Fig.1

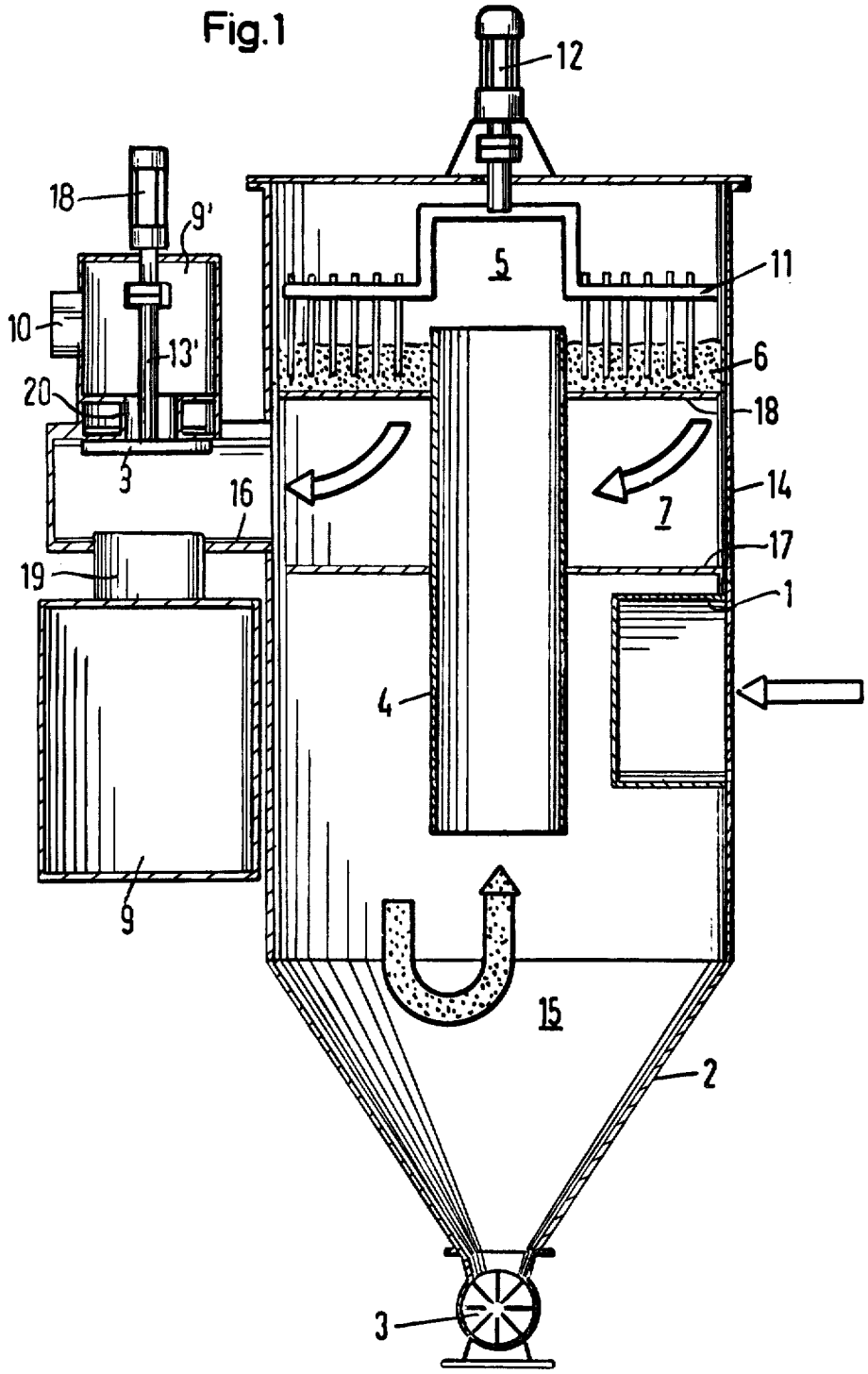


Fig.2

