June 19, 1962 K. G. LYTTON ETAL 3,039,151

PNEUMATIC SEPARATOR

Filed April 20, 1960 3 Sheets-Sheet 1

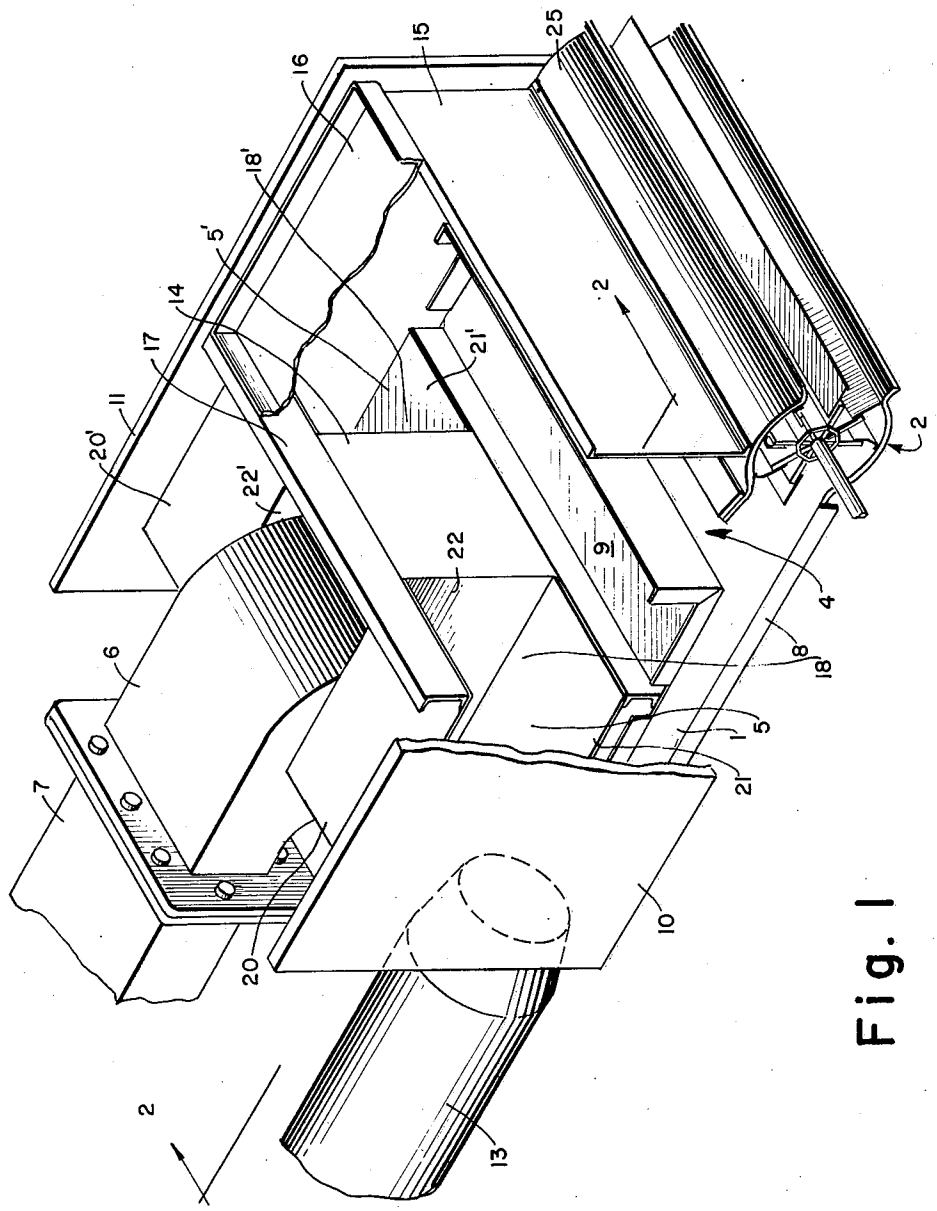

Fig. 1

