gas to said casing at a position adjacent said other ends of said separating elements.

2. An apparatus for separating suspended material from gases comprising a plurality of elongated tubular separating elements of circular cross-section each provided with inlet means at one end adapted to deliver gas thereto with a whirling motion, each of said separating elements being further provided with centrally disposed gas outlet means adjacent said one end thereof and with a restricted central outlet opening for separated material at the other end thereof, and a common gas inlet chamber formed as a casing surrounding all of said separating elements throughout substantially the entire length of said elements and communicating with said inlet means of all of said elements and provided with an inlet opening for introduction of gas to said casing at a position adjacent said other ends of said separating elements and remote from the inlet means of the respective elements.

3. An apparatus for separating suspended material from gases comprising a plurality of elongated tubular separating elements of circular cross-section each provided at one end with inlet means for introducing gas thereto with a whirling motion, each of said separating elements being also provided with centrally disposed gas outlet means adjacent said one end and with a restricted central outlet opening for separated material adjacent the other end thereof, a common material-receiving chamber connected to said other ends of all of the separating elements in such manner as to receive separated material discharged through the restricted central outlet openings thereof, and an inlet chamber formed as a casing surrounding all of said separating elements and said material-receiving chamber and communicating with the inlet means of all of said elements and provided with an inlet opening at the portion thereof surrounding said material-receiving chamber.

4. An apparatus as set forth in claim 3, said material-receiving chamber and said inlet chamber being each provided with separate means for discharge of collected material therefrom.

5. An apparatus for treating gases comprising a plurality of tubular separating elements, each having an elongated chamber of circular cross-section and also having individual inlet means at one end adapted to deliver gas substantially tangentially into said chamber adjacent the outer wall thereof and a restricted outlet for separated material at the other end, common gas inlet means for delivering gas to the inlet means of the respective separating elements, and a clean gas outlet pipe disposed substantially centrally of each element and adjacent the same end as said individual inlet means, said common gas inlet means comprising a casing surrounding said separating elements and communicating with the individual inlet means of said elements, and provided with an inlet opening for introduction of gas at a point adjacent said other ends of the separating elements.

6. An apparatus for treating gases comprising a plurality of tubular separating elements, each having a vertically elongated chamber of circular cross-section and also having individual inlet means at its upper end adapted to direct gas downwardly into said chamber and adjacent the outer wall thereof with a vortical motion, and a clean gas outlet pipe disposed substantially centrally of said element and within said inlet means, the lower end of said outlet pipe being open and being substantially at the level of the upper end of said elongated chamber, a common material receptacle, all of said separating elements opening freely into said material receptacle through restricted openings at the lower ends of the respective separating elements, and common gas inlet means for delivering gas to the individual inlet means of the respective elements, said common gas inlet means comprising a casing surrounding said separating elements and communicating with the individual inlet means of said elements, and having a gas inlet opening adjacent the lower ends of said elements.

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