United States Patent [19]

Williams

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[54] **GAS CLEANING APPARATUS**

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[22] Filed: **Oct. 28, 1971**

[21] Appl. No.: **193,514**

[52] **U.S. Cl.** **15/346,** 15/340, 55/429

[51] **Int. Cl.** **A47l 5/14**

[58] **Field of Search** 15/345, 346, 340; 55/429

[56] **References Cited**

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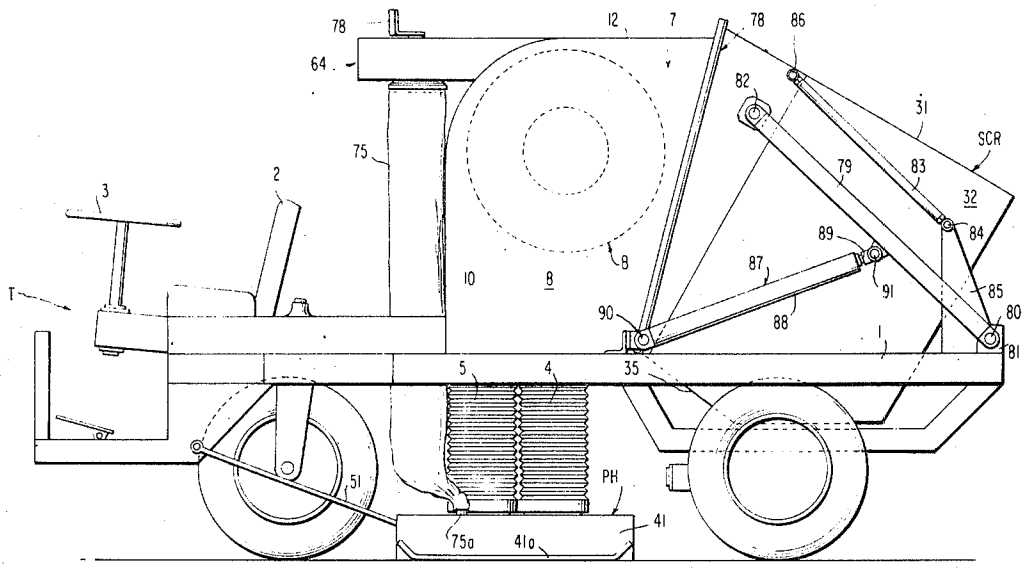
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[57] **ABSTRACT**

Apparatus for separating particulate solid material from a stream of gas, such as air, entraining such material includes a blower, a solids collection receptacle, ducting connected to the blower and to the receptacle and communicating with a source of gas with entrained particulate solid material, the blower, receptacle and ducting providing a substantially closed system in which gas is recirculated, the solid material being separated from the circulating gas and deposited in the collection receptacle. A portion of the circulating gas, usually not exceeding 30 percent by volume, is bled from the circulatory system and discharged to maintain the average pressure in the circulating system at a desired low value so as to prevent leakage blow-out of gas and entrained dust or fine solids. Means for bleeding gas off from the system is situated within structure housing the blower and a separation chamber. The solids collecting receptacle is mounted so as to be bodily movable away from the blower and ducting housing structure and so as to respond to such bodily movement by tipping to dump accumulated solids. The gas cleaning apparatus is disclosed in connection with mobile surface sweeping equipment including a pick-up head having means for regulating the flow of air from a pressure chamber against the surface being cleaned and into a suction chamber in the pick-up head.

33 Claims, 15 Drawing Figures



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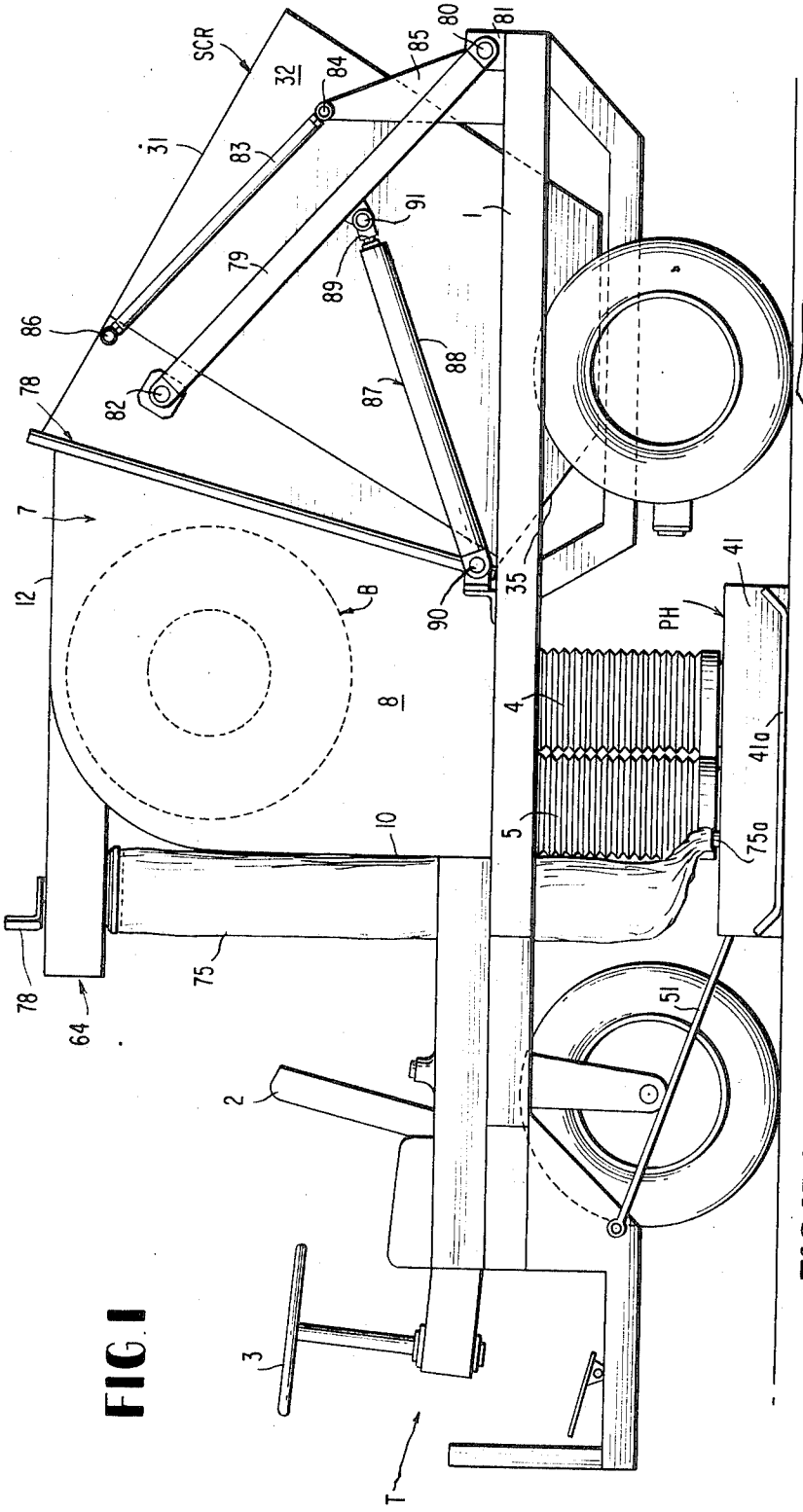