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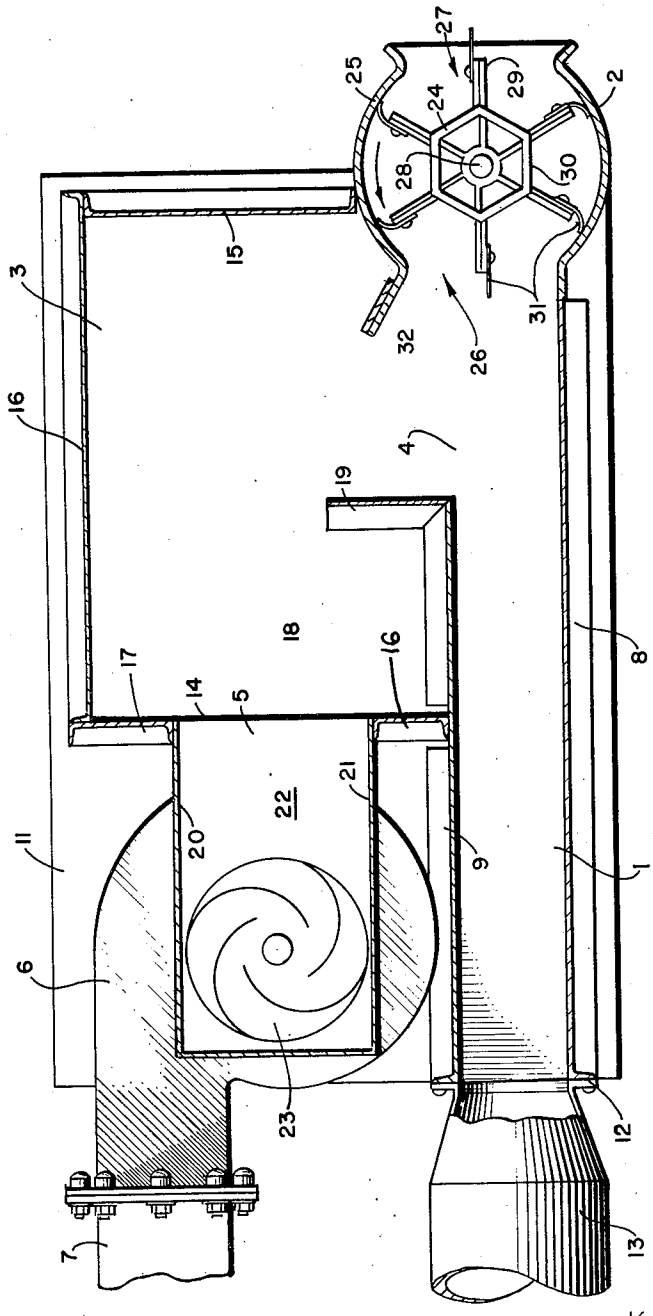

Fig. 2

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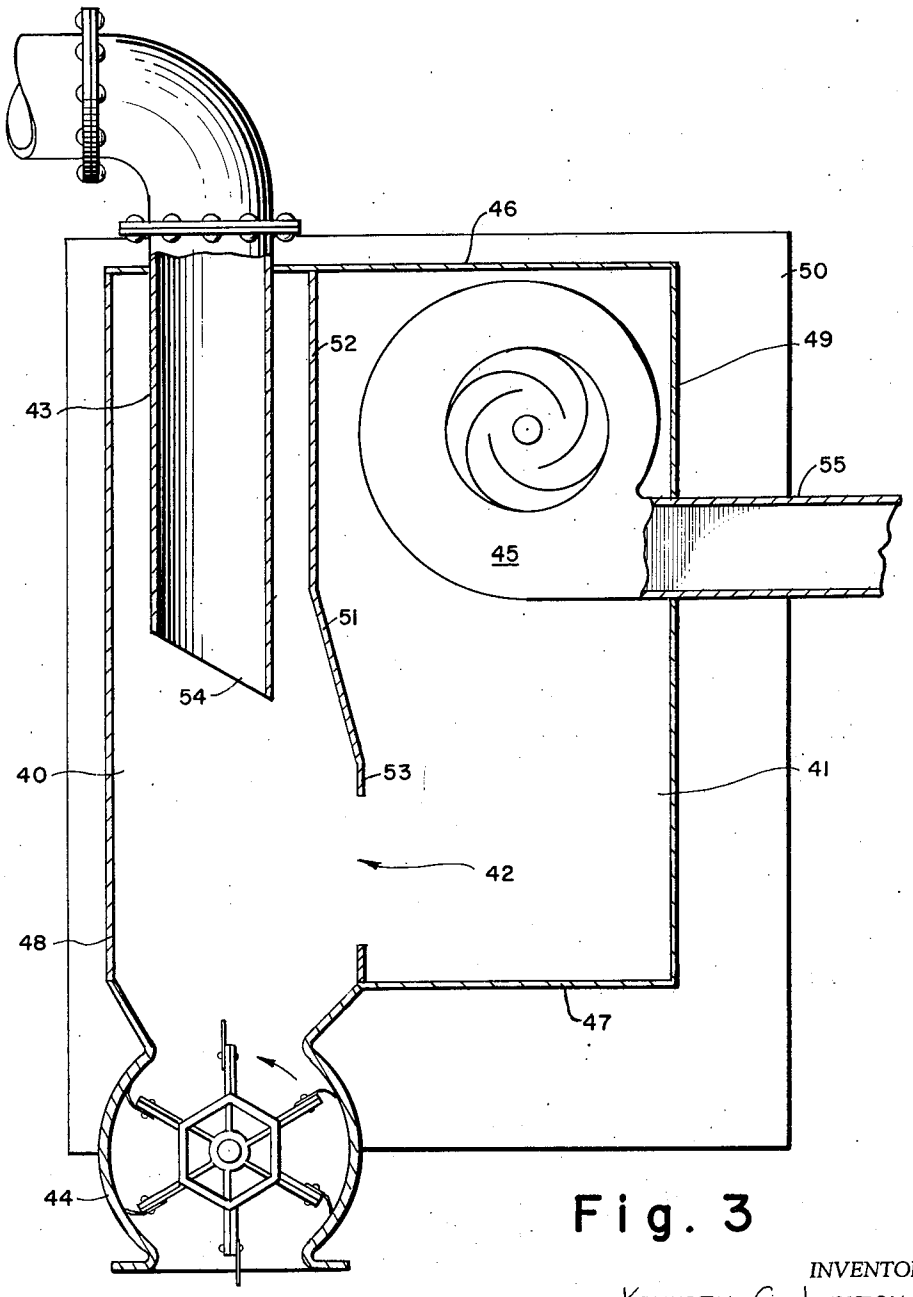

