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Baigas, Jr.

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[54] **AIR CLEANING APPARATUS**

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[52] **U.S. Cl.** **55/290,** 55/294, 55/320, 55/337, 55/418, 55/430, 55/459, 55/482

[51] **Int. Cl.** **B01d 50/00**

[58] **Field of Search** ..... 55/290, 294, 318, 320, 55/337, 339-340, 351, 392, 394, 418, 447, 423, 459, 521, 430, 482; 15/312 R, 312 A; 251/298

[56] **References Cited**

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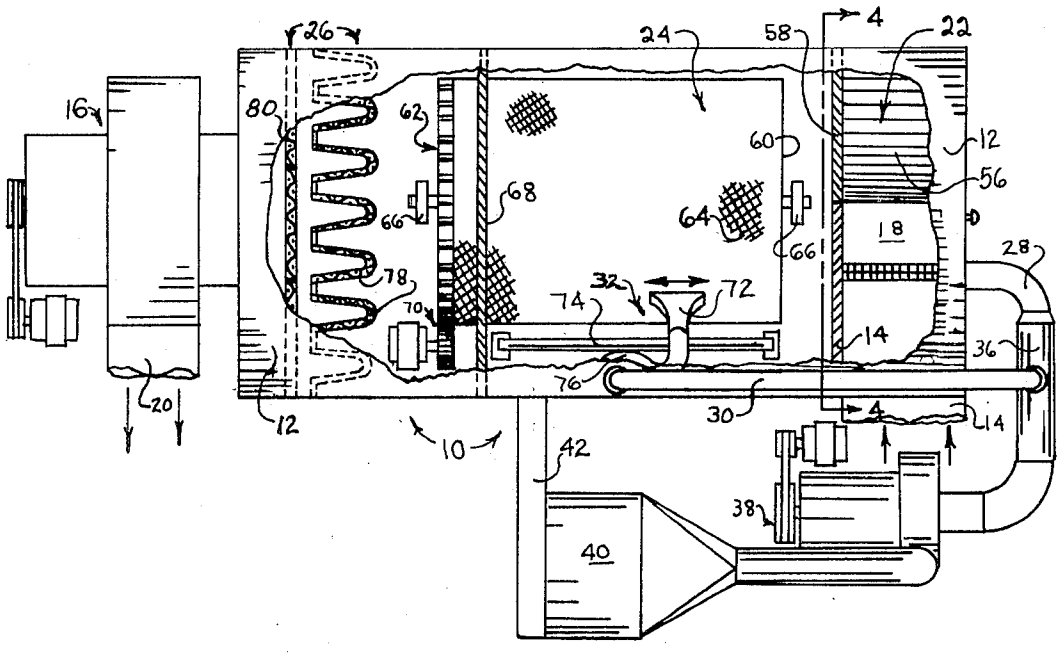
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[57] **ABSTRACT**

Air to be cleaned by the apparatus is passed continuously through a unitary housing enclosing a partial-cyclone device, a rotating drum filter, and other filtering means arranged in sequence for progressively removing matter from the air. The apparatus may be economically fabricated and installed, and is so designed and constructed as to efficiently clean large volumes of air with minimum pressure losses.