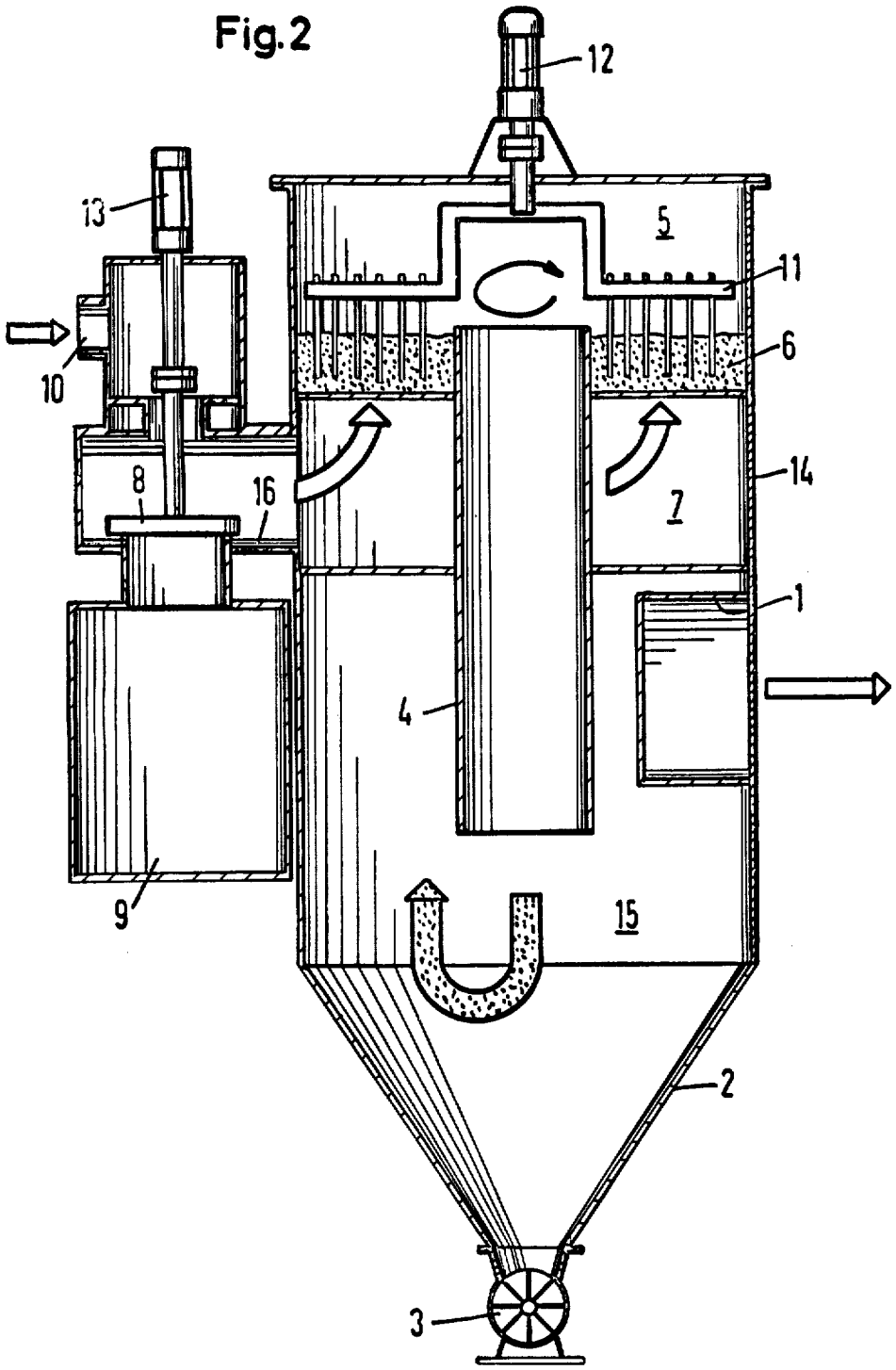
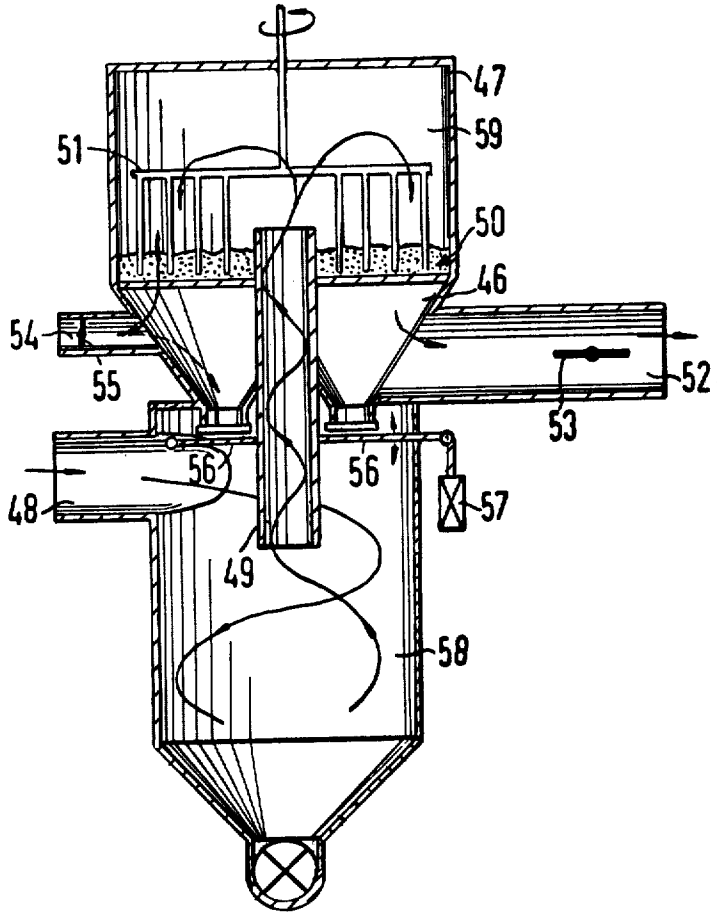