Fig. 3

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3,039,151

PNEUMATIC SEPARATOR

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The present invention relates to material handling and separation and more particularly to a method and an apparatus for separating fiber particles from a moving air column in which they are entrained.

In the manufacture of fabrics containing blended textiles, such as wool-nylon blends and the like, it is common to blend together staple fibers of the several textile components. The blending operation requires the handling and conveying of the fibers from one part of a factory to another, and, for this purpose, the fibers are suspended in a moving column of air which is drawn or pushed through conduits. When the fibers reach their destination, they must be recovered from the air column, and various techniques have been employed for this purpose. For example, the air column can be passed through a fine mesh screen and then the fibers can be doffed from the screen. This technique has the disadvantage that the fibers are often compacted on the screen, thus destroying the fluffiness of the fibers.

An object of the present invention is to provide a method for removing fibers from a column of air moving in a duct or confined path and having the fibers suspended therein by communciating the column with a low pressure source disposed laterally from the moving column through an opening in the duct having a cross-sectional area at least twice that of the duct.

A further object is to provide a method for separating fibers from a moving column of air in which they are suspended in which the column of air is moved in a duct and communicated with a low pressure source through a lateral opening in the duct and the fibers are caught as they travel straight ahead while the air is drawn through the lateral opening.

Another object of the invention is to provide a separator in which a moving column of air is drawn through a duct having means to continuously withdraw air from the duct in a generally lateral direction through a lateral opening in the duct, and a valve mechanism for catching the fibers which are carried forward to remove them from the chamber without substantially transferring air between the interior of the apparatus and the outside atmosphere.

Other objects and purposes of the invention will be made more clear by reference to the following description of a preferred embodiment which may be better understood by reference to the drawings in which:

FIG. 1 is a perspective view of the apparatus, partially cut away to show interior parts;

FIG. 2 is a section along line 2—2 of FIG. 1; and

FIG. 3 is a vertical section of a modified apparatus.

The separator shown in FIGURES 1 and 2 includes a rectangular duct or confined path 1, a valve 2 at one end of the duct, and a ballast chamber 3 at one side of the duct. The duct is connected to the ballast chamber through an opening 4 and exhaust ducts 5 and 5', which are connected to the ballast chamber at a point remote from the opening 4, lead to an exhaust blower or low pressure source 6 at the ends of the exhaust ducts. In order to carry the air recovered from the fibers to the outside air, suitable ducts 7 are connected to receive the exhaust of the blower 6 and they lead to a suitable discharge point.