7 Claims, 4 Drawing Figures



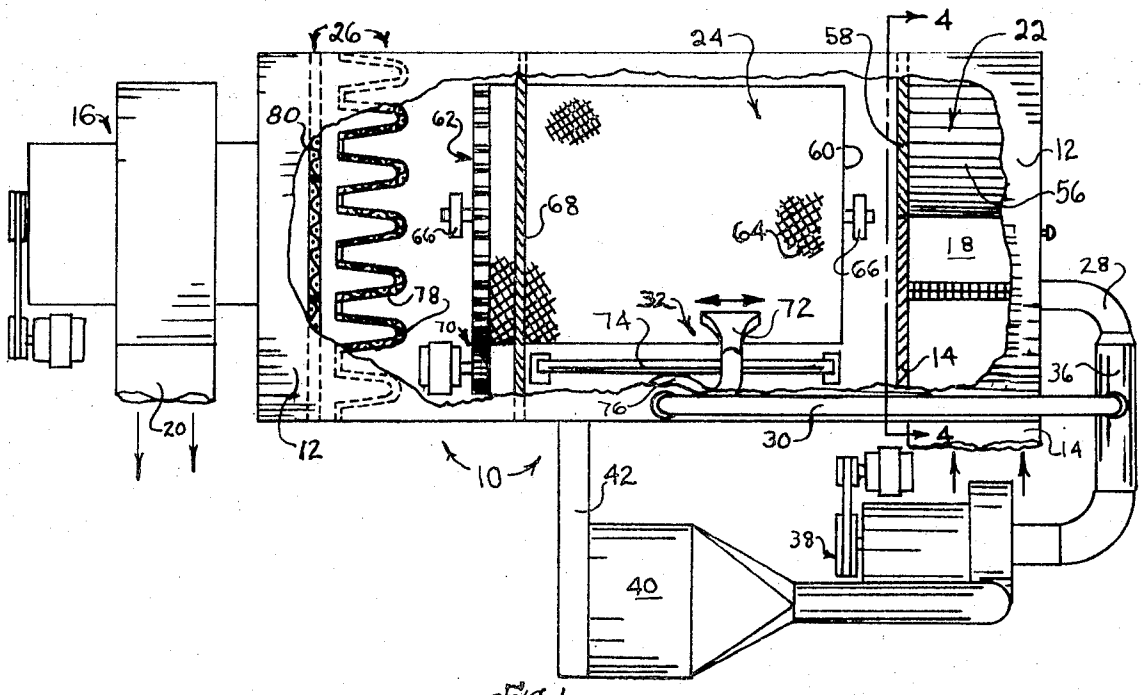

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Fig. 1

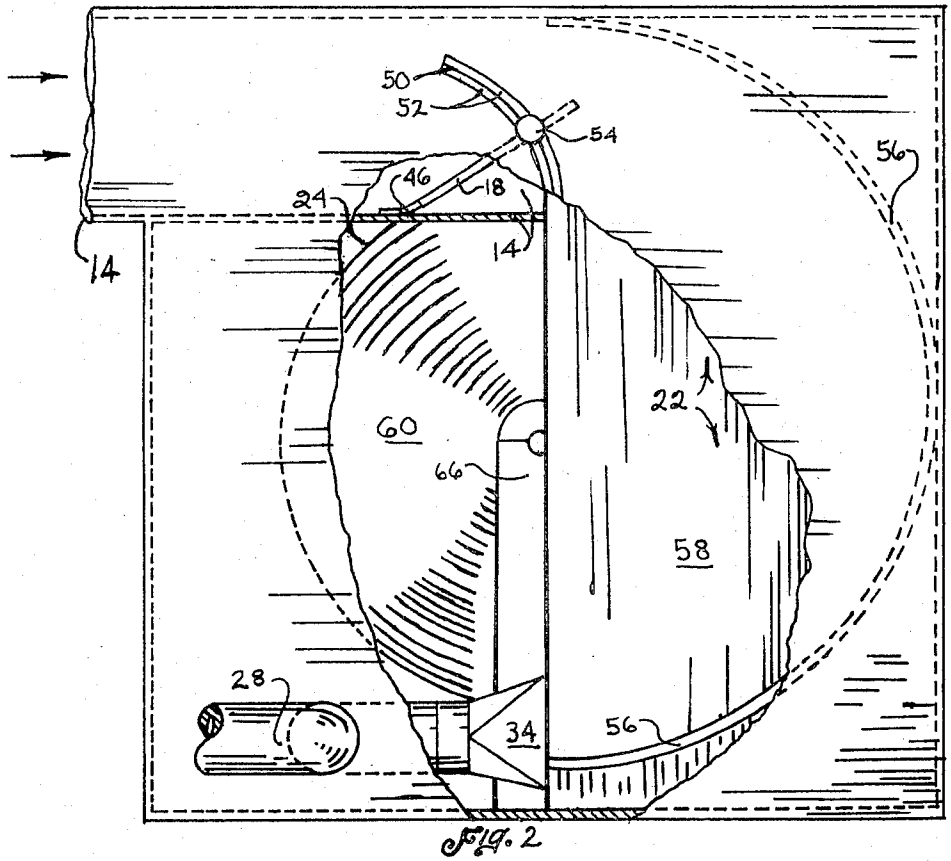

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Fig. 2

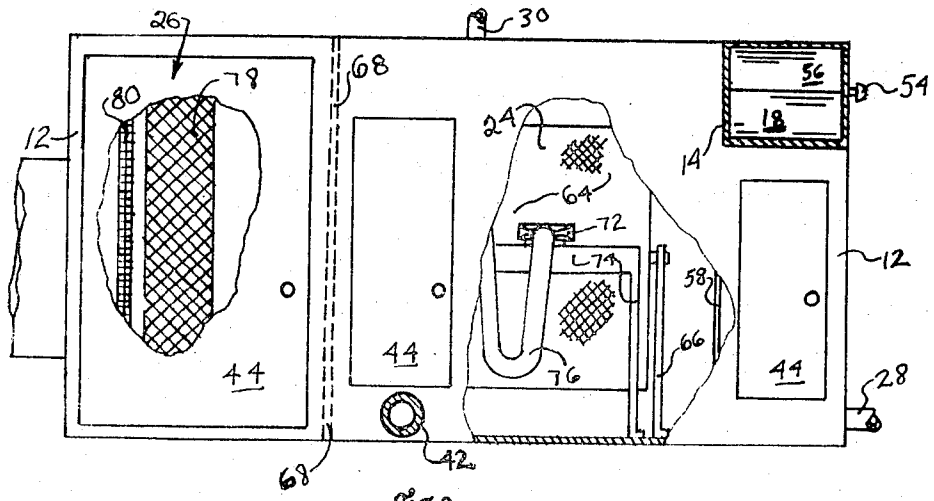

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Fig. 3

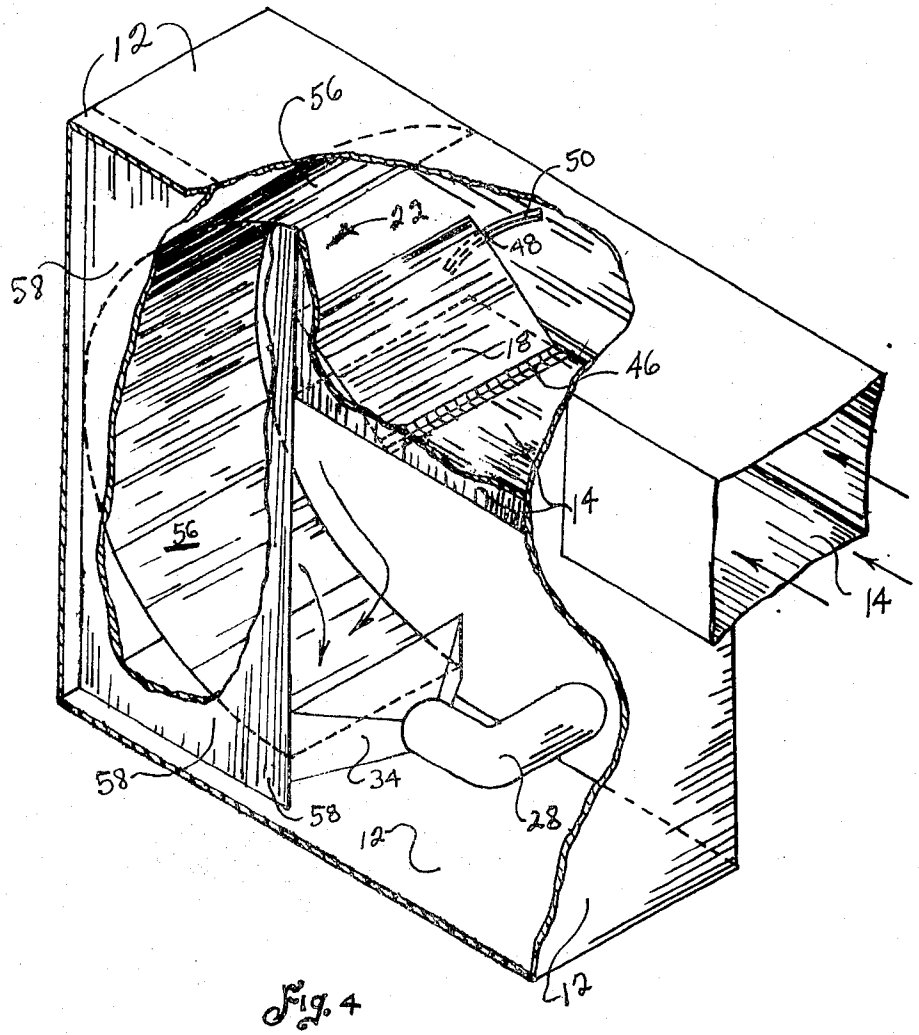

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Fig. 4

AIR CLEANING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to air cleaning apparatus and is more particularly directed to apparatus especially, but not necessarily exclusively, adapted for the efficient removal of lint, fibers, dust and other particulate matter from air in textile mills and the like.

Various textile-fiber processing operations, such as the carding operation, customarily generate large amounts of particulate matter of "fly" of the type noted above. Air-suction devices are now frequently employed to entrain such matter and remove it from the vicinity of the fiber-processing operation. The suction devices may be associated with entire processing operations or areas, or with individual fiber-processing machines therein. In the case of the carding operation, for example, various fly-generating sections of the individual cards of a series of carding machines may be enclosed by hoods or shrouds, through which air is continuously withdrawn while the machines are in operation. Such a system may illustratively encompass 100 carding machines each requiring 1,000 CFM of air at a negative pressure, at the card suction orifice, equivalent to 4 inches of water.