FIG. 1

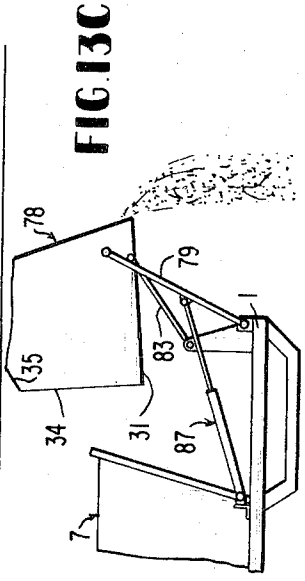


FIG. 13C

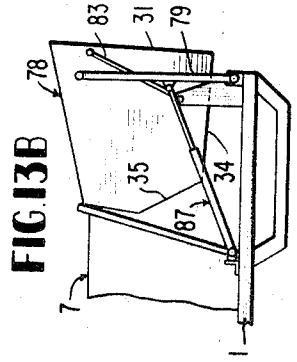


FIG. 13B

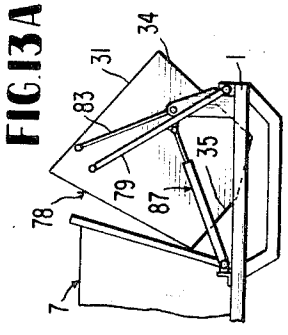


FIG. 13A

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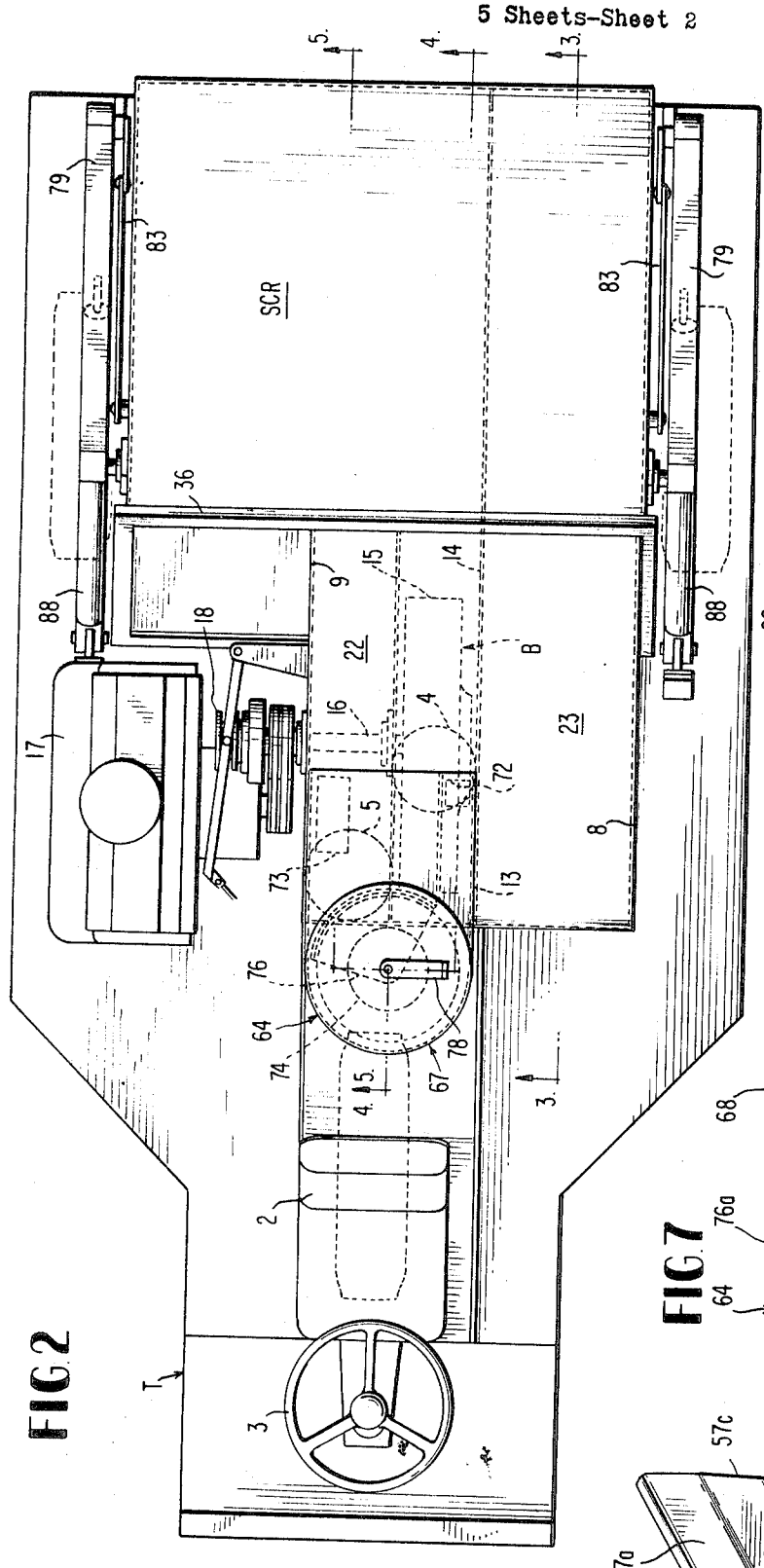