The rectangular duct or confined path 1 has a horizontal base plate 8, a horizontal top plate 9 spaced above and generally parallel to the base plate and is enclosed, at

the sides, by vertical side walls 10 and 11 which extend upwardly above duct 1 to serve as walls for other chambers or ducts. One end of the duct is closed by a suitable plate 12 which has fittings suitable for connection to conduits 13 conveying fiber-air suspensions to the separator such as by flange to flange couplings as shown in FIGURE 2. Near the other end of the conduit, the top plate 9 is cut away to provide an opening 4 for expansion of air into ballast chamber 3.

Ballast chamber 3 is enclosed by end walls 14 and 15, a cover plate 16 and parts of the upper portions of side walls 10 and 11. End wall 15 rests on the cover of valve 2 and a reinforcing channel iron 16 stands on top plate 9 and forms the support for end wall 14. At the top of the end wall 14 there is another channel iron 17, which, together with channel iron 16 provides added reinforcement for the separator and the base portions of these channel irons form part of the enclosing wall for ballast chamber 3. To permit withdrawal of air from the ballast chamber, end wall 14 has spaced square, or other shaped openings 18 and 18' and there is a small baffle plate 19 extending upwardly into the ballast chamber from the top plate 9 and at the edge of opening 4 to prevent turbulence in the air expanding from duct 1 ultimately to be evacuated through openings 18 and 18'.

The exhaust ducts through which air is drawn from the ballast chamber are connected with the ballast chamber at openings 18 and 18' and have horizontal upper panels 20 and 20', horizontal lower panels 21 and 21' and opposed vertical panels 22 and 22'. The exhaust ducts are flush with the upper portions of side walls 10 and 11 and these form the outer walls of the exhaust ducts. For exhaust of air from the ducts, there are opposed circular openings 23 in central panels 22 and 22' and a centrifugal type exhaust blower 6 is fitted into the space between exhaust ducts 5 and 5', its intake openings aligned with openings 23.

The valve 2 at the end of the confined path is a paddle wheel 24 in a cylindrical casing 25 having opposed sides cut away at 26 and 27 to provide an entrance into and an exit from the valve, the entrance being at the end of the confined path 1. The paddle wheel is mounted on a central shaft 28 which carries paddles 29, reinforced by a hexagonal brace 30, and resilient seals 31 extend from the outer ends of the paddles into engagement with the walls of the cylindrical casing. Suitable means are provided for turning the central shaft such as an electric motor, not shown. A guide 32 extends from the inner and upper edge of the cylindrical casing into the entrance to the ballast chamber in order to direct into the valve any fibers which may be carried upwardly toward the ballast chamber 3 by the air.

In use, a column of air carrying suspended fibers flows through conduit 13 into the separator and into rectangular duct 1. As the column of air reaches the vicinity of opening 4 it is drawn into the ballast chamber 3 which is continuously evacuated by blower 6. At the same time the fibers continue on in the original direction of travel and are swept out of the separator through valve 2, by the rotating paddle wheel, which prevents transfer of air between the separator and points beyond the valve. Of course, a small amount of air is swept into the separator as the valve blades are turned but air is also swept out by the valve so that the net flow of air through the valve is small.

In the modified form of the invention shown in FIGURE 3 the air column flows downwardly rather than horizontally, and air is diverted laterally rather than upwardly, but the principle of operation is the same. The separation may be aided by the attraction of gravity drawing the fibers downwardly, but the separation is effected principally by the momentum of the fibers driving

them along their original downward path while the air is drawn off. This modified separator has a vertical confined path or duct 40 in which air and fibers flow, a ballast chamber 41 connected to the duct through an opening 42, a vertical inlet pipe 43 extending into the duct 40 to a point near opening 42, valve 44 at the lower end of the duct 40 to withdraw fibers and a blower or vacuum source 45 in the ballast chamber 41 to withdraw air and expel it to outside the separator.

In detail, the duct 40 and the ballast chamber 41 are separate compartments of a single cabinet having upper and lower walls 46 and 47, end walls 48 and 49, a rear wall 50 and a front wall, not shown, but generally parallel to rear wall 50. The cabinet is divided by a panel 51 which separtes duct 40 from ballast chamber 41. The panel has upper and lower sections 52 and 53 respectively, the lower section being further from end wall 48 than the upper section to provide an enlargement in the duct 40 in the lower portion thereof. The inlet pipe 43 passes through the upper wall 46 and extends down into the enlarged portion of the duct and its lower end 54 is tapered upwardly and away from openings 42 to prevent drafts of air from drawing the fibers toward opening 42.