A system of the type described above must of course include some means for subsequently removing, from the air employed in the system, the particulate matter entrained therein. Such removal should be accomplished with maximum efficiency and minimum pressure-head losses, since otherwise the cost of operating the system could easily become excessive. Rotating-drum filters, by themselves or sometimes in association with other filtering means, have heretofore been proposed for the aforesaid purpose. However, when the air contains large quantities of entrained particulate matter, as is frequently the case, filters of the aforesaid type quickly become "loaded" in operation, even when equipped with automatic stripping means, and as a result undergo severe drops in efficiency. In an effort to alleviate the aforesaid problem, it has also been heretofore proposed to first remove part of the particlate matter from the air by passing the same through a conventional cyclone device disposed upstream from the rotating-drum filter. This, however, presents additional problems. Conventional cyclone devices are relatively expensive both from the viewpoint of fabrication and the viewpoint of installation. Additionally, the considerable size of a conventional cyclone device does not permit its use at all in some installations, or at best requires that the device be located some distance from the rotating-drum filter and the remaining components of the system. In the latter case, the requisite additional duct-work increases installation costs and also duct pressure losses. A further and perhaps most important disadvantage, which is present irrespective of the foregoing considerations, resides in the fact that a pressure loss of some three to four inches is inherent in the operation of a conventional cyclone device, which normally conducts the air and entrained particulate matter introduced therein at high velocity through at least one and usually several complete revolutions about the device's central axis. In a system such as previously mentioned wherein 100 cards are each supplied air at the rate of 1,000 CFM and at a negative pressure of four inches of water, pressure losses in the duct-work and in the rotating drum and/or other conventional filtering means

normally total approximately three inches. An additional pressure loss of some three to four inches entailed by the inclusion of a conventional cyclone device would therefore require that the system realize a suction-pressure of some 10 to 11 inches. As will be apparent to those skilled in the art, the realization of such a pressure in a system handling some 100,000 CFM of air would be exceedingly expensive, in terms of the power required and expended.