Fig.3



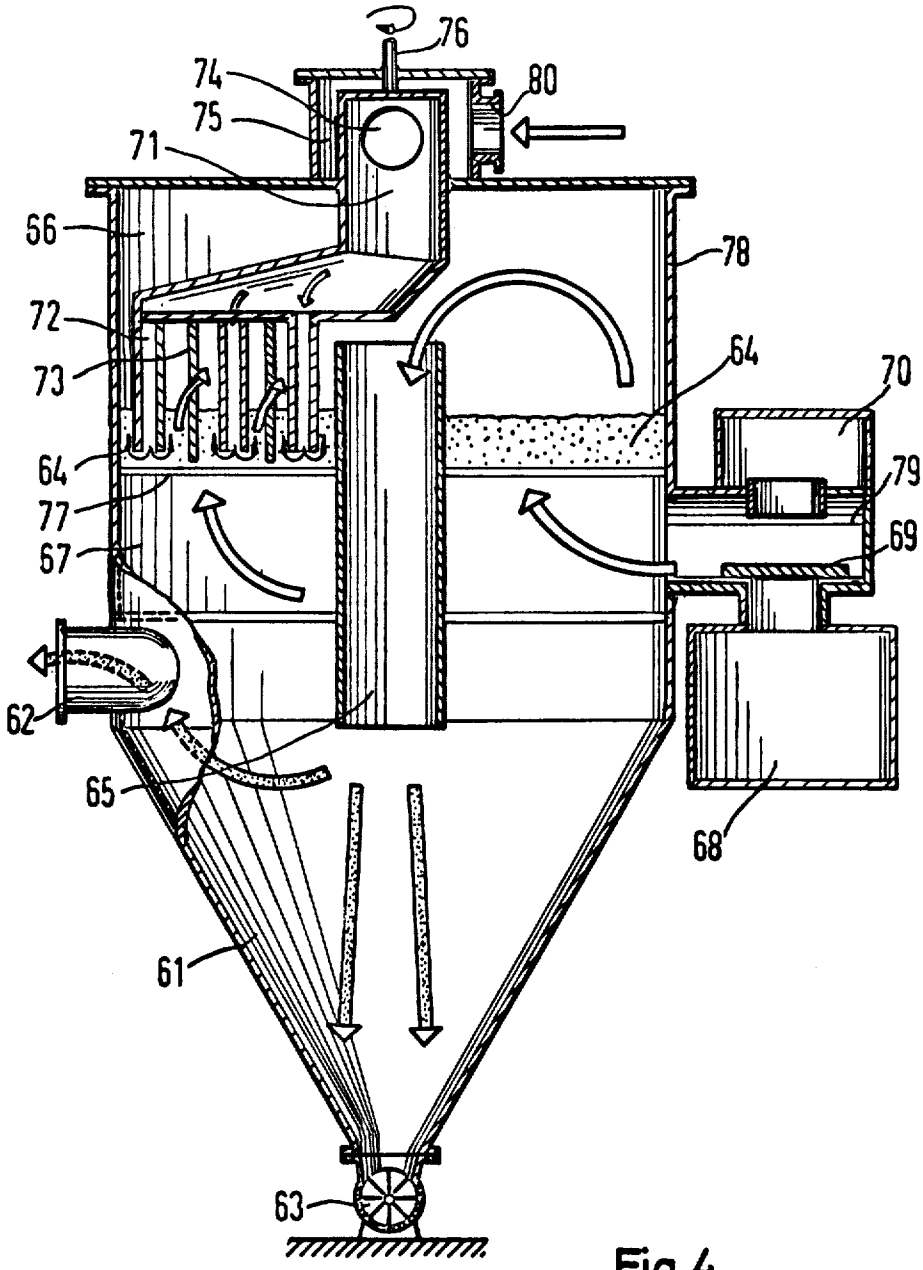


Fig.4

Fig. 5

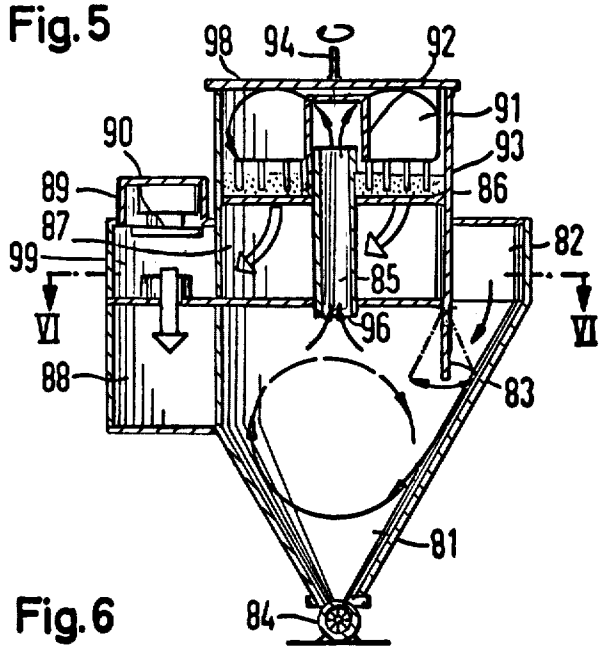
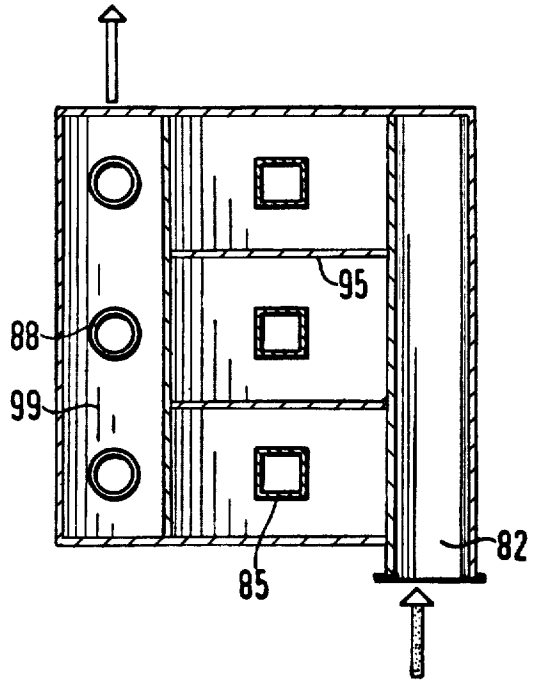