FIG. 2

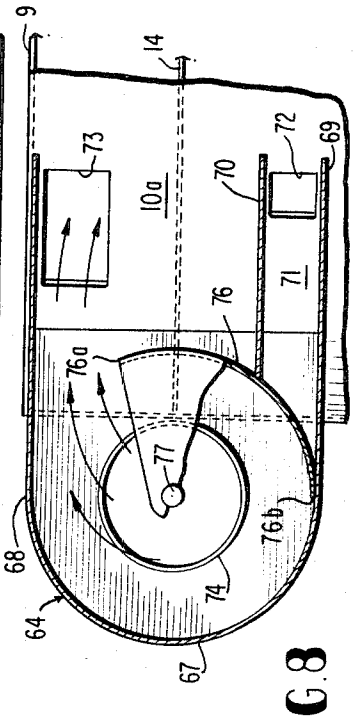


FIG. 8

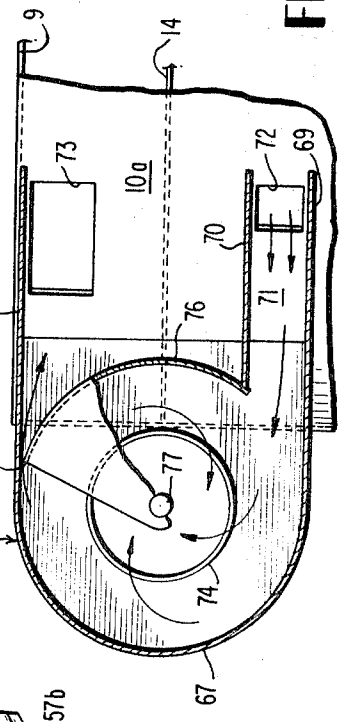


FIG. 7

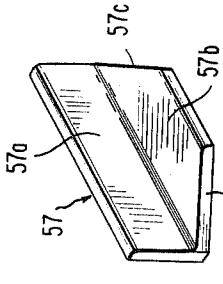


FIG. 12

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FIG. 3

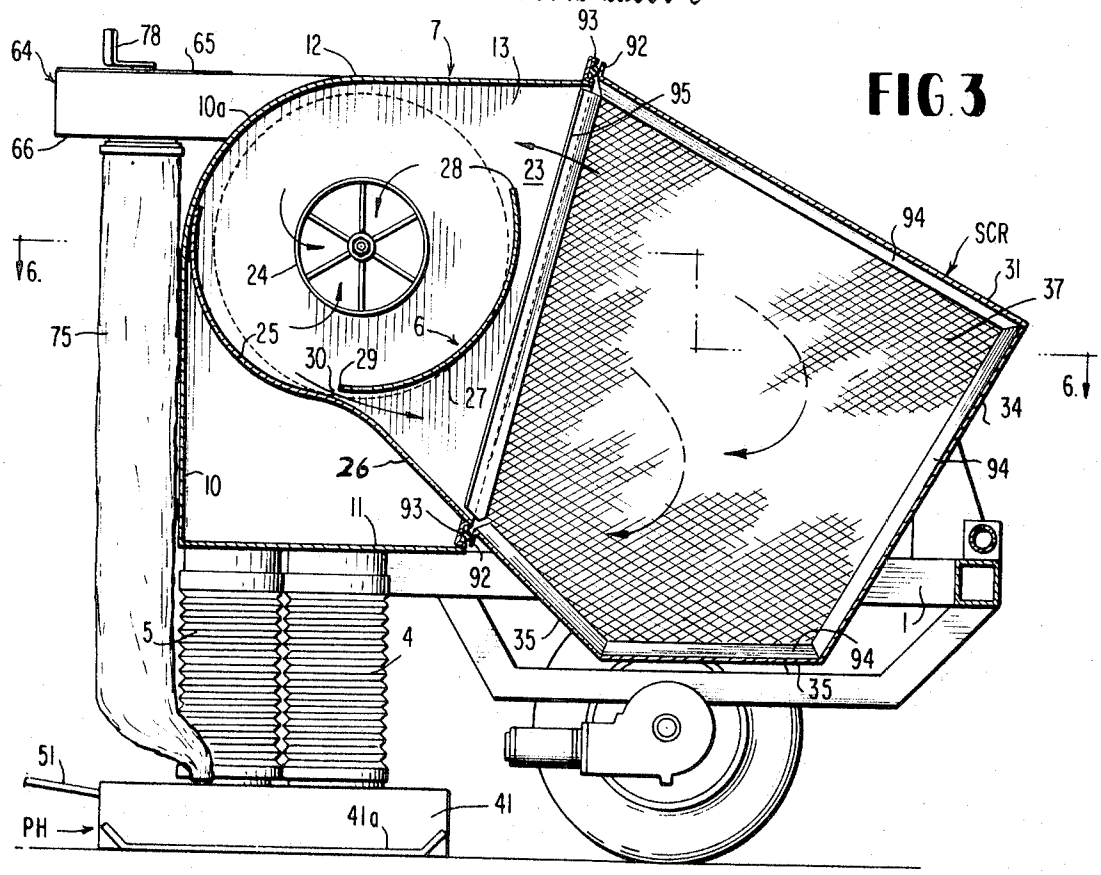
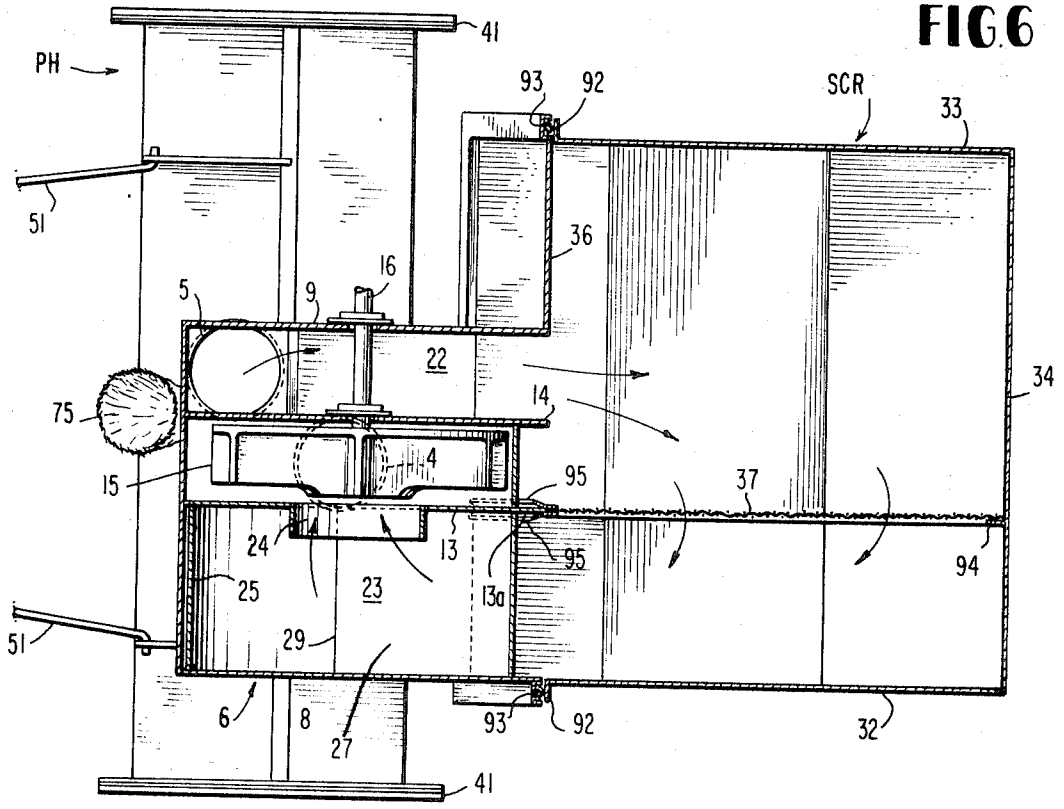