SUMMARY OF THE INVENTION

The present invention provides improved air cleaning apparatus, of the general type described above, which may be employed in a system servicing 100 carding machines as hereinbefore described, to effectively remove particulate matter from the 100,000 CFM of air handled by such system, and when so employed the total pressure loss in the system may be no more than approximately 7½ inches as opposed to the loss of 10 or 11 inches incurred when a conventional cyclone device is present in the system. Additionally, the apparatus of the present invention may be fabricated and installed at considerably less expense than one including a conventional cyclone device, and may be employed in restricted areas wherein the size of a conventional cyclone device would not permit its utilization.

In a preferred embodiment of the invention, the apparatus includes a compact unitary housing enclosing a partial-cyclone device, a rotating drum filter and other filtering means arranged in sequence for progressively removing particulate matter from the air conducted through the housing during operation of the apparatus. Automatic stripping means is associated with the rotating drum filter, and the additional filtering means disposed downstream of the drum filter preferably includes a bank of V-cell filters. The partial-cyclone device is of generally C-shaped configuration, and extends through an arcuate distance of less than 360 degrees and preferably no more than approximately 180°. Following its introduction into the housing, air containing entrained particulate matter is conducted through an inlet duct containing adjustable velocity-regulating valve means and is directed thereby substantially tangentially against the concave inner surface of the aforesaid partial-cyclone device adjacent the upper end portion thereof. Under the impetus of centrifugal force and gravity, a major portion of the larger-size particulate matter passes along the concave inner surface of the device to a purge-outlet adjacent its lower end. The particulate matter and a minor part of the air introduced into the housing are withdrawn through such outlet and from the housing. Adjacent its axial center portion and intermediate the aforesaid inlet and outlet associated therewith, the partial-cyclone device is open so as to permit free passage therefrom of the major portion of the air introduced therein and partially cleaned thereby. Such air passes directly to and through the rotating-drum filter disposed closely adjacent the partial-cyclone device and downstream therefrom within the housing. The minor amount of air purged with the particulate matter from the housing by the partial-cyclone device is, following condensation of the particulate matter therefrom exteriorally of the housing, preferably re-introduced into the housing so as to also pass with the aforesaid main flow of air first through the rotating-drum filter and thereafter through the additional filtering means provided within the housing

downstream from the rotating-drum filter. Due to the precleaning of the air by the partial-cyclone device, the rotating drum-filter and the other filtering means disposed downstream therefrom do not become overloaded during operation, and effectively perform their respective filtering functions at all times. In its passage through the housing of the apparatus, the air is therefore thoroughly cleaned, yet undergoes only a minimal pressure loss as compared to that loss in pressure which would ensue if the air were first conducted through a conventional cyclone. Among the factors contributing to such minimal pressure loss are the fact that the present partial-cyclone device conducts the entrained particulate matter only through part of a single revolution, preferably only approximately 180°, and is so positioned as to also possibly benefit to a slight extent from the force of gravity. The velocity of the air introduced into the partial-cyclone device can therefore be much less than that required for satisfactory operation of a conventional cyclone, and is so regulated by the adjustable valve means associated with the present device as to be just sufficient for removal of a major part of the larger-size particulate matter entrained in the air to be cleaned in the particular installation of the apparatus. Further, since the partial-cyclone device is located within the same housing as the rotating drum-filter, and is disposed closely adjacent to and in free communication with the same, duct-type pressure losses therebetween are virtually non-existent.

DESCRIPTION OF THE DRAWINGS

Other features and benefits of the invention will be in part apparent and in part pointed out hereinafter in the following description of an illustrative embodiment thereof, which should be read in conjunction with the accompanying drawings, in which:

FIG. 1 is a top plan view, partially diagramatic and partially broken away to disclose details of interior construction, of air cleaning apparatus embodying the invention;

FIG. 2 is an enlarged side elevational view, partially broken away to disclose details of interior construction, of the main housing of the apparatus of FIG. 1;

FIG. 3 is a partially broken away front elevational view of the main housing of the apparatus; and