The valve 44 at the lower end of the duct 40 is essentially the same as valve 2 shown in FIGURES 1 and 2. Blower 45, which is in ballast chamber 41, has lateral openings to withdraw air from the chamber, and its discharge pipe 55, extends through end wall 49.

As an air-fiber suspension flows through the inlet pipe 43, the air expands on reaching the lower end of the tube into the duct 40 and then into the ballast chamber 41. Air is continuously removed by the blower and the air flows generally from the end of the inlet pipe 43 to the blower, the direction of travel of the air being turned through an angle of about 135° as shown in FIGURE 3.

The present invention provides a method and apparatus for separating suspended fibers from a moving column of air by communicating the column of air with evacuating means disposed generally laterally of the direction of travel of the air column. As a result, the forward flow of air along its original direction of travel is reduced or stopped while the fibers continue to move in that forward direction to a receiver, carried by their own momentum. The column of air passes through the duct and is communicated wth the low pressure source through an opening in the duct having at least twice the cross-sectional area of the duct, and preferably the low pressure source is separated from the duct by a ballast chamber, so that the moving air column can flow toward the low pressure source more smoothly and evenly.

The low pressure source may be a suction fan, vacuum pump or similar device, and, as the air column reaches the section of the confined path adjacent the lateral opening, the air is drawn toward the low pressure source and, so to speak, flows away from the fibers. The direction in which this air flows away is such that the air flow turns from its original direction through an angle of from 45° to 180° to be drawn by the low pressure source, and an angle of 180° is preferred. Such angles provide the most rapid withdrawal of air from the air column and avoid currents of air which would carry the fibers along. If the angle was less than 45° the fibers might be carried along with the air. At a small angle the effect probably would be similar to increasing the size of the duct slightly so that the air would not flow away from the fibers, but, at a large angle, the withdrawal of air is more rapid and separation is effective. The fibers are not drawn along with the air expanding toward the low pressure source, since their momentum carries them forward.

The reason for the successful separation of air from fibers is not fully understood, but certain physical laws, particularly the so-called Bernouli principle, probably are applicable. This principle states that the pressure in a moving column of a fluid, such as air, is increased when there is a decrease in speed of the air.

If air is flowing through a duct having a varying cross-sectional area, the speed of the air is greatest as the air flows through the portions of the duct having the smallest cross-section. This follows from the fact that the same amount or mass of air flows past each point along the duct at any given time and that mass of air must move at a greater speed past the narrower parts of the duct so that the same mass of air will flow through them as will flow thorugh the wider portions of the duct. As a result of this increased speed, the pressure of the air will be lowest at the narrower parts of the duct.

Applied to the present invention, it will be observed that the opening in the duct, through which the suspension of fibers and air flows, has a cross-sectional area at least twice that of the duct itself. As the air is drawn through this opening the effect should be one of increasing the duct size so that its speed probably is reduced, thus drawing the air off slowly and evenly. In addition, since the speed of the air is slower as it goes through the lateral opening than it is in the duct, its pressure probably increases as it goes through the opening. If the pressure increases, this provides a back pressure preventing any sudden drafts of air through the lateral opening which would be apt to sweep fibers along.

This pressure differential might have another effect if the pressure in the lateral opening were higher than along the duct. Since the frictional resistance of the air against the fibers is lower where the pressure is lower, the fibers would tend to move more freely along their original path than against this back pressure. That is, as the pressure decreases, the viscosity or frictional resistance of the air column is reduced, which reduces the frictional forces between the air column and the fibers so that the momentum of the fibers carries them forward through the air. For the same reason, if the pressure in the lateral opening of the separator is greater than in the duct, the back pressure in the opening will resist movement of the fibers through the opening and will continue along their original direction of travel in the duct which should have a lower pressure.

The ballast chamber also would be significant in the application of this theory. This chamber actually could be looked upon as a large duct having a cross-sectional area even larger than the opening between it and the duct carrying the fiber-air suspension. It then would further slow the air speed and provide additional back pressure, thus aiding in the smooth removal of air from the fibers.

The above theory forms no part of the invention, and is included herein as a possible explanation for the operation of the apparatus and method described herein.