FIG. 6



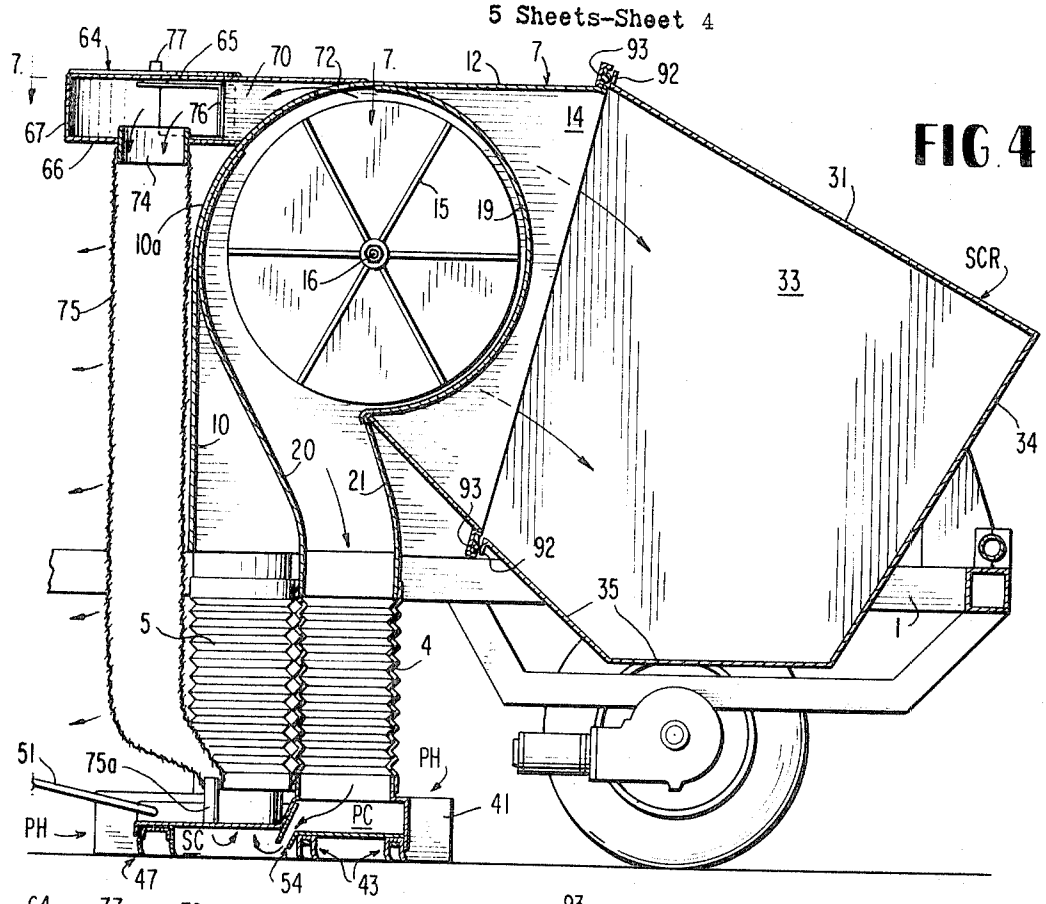

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FIG. 4

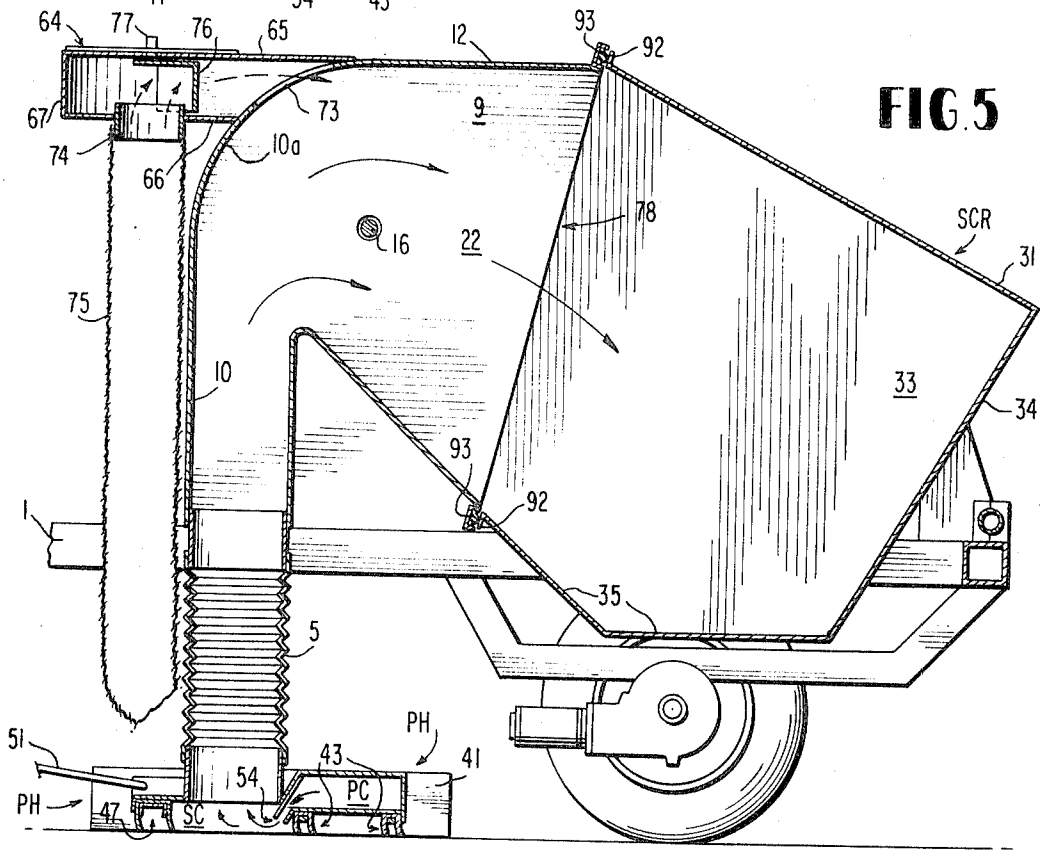

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FIG. 5

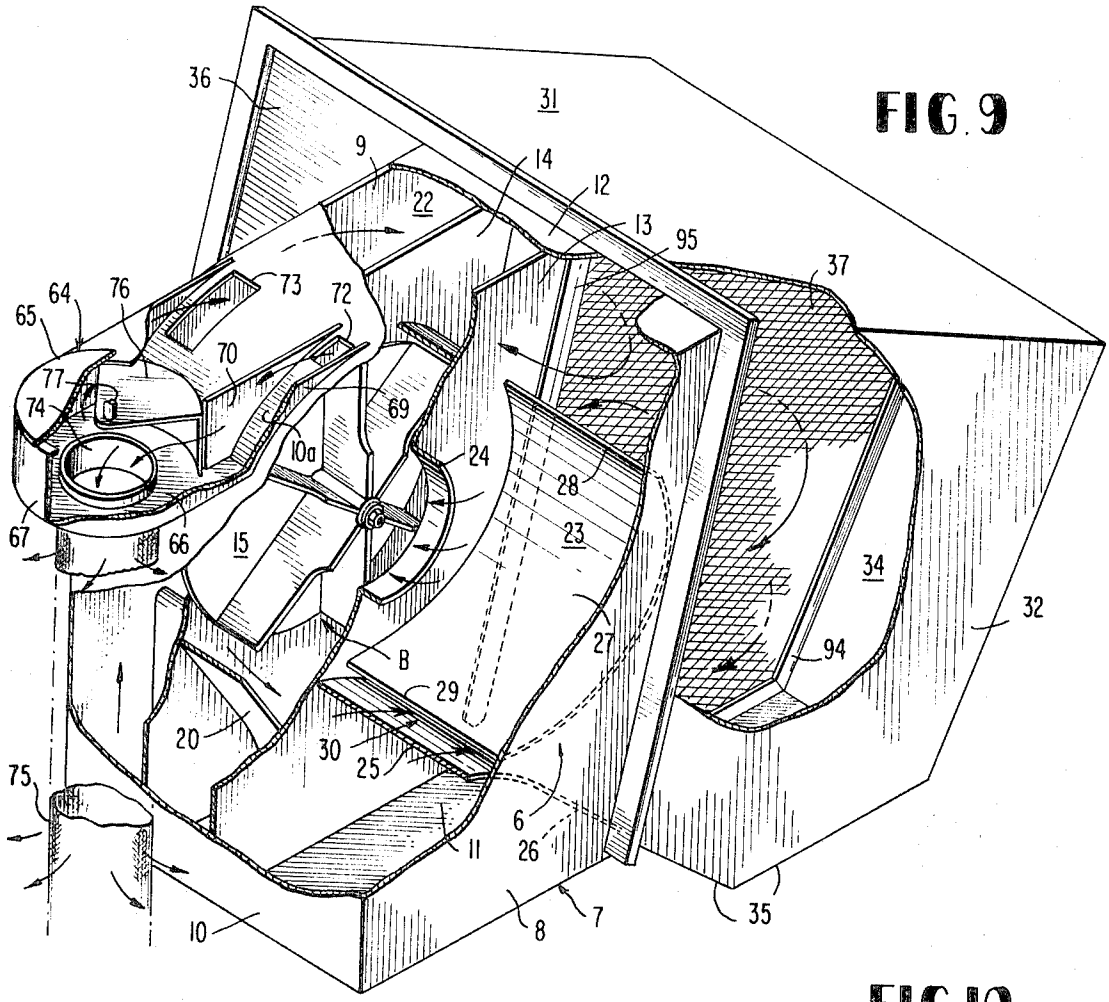


FIG. 9

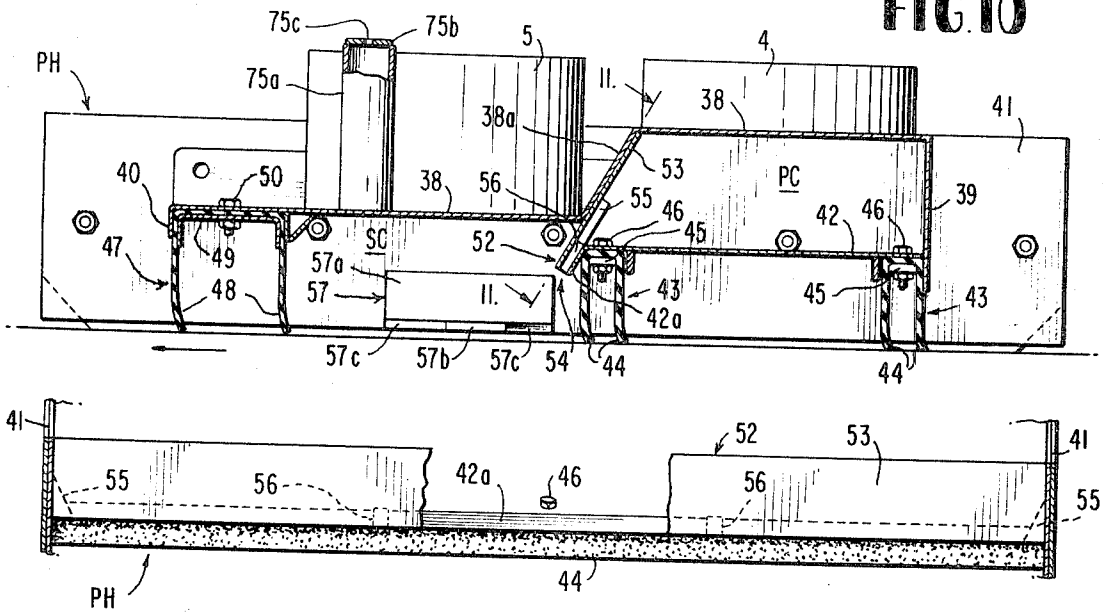


FIG. 10

FIG. 11

GAS CLEANING APPARATUS

This invention relates to apparatus for separating gas from particulate solid matter entrained in a stream of the gas. More particularly the invention provides improvements in previously known separation apparatus in which particulate solid matter is picked up in a stream of gas, e.g., air, and conducted in a substantially closed recirculating air stream system to separating means including a receptacle into which solid matter separated from the air stream is deposited. Such recirculating systems are used, for example, in connection with street or other surface cleaning equipments in which the cleaning action is performed mainly if not entirely by air stream action, as distinguished from by brushing the surface mechanically. While such recirculating systems are intended to be, and in practice essentially are, closed, it is inevitable that some, although relatively very little, air is drawn from outside the system into the suction side of the system which thereby increases the total amount of air in the system. Since the system is essentially of fixed volume, the drawing in of additional air tends to increase the average pressure throughout the system. This increase in pressure will cause some air with entrained dust to be discharged from the high pressure side of the circulation system through leaks in the ducting or collection receptacle or from the pressure chamber of the pick-up head. Air leaking under pressure carries with it entrained dust or other particles, discharging of which to the atmosphere is naturally undesirable, in fact in many situations, intolerable.

An object of the present invention is to provide an apparatus of the general character outlined above but which includes a new and improved arrangement of ducting and valve means by which a relatively small portion of the gas circulating in the otherwise closed system is bled off and discharged from the system, thereby avoiding the building up of the average pressure throughout the system and preventing dust or other solid matter from being blown out of the system.

Another object of the invention is to provide such an apparatus including a filter through which gas bled off from the system is discharged, and in which the bleed-off valve means is operable for reversing flow of gas through the filter to dislodge solid matter from the filter and deliver it to the suction side of the recirculation system.

Another object of the invention is to provide a recirculation gas cleaning apparatus including an improved separation chamber fitted with a curved baffle defining a skimmer slit for removing solids from a whirling stream of gas.

Another object of the invention is to provide a surface cleaning pick-up head for use in connection with a recirculating system as described above, the pick-up head being provided with means for regulating the blasting of air within the pick-up head from a pressure chamber to a suction chamber.

A further object of the invention is to provide means for mounting the solids collection receptacle of a system as outlined above in such manner that the receptacle may be moved bodily away from a blower and ducting housing and, as an incident to such bodily movement, will be tipped to discharge collected solids.