Fig. 6



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28,396

APPARATUS FOR SEPARATING SUSPENDED SOLID PARTICLES FROM A CARRIER GAS

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Original No. 3,594,991, dated July 27, 1971, Ser. No. 777,454, Nov. 20, 1968, which is a continuation-in-part of abandoned application Ser. No. 491,670, Sept. 30, 1965. Application for reissue July 25, 1973, Ser. No. 382,581

Claims priority, application Germany, May 17, 1965, B 81,965; July 28, 1965, B 83,018; Nov. 22, 1967, P 16 07 671.4; Mar. 19, 1968, P 16 57 128.8

Int. Cl. B01d *50/00*

U.S. Cl. 55—294 **14 Claims**

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A filter chamber is superimposed on the container of a cyclone collector and vertically divided into two compartments by a filter bed of particulate material. A gas stream carrying solid particles is admitted to the cyclone collector, stripped of a portion of the solids, and passed to the upper compartment of the filter chamber by a conduit which passes the top wall of the container, the lower filter compartment, and the filter bed. Residual solid particles are removed from the gas stream passing downward through the filter bed and released from the lower compartment. A rake permits the filter bed to be stirred during regeneration by a scavenging gas passed upwardly through the filter bed.

REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of our copending application Ser. No. 491,670, filed on Sept. 30, 1965 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to phase separation, and particularly to apparatus for separating solid particles from a carrier gas in which the particles are suspended.

Cyclone collectors and filters are commonly employed for stripping a contaminated gas stream of suspended particles, particularly solid particles. It has also been proposed to arrange a cyclone collector and a filter in series to remove coarser particles from the gas in the collector, and to retain residual fine particles in the filter. However, the flow resistance of the filter and of the conduit connecting the cyclone collector with the filter tends to interfere with operation of the cyclone collector in known devices, and the high flow velocity required in a centrifugal collector for high efficiency cannot be maintained unless the effective filter surface is much greater than the cross section of the vortex in the cyclone collector.

An important object of this invention is the provision of phase-separating apparatus of the type described in which a cyclone and a filter are combined to minimize their unfavorable interaction.

SUMMARY OF THE INVENTION

According to this invention a housing defining a filter chamber therein is superimposed on the container of the cyclone collector to which the gas stream to be purified is admitted through an inlet. A filter which extends horizontally through the filter chamber divides the same into upper and lower compartments. The passages in the filter which are pervious to the carier gas of the stream and connect the compartments are dimensioned to retain the contaminating solid particles. The gas passes the filter in a downward direction from an exposed surface of the filter and is led outward from the lower compartment through a gas port.

The container of the cyclone collector and the upper compartment are connected by a straight conduit passing upward through the lower compartment and the filter into the upper compartment. Accumulated solid particles are discharged from the bottom of the cyclone collector container.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated from the following detailed description of preferred embodiments when considered jointly with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 shows a battery of phase-separating apparatus of the invention in elevational section, only one unit of the battery and connecting ductwork being seen;

FIG. 2 illustrates the apparatus of FIG. 1 in a different operating position;

FIGS. 3, 4, and 5 show three modifications of the apparatus of FIGS. 1 and 2 in corresponding views; and

FIG. 6 illustrates the apparatus of FIG. 5 in plan section on the line VI–VI.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. 1 and 2, there is seen a sheet metal shell **14** having the shape of an upright cylinder provided with a conically tapering bottom **2**. An inlet pipe **1** leads tangentially into the lower half of the cylinder shell portion, and a screw conveyor **3** is attached to the apex portion of the conical bottom part **2**.

A wide coaxial conduit **4** of circular cross section is mounted on the shell **14** by means of two horizontal partitions **17**, **18** sealingly engaged by the conduit **4**. The lower partition **17** forms the top wall of a container **15** for which the pipe **1** provides a gas inlet port well above the lower, axially directed orifice of the conduit **4**. The upper partition **18** is perforated to form the foraminous supporting plate of a filter which also includes a layer **6** of sand or similar particulate material carried on the partition **18** and forming the exposed upper surface of the filter. The filter separates a cylindrical filter chamber in the shell **14** above the partition **17** into an upper compartment **5** and a lower compartment **7** downwardly bounded by the top wall **17** of the container **15**.

A rake **11** is mounted in the compartment **5** on the vertical output shaft of an electric motor **12** supported on the top wall of the shell **14** outside the shell. The shaft passes through a nonillustrated seal into the shell cavity. The prongs of the rake **11** are made of heavy steel wire and extend vertically from the compartment **5** through the exposed filter surface into the layer **6**. They move in horizontal circles through the layer **6** when the motor **12** is energized.

A gas port in the wall of the shell **14** which radially bounds the lower compartment **7** leads into a tube **16** provided with diametrically opposite valve seats constituted by rims of short coaxial tubes **19**, **20** which lead from the tube **16** into parallel rectangular sheet metal ducts **9**, **9'**. The duct **9** is connected to apparatus which uses or stores the purified gas in a manner not shown, and the duct **9'** is connected to a nonillustrated compressor by a conduit **10**.