FIG. 4 is an enlarged fragmentary perspective view, partially broken away and partially in vertical section taken substantially along line 4—4 of FIG. 1 through the main housing of the apparatus, showing the partial-cyclone device and certain immediately-adjacent components disposed within such housing.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawings, the air cleaning apparatus designated in its entirety in FIG. 1 by the numeral **10** includes a unitary housing **12** having an inlet duct **14** and a motor-driven fan assembly **16** respectively communicating with opposite end portions thereof. Air introduced into housing **12** through inlet duct **14**, which is disposed adjacent the top of the housing and has velocity-regulating valve means in the form of a plate-like member **18** associated therewith, is moved through housing **12** by fan assembly **16** and is finally discharged, after cleaning thereof, through outlet duct **20** of assembly **16**. Disposed within housing **12** for sequentially and progressively cleaning the air passing therethrough are a partial-cyclone device **22**, a rotating-drum filter device **24**, and additional filtering means **26**, all of which are described in more detail hereinafter. Conduits **28, 30** extending from housing **12** respectively interconnect stripping means **32** of drum filter **24** and a purge outlet **34** (FIGS. 2 and 4) of cyclone device **22** with a header **36** communicating via a purge fan assembly **38** with a conventional particulate-matter separating or "condenser" device **40** such as that manufactured and sold by Saco-Lowell Shops Division of Maremont Corporation. Another conduit **42** returns exhaust air from condenser **40** to housing **12** downstream from partial-cyclone device **22** and in the vicinity of the drum filter **24** within the housing. With the exception of the various inlets-outlets communicating therewith as described above, housing **12** is of air-tight exterior construction, but preferably is provided with suitable access doors **44** (FIG. 3) through which convenient access to the interior of the housing may be realized when desired.

Referring now particularly to FIGS. **2** and **4**, plate-like valve member **18** is disposed within and extends across substantially the full width of the portion of the inlet duct **14** located inwardly of housing **12.** Member **18** is pivotally mounted along its upstream edge to the lower part of duct **14**, as by means of a suitable hinge **46**, so as to permit adjustment of its pivotal position to vary as desired the effective cross-sectional area of duct **14** and therefore the velocity of the air and entrained particulate matter introduced into housing **12** through duct **14.** To facilitate adjustment of the pivotal position of plate-like member **18**, a threaded rod **48** secured to its downstream edge projects therefrom an arcuate slot **50** provided in the adjacent end wall of housing **12.** Slot **50** has suitable resilient sealing strips **52** associated therewith to prevent leakage of air therethrough. An operating knob **54** threadably secured to the outer end of rod **48** may be rotated in one direction to cause the same to bear against the adjacent wall of housing **12** and thereby secure plate-like member **18** in a desired position of pivotal adjustment. By rotating knob **54** in the opposite direction and thereafter moving the same longitudinally of slot **50**, the pivotal position of member **18** may be varied as desired. Suitable indicia (not shown) may be provided in association with slot **50** and knob **54**, if desired, to facilitate desired placement of plate-like member **18.**

Partial-cyclone device **22** comprises a generally C-shaped baffle member **56** which extends, through an arc of approximately **180** degrees and about a substantially horizontal imaginary axis, between the mouth of inlet duct **14** adjacent the top of housing **12** and that of purge outlet **34** adjacent the bottom of housing **12.** The aforesaid axis about which arcuate baffle member **56** extends lies in approximately the same vertical plane and is approximately equidistant between the mouths of inlet duct **14** and purge outlet **34.** One side of C-shaped member **56** is closed by the adjacent end wall of housing **12,** while the opposite side of member **56** is closed by a wall **58** extending the full height of housing **12** but only partially across the width thereof, as is best shown in FIG. **4.**