Other objects of the invention will become apparent from a reading of the following description of a preferred embodiment, the appended claims, and the accompanying drawings, in which:

FIG. 1 is a somewhat schematic side elevational view of mobile surface sweeping equipment comprising a truck and apparatus for separating entrained solids from air supported thereon;

FIG. 2 is a top plan view of the equipment shown in FIG. 1;

FIG. 3 is a longitudinal vertical section on the line 3—3 of FIG. 2;

FIG. 4 is a vertical section on the line 4—4 of FIG. 2;

FIG. 5 is a vertical section on the line 5—5 of FIG. 2;

FIG. 6 is a horizontal section on the line 6—6 of FIG. 3;

FIG. 7 is an enlarged scale horizontal section on the line 7—7 of FIG. 4, an air bleed-off valve being shown in position for bleeding air from a main air circulatory system;

FIG. 8 is a view similar to FIG. 7, but showing the valve in a different position, for reverse flow cleaning of a filter;

FIG. 9 is a perspective view, with parts broken away, showing the inside of a housing with a blower and ducts and separator chamber being illustrated;

FIG. 10 is an enlarged scale cross section of a pick-up head;

FIG. 11 is a fragmentary longitudinal section of the pick-up head on the line 11—11 in FIG. 10, with parts broken away, and drawn on a smaller scale than FIG. 10;

FIG. 12 is a perspective view of an angle plate member included in the pick-up head construction; and

FIGS. 13A, 13B and 13C are diagrammatic elevational views showing successive positions of a solids collection receptacle during a dumping operation.

A representative embodiment of the invention is shown as being mounted on a mobile truck or the like permitting the equipment to be moved over a street or other surface to be cleaned. In general, surface cleaning is effected by directing a blast of air against the surface to entrain particulate solid matter in an airstream which is then delivered to equipment for separating the solid particulate matter from the airstream and for then returning the air under pressure so as to recirculate continuously in the cleaning of the surface. The equipment is shown as being mounted on a wheeled truck T having a frame 1 for supporting the equipment for picking up solid particles in the airstream and separating the particles from the air. An operator's seat 2 and steering wheel 3 are shown conventionally. The truck T may be driven by any conventional means.

Considering the surface cleaning and air and solids separating equipment generally, a blower B receives its intake of air from a solids collection receptacle SCR, thereby reducing the pressure in the receptacle to a relatively negative pressure. The blower delivers air under pressure through a duct 4 to a pressure chamber PC in a hollow pick-up head structure PH, the construction of which is described more particularly hereinafter. An air blast is delivered from the pressure chamber PC downwardly against the surface to be cleaned and thence to a suction chamber SC in the pick-up head. Air with entrained particulate matter flows from the suction chamber SC to the solids collection receptacle SCR through a suction duct 5 and further ducting

means to be described later. The air with entrained solid matter entering the collection chamber SCR is reversed in its flow in the receptacle so that some of the solid matter drops out of the airstream into the bottom of the receptacle. Air thus at least partially cleaned flows to the blower intake via supplemental separating structure generally designated **6** in FIGS. **3, 6** and **9** and which will be further described hereinafter. Air flows from the supplemental separating structure **6** to the blower intake, thus completing the circulation which is repeated continuously over the same system route.

Considering the illustrative construction more particularly, a housing generally designated **7** encloses the blower B and provides ducting required for the air to flow over the recirculating path generally described above. The housing **7**, which is mounted on the support **1**, includes side walls **8** and **9**, a front wall **10**, a bottom wall **11**, and a top wall **12**. The rear face of the housing **7** is open, that is unwalled.

Mounted in the housing **7** are two vertical partitions **13** and **14** extending fore-and-aft between the front wall **10** and the open rear face of the housing. Rotatably mounted in the space between the partitions **13** and **14** is the blower impeller **15** driven through a shaft **16** by an engine **17** and clutch **18** generally indicated in FIG. **2**. As shown in FIGS. **4** and **9**, a curved shroud **19** is mounted between the partitions **13** and **14** so as partially to surround the impeller **15**. Also, as shown in FIG. **4**, are transition members **20** and **21** mounted between the partitions **13** and **14** and extending downwardly from the shroud **19** to the pressure duct **4** leading to the pressure chamber PC of the pick-up head PH. Air discharged peripherally by the impeller **15** is thus delivered downwardly through the pressure duct **4** to the pressure chamber PC.

The space **22** in the housing **7** between the housing side wall **9** and the partition **14** serves as part of duct means communicating with the suction duct **5** and suction chamber SC of the pick-up head PH, the space **22** being open at the rear face of the housing **7**.

As shown in FIGS. **2, 3, 6** and **9**, the space between the partition **13** and the housing side wall **8** serves as a separation chamber **23** which is useful for removing from air flowing to the blower any entrained solid matter which was not deposited in the collection receptacle SCR.

The chamber **23** is open at its rear to the receptacle SCR and communicates with the blower intake through an inlet opening **24** in the partition **13**. Mounted in the separation chamber **23** is a curved partition **25** with a rearward-downward extension **26** projecting to the rear of the housing **7** as clearly shown in FIG. **3**. The curved partition **25** follows generally the curvature of a curved part **10***a* of the housing front wall **10**.

Mounted in the separation chamber **23** is a curved baffle **27** generally following the curvature of the partition **25**. The upper edge **28** of the baffle **27** is spaced substantially below the top **12** of the housing **7**, whereas the lower or opposite edge **29** of the baffle **27** is spaced from but is relatively very close to the mergence of the curved partition **25** with its extension **26**. The relatively large spacing of the baffle edge **28** from the top **12** of the housing provides for free flow or air from the collection receptacle SCR tangentially into the separation chamber **23** so as to create a swirling or vortex action which centrifugally concentrates any remaining solid particles out against the wall **10***a*, **25** of the separation chamber **23**. The concentrated solids are skimmed out through a skimmer slit **30** defined by the lower edge **29** of the curved baffle **27** and the adjacent part of the partition **25**.

The solids collection receptacle SCR is mounted on the support **1** by means permitting it to be raised and dumped as later to be described. At this point it is sufficient to explain the construction of the collection receptacle SCR as it is related to its functioning as part of the circulating system for separating solids from air. The receptacle includes a top wall **31**, side walls **32** and **33**, a rear wall **34**, and an obtusely angled bottom wall **35**. The front face of the receptacle is open, that is unwalled. When the receptacle is in operative position, its open front face permits free communication between the receptacle and the duct space **22** in the housing **7** between the side wall **9** and the partition **14** of the housing. The open front face of the receptacle also places the receptacle into communication with the separator space **23** included between the housing partition **13** and housing side wall **8** as described above. As shown in FIG. **6**, the housing **7** is provided with a laterally offset wall extension **36** which closes the open front face of the collection receptacle SCR beyond the housing wall **9**.

As shown in FIGS. **3, 6** and **9**, the collection receptacle SCR is fitted with a screen partition **37** extending fore-and-aft and generally in alignment with the housing partition **13** and dividing the receptacle into two sections. Air with entrained solid matter enters the receptacle SCR from the duct space **22** and flows through the screen **37** before being returned to the blower intake **24** by way of the supplemental separation chamber **23**. The screen **37** is useful for intercepting a considerable portion of the entrained solid matter before the circulating air is returned to the blower.

One form of pick-up head suitable for use in connection with an air cleaning apparatus according to the invention is shown in FIGS. **10** and **11**, although other pick-up head constructions may be used. The pick-up head PH as shown in FIGS. **10** and **11** includes a stepped top plate wall **38** provided with longitudinal flanges **39** and **40**, and end panels **41**. A horizontal wall **42** is welded or otherwise secured to the inside of the flange **39** spaced below the top wall **38** and extends toward the longitudinal center of the pick-up head PH. The horizontal wall **42** mounts two flexible or yieldable U-shaped members **43** formed with spaced downwardly extending aprons or curtains **44**. The members **43** are secured to the wall **42** by clamping strips **45** and bolts **46**.