The present invention also provides a valve at the end of the confined path through which the fibers and air travel to catch the fibers freed from the air column as described above. The valve continuously removes the fibers into bags or other receptacles while preventing the introduction into the air column of more than a minimum of air, thus avoiding interference with the pressure of the air column. One form which this may have, as described above, is a rotating paddle wheel at the end of the duct which carries the fibers and the air column, the wheel having an axis extending transversely across the duct. The paddles seal against the top and bottom of the duct, and, as the paddle wheel turns, it catches the fibers and sweeps them into a receiver.

Although the above description has referred to the use of air, it is obvious that any other gas could be used.

Suitable operating conditions for the separator include air speeds of 3400 feet per minute at the inlet, 1700 feet per minute at the throat opening, 1000 feet per minute at the first doffer and 400 feet per minute at the second doffer. The throat opening is 6" x 36".

This application is a continuation-in-part application of our earlier application Serial No. 654,735, filed April 24, 1957.

While preferred embodiments of the invention have been described it should be understood that various changes and modifications may be made in the details of construction of the apparatus and specific steps of the method without departing from the scope of the invention as set forth in the claims.

What is claimed is:

1. A method of separating fibers from a moving column of air in which they are suspended which comprises passing said column of air through a confined path, communicating said moving column of air with a low pressure source through an area having a cross-section at least twice the area of said confined path, the area being positioned to change the direction of travel of said moving column of air to permit the fibers to leave the moving column of air as the direction of movement thereof is changed, and collecting the fibers as they move along substantially their original direction of travel after they leave the moving column of air.

2. A method of separating fibers from a moving column of air in which they are suspended which comprises passing said column of air through a confined path, communicating said moving column of air with a low pressure source through an area having a cross-section at least twice the area of said confined path, the area being positioned to change the direction of travel of said moving column of air to permit the fibers to leave the moving column of air as the direction of movement thereof is changed, and collecting and discharging the fibers as they move along substantially their original direction of travel after they leave the moving column of air without substantially introducing air into said moving column from outside said confined path.

3. A method of separating fibers as set forth in claim 2 in which the low pressure source is positioned to change the direction of travel of the column of air through an angle between 45 and 180°.

4. A method of separating fibers as set forth in claim 3 in which said angle is 180°.

5. A method of separating fibers as set forth in claim 2 in which said moving column of air is communicated with a ballast chamber from which the air is evacuated by a low pressure source and the direction of travel thereof is changed.

6. A method of separating fibers as set forth in claim 2 in which the fibers are caught and discharged by a rotating paddle wheel.

7. A separator for removing fibers from suspension in a moving column of air which comprises a duct providing a confined path of said column of air, a low pressure source positioned laterally of said confined path, means communicating said low pressure source with said duct, and valve means positioned along the direction of travel of said moving column of air to catch fiber particles freed from the moving column as the direction of travel thereof is changed, and discharge the fibers from the separator without substantially introducing air into said separator.

8. A separator for removing fibers from suspension in a moving column of air which comprises a duct providing a confined path for said column of air, a low pressure source positioned laterally of said confined path, said duct having an opening in its lateral wall communicating with said low pressure source, and valve means positioned along the direction of travel of said moving column of air to receive fiber particles freed from the moving column as the direction of travel thereof is changed, and pass the fibers from the separator without substantially introducing air into said separator.

9. A separator as set forth in claim 8 in which the valve comprises a paddle wheel, means mounting said paddle wheel for rotation on an axis transverse to the direction of travel of said moving column of air, and means for rotating the paddle wheel on its axis.

10. A separator as set forth in claim 9 including a cylindrical casing surrounding said paddle wheel, the paddles of said paddle wheel being in scraping engagement with the inner wall of said casing, and the casing having a pair of axially extending openings in the wall thereof, one of said openings being positioned in communication with said duct and the other opening serving as a discharge.

11. A separator as set forth in claim 8 in which said low pressure source is positioned so that air drawn from said moving column of air toward said low pressure source will change direction by an angle of about 45 to about 180°.

12. A separator as set forth in claim 10 in which said angle is 180°.

13. A separator as set forth in claim 8 including a ballast chamber adjacent to said duct and communicating with said duct through said opening, said low pressure source communicating with said ballast chamber, whereby air in said moving column is drawn into said ballast chamber which is evacuated by said low pressure source.

14. A separator as set forth in claim 8 in which the low pressure source is a blower fan.

15. A separator as set forth in claim 8 in which said opening has a cross-sectional area at least twice the cross-sectional area of said duct.

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