Air and entrained particulate matter introduced into housing **12** through inlet duct **14** is discharged by such duct substantially tangentially against the concave inner surface of the upper end portion of baffle member **56.** The velocity of the incoming air and particulate

matter are so adjusted by valve plate **18** that centrifugal force assisted perhaps to some extent by gravity, causes a major portion of the larger size particulate matter (e.g., 95 percent of the fibrous particulate matter having a length of 1/64 inches or more) and a minor portion of the air to be directed by curved baffle member **56** along the length thereof and into purge outlet **34.** The same is then withdrawn through conduit **30** by purge fan assembly **38** and thereafter directed to the particulate-matter separating device **40** disposed exteriorly of housing **12.** Only approximately **10%** or less of the air introduced through inlet duct **14** into housing **12** is withdrawn therefrom through purge outlet **30** and, as previously indicated, such air may be and preferably is subsequently returned to housing **12** from particulate-matter separating device **40** by return conduit **42.** The remaining 90 percent or more of the incoming air direct by inlet duct **14** against the upper end portion of C-shaped baffle member **56** passes therefrom, in a partially cleaned state and as indicated by the directional arrows in FIG. **4,** through the large open central area disposed adjacent the imaginary axis of curvature of member **56** and between the mouths of duct **14** and purge outlet **34.** Such air then freely passes generally longitudinally of housing **12,** through the sizable open area disposed forwardly of interior wall **58** and below duct **14,** to that central portion of the housing enclosing rotating-drum filter **24.**

Rotating-drum filter **24** is of a known type having a closed end **60** disposed adjacent partial-cyclone device **22,** an open end **62,** and suitable filtering media **64** extending about and defining its peripheral cylindrical surface. Drum **24** is mounted for rotation about its central axis, which preferably is substantially aligned with the axis of curvature of baffle member **56** of partial-cyclone device **22,** by suitable end-supports **66.** The open end portion **62** of drum **24** projects through an air-tight sealing partition **63** extending transversly within housing **12,** and suitable drive means **70** are associated therewith for imparting rotation to drum **24.** Stripping means **32** comprises a suction head **72** mounted by a suitable support **74** for reciprocatory movement longitudinally of drum **24,** under the impetus of suitable drive means (not shown), closely adjacent the filter media **64** defining the cylindrical peripheral surface of drum **24.** A flexible tube or conduit **76** interconnects suction head **72** and the conduit **28** leading from housing **12** and to the previously-described header **36** disposed exteriorly of the housing. As will be apparent to those skilled in the art, the partially-cleaned air introduced into the vicinity of drum **24,** primarily from partial-cyclone device **22** and to a much lesser extent from return conduit **42** of device **40,** passes generally radially inwardly through the drum's filter media **64** and, following such filtration, is discharged generally axially of the drum through its open end **62.** Particulate matter filtered from the air by media **64** is periodically stripped from the latter by suction head **72,** and delivered by purge-fan assembly **38** through conduits **76, 28** and header **36** to particulate-matter separating device **40.**

Further filtration of the now twice-cleaned air discharged from open end **62** of drum filter **24** is achieved by the additional filtering means **26** disposed downstream of drum filter **24** within housing **12.** As is shown in FIGS. **1** and **3,** such additional filtering means preferably includes a bank of V-cell filters **78,** which afford a relatively large surface area for filtration of the air passing therethrough, and may be followed by an array of planar filters **80.** Filters **78, 80** preferably extend, as shown, across substantially the full width and height of housing **12.**

The air finally passing from housing **12** and discharged through outlet duct **20** of fan assembly **16** will be substantially free of entrained particulate matter, and will have undergone only a minimal pressure loss during its passage through housing **12.** Of particular importance in the foregoing regard is the fact that partial-cyclone device **22** of the apparatus, while removing a major portion of the entrained particulate material within the incoming air and thereby preventing overloading of the filtering means disposed downstream therefrom, occasions a pressure loss of only approximately one-half of an inch, as compared to the pressure loss of some three to four inches inherent in the operation of a conventional cyclone device. Since the effective operating path of device **22** is less than a full revolution, and preferably is only approximately 180°, the velocity of the air and particulate matter directed by duct **14** into device **22** need not be of the higher magnitude required in a conventional cyclone and is adjusted by plate-like valve member **18** so as to be considerably less than such magnitude. The particular velocity realized by adjustment of valve plate **18** will vary depending upon the amount of particulate material entrained within the air to be cleaned, since lesser velocities will suffice for lesser concentrations of particulate material, but in any event need not be large. Additionally, since device **22** is disposed within the same unitary housing **12** as the remaining downstream filtering means, duct losses are not increased and fabrication and installation costs and procedures are reduced and simplified.