Underneath the opposite edge of the pick-up head PH, that is adjacent to the flange **40**, is mounted another flexible member **47** generally U-shaped in cross section and comprising aprons or curtains **48**. A channel-shaped strip **49** and bolts **50** clamp the member **47** to the bottom face of the top wall **38**.

The end panels **41** are provided with skids **41***a* which rest upon the surface being cleaned and support the pick-up head PH. The curtains **44** and **48** and the end panels **41** together enclose a working air space including both the pressure chamber PC and the suction chamber SC. The curtains assist in supporting the pick-up head, but the curtains **48** are flexible enough to yield upwardly and admit cans and other objects into the pick-up head working space. As shown in FIGS. **1** and **6**, the pick-up head PH is towed along in the direction

of cleaning movement progress by draw bars 51 connected at their rear ends to the pick-up head PH and connected at their front ends to the truck frame 1.

Extending generally centrally and longitudinally inside the pick-up head and transversely to the direction of cleaning movement progress is an inclined parition generally designated 52 which separates the suction chamber SC from the pressure chamber PC. The partition comprises a plate 53 secured to the inner face of the step-down part 38*a* of the top plate wall 38, and an inclined flange 42*a* extending along the front edge of the horizontal plate 42. The flange 42*a* is parallel to and spaced from the lower portion of the plate 53 so as to provide an elongated orifice slit 54 for discharging blast air from the pressure chamber PC against the surface being cleaned at a downward-forward inclination and thence into the suction chamber SC. The spacing of the lower part of the plate 53 from the flange 42*a* and hence the width of the slit 54 are fixed by two spacers 55 at the respective ends of the orifice slit between the plate 53 and the flange 42*a*, and two intermediate spacers 56 between the plate 53 and the flange 42*a*. The end spacers 55 have downwardly inwardly sloping edges as shown in FIG. 11. These edges direct blast air emerging from the slit orifice inwardly and away from the respectively adjacent ends of the suction chamber toward the longitudinal center of the latter.

At each end of the suction chamber SC is an angle plate member 57 secured to the inside of the adjacent end panel 41. One angle plate member 57 is shown in FIG. 12 as having its vertical web 57*a* secured to the inner face of the one end panel 41 and having its horizontal web 57*b* extending inwardly from that panel into the suction chamber. The other angle plate member 57 (not shown) is similarly mounted on the other end panel 41. The horizontal webs 57*b* of the members 57 are chamfered 45° at 57*c* as shown also in FIG. 12. The plate members 57 divert blast air from ends of the suction chamber toward its center and thus prevent blow-out of blast air at the ends of the suction chamber.

In operation, air delivered under pressure by the blower B flows downwardly through the pressure duct 4 into the pressure chamber PC of the pick-up head. Air under pressure in the pressure chamber flows at high velocity in the manner of a blast through the slit orifice 54 to impinge upon the surface being cleaned at an angle so as to dislodge particles from the surface and disperse them in the suction chamber SC. Air with entrained particulate solid material is then drawn from the suction chamber up through the suction duct 5 into the duct space 22 in the housing 7 and thence into the collection receptacle SCR between the receptacle side wall 33 and the screen 37, a considerable portion of the entrained solid material descending to the bottom of that part of the receptacle by gravity. The screen 37 intercepts non-descended solid particles from the airstream as it passes into the part of the collection receptacle between the screen 37 and the side wall 32 of the receptacle. The airstream flows from the latter part of the receptacle into the supplemental separation chamber 23 and thence through the blower intake 24, thus completing the recirculation flow path. Very fine solid particles remaining in the airstream flowing from the receptacle SCR into the supplemental separation chamber 23 are largely removed by the centrifugal action resulting in skimming off of fine solid particles through the skimmer slit 30 and returning of those particles downwardly along the partition extension 26 to the collection receptacle.

Although the recirculation system described above is essentially a closed system, as a practical matter some air in addition to that being circulated inevitably is drawn into the system where under suction conditions, principally at the ground/curtain interface. Air may also be drawn in in lesser degree through any leaks in imperfectly sealed joints in the housing 7 defining the suction duct space 22, and where the collection receptacle SCR fits against the housing 7 without perfect sealing. Whatever additional air is drawn into the closed system tends to raise the average system pressure above atmospheric pressure. This means that there must be some discharge of air from the system to compensate for that drawn in. Emitting air through leakage or say under the curtains 44 adjoining the pressure chamber PC would result in blowing dirty air into the atmosphere which would obviously be undesirable and which would result in sacrificing advantages otherwise obtainable by the use of the closed circulating system.

The construction illustrated and described above has provision for discharging or bleeding off air in an amount approximately equal to that drawn in incidentally so as to maintain the average system pressure at a desired low level. The air discharged or bled off is delivered to the atmosphere without discharging significant amounts of dust or other particles freely to the atmosphere. This is accomplished by by-passing or bleeding some of the circulating air, which may contain some entrained solid particles, through a filter by means of equipment now to be described.

A by-pass or pressure relief plenum structure generally designated 64 is mounted on the housing 7 adjacent the top of the curved part 10*a* of the housing front wall 10. The plenum structure 64 includes a top wall 65, a bottom wall 66, a curved end wall 67, an outer side wall 68, and an inner side wall 69. The plenum bottom wall 66 abuts the curved part 10*a* of the housing front wall 10 as shown in FIGS. 4, 5 and 9. The side walls 68 and 69 conform at their rear ends to the curvature of and they abut the curved wall part 10a of the housing front wall. The plenum structure 64 includes an additional wall 70 which is spaced inwardly from the wall 69 as shown in FIGS. 7 and 8 so as to provide a flow passage 71 leading tangentially into the round part of the plenum.

A pressure relief or by-pass opening 72 is formed in the blower casing adjacent the juncture of the housing front wall 10 and the top wall 12 as shown in FIGS. 2, 4 and 9. The pressure relief opening 72 communicates with the flow passage 71 of the plenum 64.

A suction port 73 is formed in the housing 7 adjacent the convergence of the front wall 10a with the housing top wall 12 so as to communicate with the ducting space 22 previously described as being between the housing wall 9 and the partition 14. The port 73 is also adapted to communicate with the plenum 64 at a zone spaced circumferentially from the tangential reception of air entering the plenum from the passage 71.

At the center of the plenum 64 is a gas bleed outlet extending through a spigot 74 on which is mounted the open end part of a filter bag 75 of foraminous material.

A segment-shaped by-pass control valve 76 is pivoted at 77 at the center of curvature of the plenum wall 67 and is operable by a handle 78 located above the plenum 64 as shown in FIGS. 2 and 3 so as to be movable

to two positions as shown respectively in FIGS. 7 and 8.