The disc member **8** of a lift valve is mounted on the piston rod **13'** of a hydraulic jack **13**. The jack cylinder is mounted atop the duct **9'**, and the piston rod **13'** passes

through the duct 9' and axially through the tube 20. The jack 13 permits the disc member 8 to be shifted between the positions of FIGS. 1 and 2 in which the valve seats on the tubes 19, 20 are sealed respectively.

As will be described hereinafter in more detail with reference to FIG. 6 and is not visible from FIGS. 1 and 2, the apparatus consists of several juxtaposed, identical shells 14 and the corresponding elements mounted in the shells, and the shells are connected to a common inlet manifold, the common screw conveyor 3, and the common ducts 9, 9' in the manner partly evident from FIGS. 1 and 2.

During normal operation, contaminated gas is introduced from the nonillustrated manifold into the container 15 whose cylindrical walls are so positioned relative to the tangential inlet pipe 1 as to deflect the entering gas stream into a vortex whose axis approximately coincides with the longitudinal axis of the conduit 4. The coarser solid particles in the stream are driven radially outward by centrifugal force against the shell 14, thereby separated from the carrier gas, slide along the wall into the conical bottom 2 of the cyclone collector which is mainly constituted by the inlet pipe 1 and the container 15, and are removed by the screw conveyor 3.

The carrier gas which is moved toward the center in an initially downwardly spiraling path enters the orifice of the conduit 4 and rises in the conduit 4 to the upper filter compartment 5 while still rotating about the axis of the shell 14. The gas discharged upwardly from the conduit 4 is caused by the walls of the compartment 5 to form one of two flow patterns or combinations of these patterns depending on dimensional features of the apparatus and the flow velocity of the gas.

If the circumferential component of gas flow predominates in the conduit 4, the gas in the chamber 5 flows in a spiraling path about the axis of the shell 14 and strikes the exposed surface of the layer 6 at an acute angle in a mainly tangential direction relative to the shell axis. If the gas flow in the conduit is predominantly axial, the gas is deflected by the top wall of the shell into an approximately toroidal pattern, and strikes the exposed surface of the layer 6 at an acute angle in a radial plane, the principal component of the gas flow at the point of impact being radially inward.

The effectiveness of the filter layer 6 at equal thickness is inversely proportional to the angle formed by the direction of movement of the impinging solid particles in the gas and the exposed filter surface. The thickness of the filter bed can be decreased without loss of filter efficiency when the angle betwen the entering gas and the filter surface is reduced, as by changing the dimensions of the apparatus or by modifying the velocity and direction of the contaminated gas stream entering the cyclone container 15.

The fine particles separated from the gas stream accumulate on the exposed filter surface. They are held down on the particulate filter medium of the layer 6 by the flowing gas and become themselves effective as a portion of the filter. If the permeability of the filter is reduced by an overly thick surface layer of fine particles, it can be restored by operating the rake 11 and mixing the fines with portions of the particulate material below the initial surface. The rake 11 also is effective in overcoming channeling in the layer 6 if it should occur.

The valve disc 8 is held by the jack 13 in the position shown in FIG. 1 during normal operation of the apparatus, so that the purified gas which downwardly emerges from the openings in the partition 18 flows into the duct 9 for further use or storage. The arrows in FIG. 1 indicate the direction of normal gas flow.

When the layer 6 is saturated with fine particles, the valve disc 8 is shifted into the position seen in FIG. 2, and a scavenging gas under high pressure is blown into the lower filter chamber 7, upwardly through the layer 6 into the compartment 5, and down through the conduit 4 into the container 15. The layer 6, in effect, is regenerated by gas classification. The heavier and coarser particles remain in the filter chamber, and the smaller and lighter particles are blown down into the container 15 where they are mostly collected in the conveyor 3. If so desired, the inlet pipe 1 may be disconnected from the aforementioned, nonillustrated manifold, and the scavening gas may be either released to the atmosphere, or it may be further processed as needed.

It has been found advantageous to regenerate one separator in each battery while at least two other separators perform their normal filtering function. Under these conditions, the partly stripped scavenger gas may be blown from the container 15 into the common manifold of the battery for further purification by the operating separators, whereby the purified scavenger gas is ultimately received in the duct 9. A portion of the purified gas is preferably compressed to a pressure sufficient to overcome the pressure of the contaminated gas in the manifold, and the compressed purified gas employed as the scavenging gas.

The removal of fines from the layer 6 by upwardly flowing gas is greatly accelerated if the rake 11 is simultaneously moved slowly through the particulate material on the partition 18.

In the modified separating apparatus shown in FIG. 3, the lower filter compartment 46 is the frustoconical bottom portion of a hoursing 47 whose cylindrical top compartment 59 is downwardly bounded by a filter 50 not significantly different from the filter 6, 18 described above, and equipped with a rotary rake 51 similar to the rake 11, and not shown in detail.

A wide low-pressure duct 52 and a narrower high-pressure duct 54 extend radially outward from the lower filter compartment 46 for release of a purified gas and admission of a compressed scavenging gas respectively, and are provided with individual butterfly valves 53, 55.

The housing 47 is mounted coaxially atop the cylindrical portion of a cyclone container 58 to which the contaminated gas is admitted tangentially through an inlet pipe 48. The spiraling, partly stripped gas rises from the container 58 to the upper filter compartment 59 through a straight, vertical, coaxial conduit 49, as described above.