It will thus be seen that there has been provided an improved air cleaning apparatus realizing the benefits and possessing the features hereinbefore noted. Although a specific embodiment of the invention has been shown and described, it is to be understood that this was for purposes of illustration only, and not for purposes of limitation, the scope of the invention being in accordance with the following claims.

That which is claimed is:

1. Apparatus for cleaning air in textile mills and the like, comprising:

elongate housing means;

means for passing air from which particulate matter is to be removed through said housing means;

a plurality of air-cleaning means disposed within and enclosed by said housing means for progressively cleaning the air during its passage through said housing means;

said air-cleaning means including partial-cyclone means disposed within said housing means and comprising a generally C-shaped baffle member extending through an arc distance of no more than approximately 180° about a substantially horizontal axis;

said means for passing air through said housing means including an inlet duct communicating with said housing means and said baffle member adjacent one end of said baffle member for directing incoming air and particulate matter substantially tangentially against the concave inner surface of said baffle member;

adjustable velocity-regulating valve means within said housing means for regulating the velocity of air and entrained particulate matter introduced into such partial-cyclone means through said inlet duct, said valve means comprising a plate-like member pivotally mounted within said inlet duct, and valve operating means connected to said plate-like member for varying the pivotal position thereof and for thereby varying the effective flow-area of said inlet duct;

a purge outlet adjacent the end of said baffle member opposite from said one end thereof for receiving particulate matter directed thereto along said baffle member by centrifugal force;

rotating-drum filter means disposed within said housing means downstream from said partial-cyclone means for receiving and further cleaning partially-cleaned air discharged from said partial-cyclone means, said drum filter means including a generally cylindrical drum rotatable about a central axis and having filter media extending about the generally cylindrical peripheral surface thereof for filtering the air passing therethrough and into said drum, and further having at least one open end for discharging the filtered air in a generally axial direction from said drum through said open end thereof;

additional filtering means disposed within said housing means downstream from said drum filter means for receiving the air discharged from said drum-filter means and for further filtering the same prior to passage of the air from said housing means;

particulate-matter separating means disposed exteriorally of said housing means;

stripping means disposed within said housing means for stripping particulate matter from said media of said rotating-drum filter means;

means including a plurality of conduits for conducting particulate matter from said purge outlet of said partial-cyclone means and from said stripping means associated with said rotating-drum filter means to said particulate-matter separating means;

and a return conduit for returning exhaust air from said particulate matter separating means to the interior of said housing means at a location therein downstream from said partial-cyclone means and adjacent said rotating drum-filter means.

2. Apparatus as in claim **1**, wherein an area intermediate said ends of said baffle member and adjacent the axial center thereof is open for free passage from said baffle member of air from which particulate matter has been centrifuged.

3. Apparatus as in claim **1**, wherein said inlet duct is disposed adjacent the top of said housing means, and said purge outlet is disposed adjacent the bottom of housing means, and said ends of said baffle member lie in approximately the same vertical plane.

4. Apparatus as in claim **1**, wherein said inlet duct and said housing have an arcuate slot extending therethrough, and said valve operating means comprises a rod member connected to said plate-like member and extending therefrom through said slot, and an operating knob connected to the outer end of said rod-like member exteriorly of said housing.

5. Apparatus as in claim **4**, including resilient sealing means operatively associated with said slot for minimizing leakage of air therethrough.

6. Apparatus as in claim **1**, wherein said additional filtering means includes a bank of V-cell filters mounted within said housing means downstream from said rotating-drum filter means for further filtering the air discharged from said rotating-drum filter means prior to passage thereof from said housing means.

7. Apparatus as in claim **6**, wherein said additional filtering means further includes an array of substantially planar filters mounted within said housing downstream from said bank of V-cell filters.

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