The bottom wall of the lower filter compartment 46 partly forms the top wall of the container 58. It is apertured, and the apertures are normally closed by trap doors 56 which may be swung open by a hydraulic motor 57. The doors 56 and the valve 55 in the high-pressure duct 54 are closed during normal operation of the separator shown in FIG. 3, and contaminated gas is normally admitted through the inlet pipe 48, while purified gas is discharged through the low-pressure duct 52, and solid particles are partly collected at the bottom of the container 58 and in the particulate material of the filter 50.

When it is desired to remove fine particles from the filter 50, the valve 53 is closed, the valve 55 is opened, and the rake 51 is rotated. The tines are partly carried from the filter 50 through the conduit 49 into the container 58. The illustrated arrangement, moreover, permits the particle layer of the filter 50 to be stirred very intensively by the rake 51 so that the fine particles are uniformly distributed in the original filter medium and partly drop through the openings in the supporting member of the filter 50 into the lower compartment 46 where they accumulate on the trap doors 56, and may be dropped into the container 58 by opening the doors. Very rapid purification of the filter 50 may thus be achieved.

The apparatus shown in FIG. 4 is similar to that described above with reference to FIGS. 1 and 2, and operates in substantially the same manner. A shell 78 provides the container 61 of a cyclone collector and the upper and lower compartments 66, 67 of a filter chamber which are separated by a layer 64 of particulate material carried by a foraminous supporting member 77.

A contaminated gas admitted in a tangential direction into the container 61 through an inlet pipe 62 is partly stripped of solid particles by centrifugal force, and the

coarse, solid particles are discharged by a screw conveyor **63**. The partly purified gas rises through a vertical cylindrical conduit **65** into the upper filter compartment **66**, and the purified gas is released from the lower compartment **67** through a discharge port **79** into a duct **68** when the duct is opened by a valve **69**.

In the regenerating condition of the apparatus illustrated in FIG. 4, the valve **69** closes the duct **68** and admits compressed scavenging gas from another duct **70**. The scavenging gas passes upward through the layer **64** and is ultimately released from the container **61** by the inlet pipe **62**, as described in more detail above.

The apparatus of FIG. 4 differs from the embodiments described so far by the rake employed for mixing, smoothing, and classifying the layer **64**. The rake has an approximately L-shaped hollow arm **71** whose radial or horizontal portion carries hollow spikes **72** in addition to solid wire prongs **73**. The spikes **72** are as long as the prongs **73** and terminate well below the exposed surface of the layer **64** in nozzles open in a tangential or circumferential direction relative to the axis of the apparatus.

The upright or axial portion of the arm **71** is journaled in the top wall of the shell **78** and axially secured in a nonillustrated manner. Its upper end is spacedly enveloped by a casing **75** sealed to the top wall of the shell **78** and communicates with the interior of the casing **75** through an opening **74**. A nipple **80** connects the casing **75** with a compressor through nonillustrated control valves. The output shaft **76** of a nonillustrated motor enters the casing **75** and is attached to the arm **71** for turning the same about the axis of the shell **78**.

While the arm **71** is driven to draw the spikes **72** and the prongs **73** through the particulate material of the layer **64**, gas under pressure is admitted to the casing **75**, and the gas is discharged in respective jets from the nozzles of the spikes **72**, thereby accelerating the separation of fines from the layer **64** during regeneration of the latter. The several rakes illustrated also are effective in smoothing the exposed surfaces of the layers **6**, **50**, **64** and of maintaining uniform thickness in the same.

The separating apparatus of the invention shown in FIGS. 5 and 6 mainly differs from the devices described above by the angular configuration of containers, chambers, and conduits which are of circular cross section in the aforedescribed embodiments.

The shells **98** of the three separating units in the battery illustrated in FIGS. 5 and 6 are made of flat sheet metal and are separated from each other by parallel flat walls **95** common to two adjacent shells **98**. The cyclone container **81** of each shell has the shape of a downwardly tapering wedge, and the narrow bottom ends of the several cyclone containers **81** communicate with a common screw conveyor **84**. Each container receives contaminated gas from a common inlet manifold **82** through an inlet port bounded by one of the obliquely sloping fixed walls of the container **81** and by a rectangular flap **83** hinged to the top wall of the container and pivotally adjustable about a horizontal axis in a nonillustrated conventional manner to control the flow section of the inlet port, as indicated by a curved double arrow.

The container **81** is connected with the upper compartment **91** of a directly superimposed filter chamber by a square vertical conduit **85** which passes through the top wall of the container **81**, the lower filter compartment **87**, and the filter **86**, substantially as described above, the upper orifice of the conduit **85** being sufficiently above the exposed surface of the filter **86** to prevent the latter from being disturbed by the gas stream discharged near the top wall of the upper compartment **91**.

A rake is mounted on the top wall of the compartment **91** by means of the vertical output shaft **94** of an electric motor, not itself shown, and consists mainly of a carrier bar **92** which extends in two opposite radial directions from the shaft **94** and carries axially elongated prongs **93**.

In the illustrated position of a lift valve **90**, purified gas released from the underside of the filter **86** into the lower filter compartment **87** passes through a discharge port **99** into a duct **88** common to the three separators seen in FIG. 6. In the nonillustrated regenerating position of the valve **90**, a compressed scavenging gas is admitted from a duct **89** into the port **99** and the lower compartment **87** to blow fine particles from the filter **86** into the container **81** while the scavenging gas, at least partly stripped of solid particles, is mixed with the contaminated raw gas in the manifold **82**.

Because of the configuration of the walls of the container **81** which converge toward the screw conveyor **84**, the contaminated gas admitted to the container along one of the converging walls is deflected by the other converging wall into a vortex having a horizontal axis. This rotary movement of the gas cannot be usefully propagated through the conduit **85** into the upper filter compartment **91**, and the conduit is therefore dimensioned, shaped, and equipped to favor longitudinal gas flow with a minimum of turbulence.

A frustoconical baffle **96** arranged at the lower orifice of the conduit **85** in the container **81** is positioned to deflect the entering gas from a horizontal into a vertical direction, and the gas discharged axially from the top orifice of the conduit **85** toward the transverse top wall of the compartment **91** is deflected by the latter into an approximately toroidal flow pattern not significantly affected by the rectangular shape of the compartment, when viewed from above. The principal flow of gas in the compartment **91** is indicated in FIG. 5 by arrows, and the acute angle at which the gas impinges on the filter **86** while flowing substantially in radial planes about the longitudinal axis of the conduit **85** is evident.

During operation of the battery of separating units shown in FIGS. 5 and 6, the valve **90** usually assumes the position seen in FIG. 5 in all three units, as is evident from FIG. 6. The time required for regenerating the filter **86** is much shorter than the period during which enough solid particles are caught on the filter to require regeneration.

It is a common feature of the several illustrated embodiments of the invention that the filters have exposed surfaces that are smaller by the cross section of the associated vertical conduits than the greatest horizontal cross section of the associated cyclone containers, and not greater than the cross section of the vortex in the cyclone container. Yet, the devices of the invention have been operated successfully at high flow rates in numerous industrial plants. Because of the oblique angle at which the entrained solid particles meet the exposed surfaces of the filters, the depth of the filters can be made very small. Their effective filtering depth is greater than the depth measured at right angles to the exposed surface, and almost equal to the depth as measured in the direction of incidence of the solid particles.

The permeability of the filters to the carrier gas, however, is determined almost exclusively by the actual filter depth at right angles to the exposed surface, and can be held very small in the apparatus of the invention, a particulate layer having a depth of 5 cm. being typical in industrial equipment of the invention. If the direction of gas flow were reversed under otherwise similar conditions, the filtering layer would have to be made 15 cm. deep. The flow resistance of the straight conduits which connect the cyclone containers to the filter compartments is minimal, and the cyclone collectors in the apparatus of the invention can be operated at very low inlet pressure. The back pressure due to the connecting conduits and the filters is very small with all practical filter media.

Sand has been mentioned as an example of a filter medium, but the invention is not limited to specific particulate materials used in the filters, and actually is not limited to particulate filter media, although particulate filter media are preferred because of their low cost and operating advantages evident from the preceding description of preferred embodiments. Sintered, porous metal

and ceramic plates have been used successfully in the apparatus of the invention and may be used where their greater cost is justified. The particle size of the particulate filter material or the pore size of a sintered filter plate will readily be selected by those skilled in the art to suit specific operating conditions.

It will be appreciated that many specific features of the several embodiments described and illustrated are interchangeable. The square or rectangular conduit **85** seen in FIG. 6 thus may be used with or without the baffle **96** in the embodiments of the invention shown in FIGS. 1 to 4, and the rectangular containers and compartments illustrated in FIGS. 5 and 6 may be replaced by equivalent elements having cylindrical, conical, or otherwise arcuately curved walls, while at least some of the cylindrical or conical walls shown in FIGS. 1 to 4 may be replaced by flat, angularly connected walls in an obvious manner. Such permutations and variations of disclosed features will be obvious to those skilled in the art and are specifically contemplated.

What we claim is:

1. In an apparatus for separating suspended solid particles from a carrier gas, in combination:

a. centrifugal separator means for separating relatively coarse solid particles from said carrier gas, and for collecting the separated particles, said separator means including

1. a container of circular cross section about an upright axis, said container having a top wall,
2. inlet means on said container for admitting a stream of said carrier gas having said solid particles suspended therein to said container and directing said stream tangentially into said container relative to said axis, whereby the admitted gas moves in a vortex about said axis, and
3. discharge means for discharging accumulated solid particles from said container;

b. a housing including side and top walls superimposed on said container and defining a filter chamber therein;

c. a plate member extending horizontally across said chamber and dividing the same into an upper compartment and a lower compartment;

d. a gas port leading outward from said lower compartment;

e. filter means for removing relatively fine solid particles from said carrier gas,

1. said filter means including a layer of particulate filter material carried on said plate member and having an exposed substantially horizontal, upper face in said upper compartment,
2. said plate member being formed with openings connecting said compartments for flow of fluid therebetween and of a size to retain said particulate filter material;

f. a conduit extending from said container through said lower compartment, said plate member and said layer in engagement with the top wall of said container and said plate member, said conduit having

1. an axis substantially coinciding with said axis of said container, and
2. two axially terminal orifices in said container and upwardly spaced from said exposed face in said upper compartment respectively; and

g. rake means in said upper compartment for raking said layer, said rake means including

1. a plurality of elongated agitating members, and
2. drive means for moving said agitating members in a circular, horizontal path while said agitating members extend downwardly into said layer through said exposed upper face of said layer.

2. In an apparatus as set forth in claim **1**, said exposed surface being not greater than the greatest cross section of said container at right angles to the axis of said vortex.

3. In an apparatus as set forth in claim **2**, said conduit being of substantially circular cross section.

4. In an apparatus as set forth in claim **1**, the orifice of said conduit in said container being downwardly spaced from said top wall of the container.

5. In an apparatus as set forth in claim **4**, said conduit having an upright axis, baffle means in said upper compartment for deflecting a stream of gas discharged from the orifice of said conduit in said upper compartment into a substantially toroidal path centered in said upright axis.

6. In an apparatus as set forth in claim **4**, said top wall of the contianer constituting a bottom wall of said lower compartment.

7. In an apparatus as set forth in claim **4**, said inlet means defining an entry port for said stream into said container, said entry port being upwardly spaced from the orifice of said conduit, in said container.

8. In an apparatus as set forth in claim **1**, a plurality of nozzles, supply means for supplying a gas under pressure to said nozzles, and mounting means mounting said nozzles on said housing for discharge of said gas under pressure against said layer, and connecting the nozzles to said drive means for movement thereby in said path.

9. In an apparatus as set forth in claim **8**, said nozzles having respective orifices intermediate said exposed surface and said plate member.

10. In an apparatus as set forth in claim **1**, scavenging means for admitting a scavenging gas under pressure to said lower compartment while no carrier gas is being admitted to said container, and while said agitating members are moved in said path thereof by said drive means.

11. In an apparatus as set forth in claim **1**, two ducts, and valve means operatively interposed between said ducts and said gas port and operable to connect each of said ducts to said port while simultaneously closing the other duct, one of said ducts when connected to said gas port by said valve means constituting said scavenging means.

12. In an apparatus as set forth in claim **11**, said valve means including two coaxial, axially spaced valve seats on said ducts respectively, a valve disc, and moving means for moving said valve discs between two positions in which the disc sealingly engages said valve seats respectively.

13. In an apparatus for separating suspended solid particles from a carrier gas, in combination:

a. a common supply manifold supplying the carrier gas and suspended particles;

b. a plurality of separator means for separating relatively coarse solid particles from said carrier gas, and for collecting the separated particles, each separator means including a ccontainer having a gas outlet port and means for discharging accumulated solid particles;

c. a filter chamber connected to the gas outlet of the container;

d. a plate member extending horizontally across each said chamber and dividing the same into an upper compartment and a lower compartment;

e. a gas port leading outward from each lower compartment;

f. filter means in each said upper compartment for removing relatively fine solid particles from said carrier gas comprising a layer of particulate filter material carried on said plate member and having an exposed substantially horizontal upper surface, said plate member being perforated to pass the carrier gas while retaining the particulate material;

g. a conduit for each container and chamber connecting the container to the space above the filter means in the chamber;

h. an ouput duct and a regenerating gas duct;

i. valve means selectively connecting the outwardly leading gas port of each chamber lower compartment to one or the other of said ducts; and

j. means for maintaining the pressure in the output

duct less than, and the pressure in the regenerating gas duct greater than the pressure in said supply manifold, whereby operation of one of said valve means reverses the gas flow through the associated filter layer and container to carry collected particles from the filter layer into the container for discharge with the solid particles previously collected in the container.

14. In an apparatus for separating suspended solid particles from a carrier gas, in combination:

a. a common supply manifold supplying the carrier gas and suspended particles;

b. a plurality of separator means for separating relatively coarse solid particles from said carrier gas, and for collecting the separated particles, each said separator means including:

1. a container,

2. inlet means connecting the container to said supply manifold and directing the gas entering the container along a wall thereof whereby the admitted gas moves in a vortex to separate the coarse particles from the gas, and

3. discharge means for discharging accumulated solid particles;

c. housing means including a filter chamber for each container;

d. a plate member extending horizontally across each said chamber and dividing the same into an upper compartment and a lower compartment;

e. a gas port leading outward from each said lower compartment;

f. filter means in each said upper compartment for removing relatively fine solid particles from said carrier gas comprising, a layer of particulate filter material carried on said plate member and having an exposed substantially horizontal upper surface, said plate member being perforated with openings to pass the carrier gas while retaining the particulate material;

g. a conduit for each container and chamber extending from the eye of the vortex in the container to the space above the filter means in the chamber;

h. rake means in each chamber for agitating the layer of particular filter material during regeneration of the layer of filter material;

i. an output duct and a regenerating gas duct;

j. valve means selectively connecting each of said gas ports to one or the other of said ducts and

k. means for maintaining the pressure in the output duct less than, and the pressure in the regenerating gas duct greater than the pressure in said supply manifold, whereby operation of said valve means reverses the gas flow through a filter layer and associated container to carry particles trapped in the layer of material into the container for discharge with the accumulated solid particles previously collected in the container.

References Cited

The following references, cited by the Examiner, are of record in the patented file of this patent or the original patent.

UNITED STATES PATENTS

3,564,570	3/1968	Lincoln et al.	55—302
299,898	6/1884	Wright	34—181
585,568	6/1897	Greiwe	55—239
940,076	11/1909	Seaver	55—337
2,134,978	11/1938	Marshall	55—320
3,090,180	5/1963	Berz et al.	55—282
387,607	8/1888	Trebau	210—273
506,879	10/1893	Jewell	210—279
575,824	1/1897	Case	55—282
650,611	5/1900	Reeves	210—277
879,963	2/1908	Hirt	210—274
3,057,137	10/1962	Perlis et al.	55—341

BERNARD NOZICK, Primary Examiner

U.S. Cl. X.R.

55—302, 337, 432, 459, 474