Normally, that is during most periods of operation, the valve 76 will be positioned as shown in FIG. 7 so that there is free opening for air with entrained dust to move from the relief opening 72 and passage 71 into the plenum circular part tangentially. In this position of the valve 76, an edge 76*a* of the valve is closely adjacent to the plenum wall 68 so as to prevent free communication between the plenum and the port 73, but leaves a narrow skimmer slit between the valve edge 76a and the plenum wall 68. The slit provides for controlled restricted communication of the port 73 with the plenum 64 at a zone spaced circumferentially approximately 180° from the tangential reception of bypassed air by the plenum. Some of the dirt laden air flowing circularly in the plenum will be relieved of its dust by centrifugal force concentrating the dust particles in the outer part of the plenum from which they are passed through the skimmer slit at the valve edge 76*a* with a small amount of air. The air and dust passing through the skimmer slit are returned to the system through the port 73, suction duct space 22, and collection receptacle SCR. However, the major part of the air received in the plenum 64 from the relief opening 72 flows to the plenum center and out through the bleed outlet 74 into the filter bag 75. The bag traps and retains practically all of the entrained dust while the bled-off air passes out through the bag to the atomsphere without harmful and unpleasant results.

After operating for some time with the valve 76 in the position shown in FIG. 7 with bleeding off of surplus air as described above, the filter bag 75 normally will accumulate a considerable amount of dust or other particles which, if not removed, would reduce the efficiency of the filter. Accordingly, it is desirable to provide for cleaning the filter. Of course, this could be done by removing the bag 75 and replacing it with a clean bag, but this would involve additional trouble and expense and extra equipment. The present construction provides for cleaning the filter bag 75 by the simple expedient of moving the valve 76 to the position shown in FIG. 8 in which the valve edge part 76*b* opposite the edge 76*a* blocks off the passage 71 and the valve edge part 76*a* is widely spaced from the plenum wall 68 so as to place the curved part of the plenum and also the interior of the filter bag 75 in substantially unrestructed communication with the port 73 and hence with the suction duct space 22 and receptacle SCR. The inside of the bag 75 is thereby subjected to suction which causes the bag to give up dust or other particles residing in the bag. Removal of the particles from the bag is enhanced by flexing of the bag resulting from reversal of flow of air into the bag from the atmosphere, as distinguished from the normal flow outwardly through the bag into the atmosphere. The air drawn into the bag 75 from the atmosphere entrains the dust dislodged from the bag walls and carries it by suction flow through the port 73 and duct space 22 into the receptacle SCR.

The setting of the valve 76 in the FIG. 8 position for cleaning the filter bag is used only periodically and for relatively short periods as compared to the operation under the normal conditions when the valve is positioned as shown in FIG. 7. The frequency of reverse cleaning the filter by positioning the valve as shown in FIG. 8 may be reduced by connecting the bottom of the filter bag to the suction side of the recirculatory system. In the form shown, the bottom of the bag 75 is connected to a tube 75*a* communicating with the suction chamber SC in the pick-up head PH. Dust or solids in the filter bag which do not adhere to the bag side walls but drop to the bottom of the bag are thus returned directly to the suction side of the system while the valve 76 is in its normal position as shown in FIG. 7. Suction removal of solid particles from the bottom of the bag 75 is improved by provision of a disk cover 75*b* on the tube 75*a* formed with a restricted air passage hole 75*c*. Air drawn by suction from the bag 75 into the suction chamber SC must flow at a high velocity through the hole 75*c* so as efficiently to entrain particles and carry them into the tube 75*a* and thence to the suction chamber SC.

The solids collection receptacle SCR is mounted so as to be supported on the truck frame 1 and to be moved from its normal position shown in FIG. 1 bodily away from the housing 7 and simultaneously to be tipped so as to discharge material collected in the receptacle to the rear and through the open face 78 of the receptacle. In the normal position of the receptacle, its open front face 78 communicates directly with the suction duct space 22 and with the separation chamber 23 in the housing 7. When the receptacle is moved bodily away from the housing 7 and is tipped, the housing contents are dumped or discharged through the open face 78 of the receptacle, thus dispensing with the necessity of providing a separate clean-out door or gate.

As shown in FIG. 1, control means for tipping the receptacle when it is moved away from the housing includes a relatively long link 79 pivoted at 80 to a bracket 81 on the support 1, and pivoted at 82 to the receptacle SCR relatively close to the receptacle open face 78 and near the top of the receptacle.

A relatively short link 83 extending above the link 79 is pivoted at 86 to the receptacle side wall 32 close to the receptacle top wall 31. The links 79 and 83 together with the support 1 and the receptacle SCR constitute a four-bar linkage.

Means for operating the control linkage includes a power operable extensible assembly generally designated 87 and in the present instance illustrated as an assembly of a cylinder 88 and piston rod 89 operable under fluid pressure from a source, not shown. The cylinder 88 is pivoted at 90 on the support 1, and the piston rod is pivoted at 91 to an intermediate part of the link 79. Fluid pressure extension of the piston rod 89 operates through the links 79 and 83 and other components of the four-bar linkage to move the receptacle SCR from the normal position shown in FIG. 1 successively through the positions shown in FIGS. 13A, 13B and 13C, thus moving the receptacle SCR bodily away from the housing 7. The control linkage responds to movement of the receptacle away from the housing by tipping the receptacle so far as to dump the contents through the same open face 78 as was positioned against the open face of the housing 7 during normal operation. The linkage and operating means located adjacent the side 32 of the collection receptacle SCR have been described. For balancing forces, a similar mechanism is provided at the side 33 of the receptacle.

When the receptacle SCR is in its normal position with its open front face adjacent the generally vertically extending open rear face of the housing 7, flanges 92 surrounding the front face of the receptacle abut sealing gaskets 93 which surround the rear face of the

housing 7. This provides a sufficiently good seal to prevent inward leakage of more air than can be compensated for by the bleeding off of air through the filter 75. The screen 37 is secured to the receptacle SCR walls 31, 34 and 35 by strips 94. As shown in FIGS. 3 and 6, two flanged strips 95 extend along the front edge of the screen 37. When the receptacle is in its normal position as shown in FIGS. 1, 3 and 6, the flanges of the strips 95 fit over and embrace a rearward extension 13a of the housing partition 13. In this manner, the front edge of the screen 37 is supported against lateral deflection, for example in the event of piling of dust and even heavier particles against one side of the screen.

Although the invention has been described in its application to air blast surface cleaning, it will be understood that apparatus according to the invention may be used for separating particulate solid material from air or other gas generally, and not only in connection with street or other surface cleaning operations. The construction illustrated and described embodies the invention in a preferred form, but it is intended that the disclosure be illustrative rather than definitive, the invention being defined in the claims.

I claim:

1. In apparatus for separating gas from particulate solid matter entrained therein and having a solids collection receptacle; a blower; means providing communication between the intake of said blower and said solids collection receptacle whereby to place the interior of said solids collection receptacle under relatively negative pressure; a hollow structure for receiving particulate solid matter for entrainment in a gas flow stream; first duct means affording communication of the blower discharge with said hollow structure; and second duct means affording communication of said solids collection receptacle with said hollow structure; said solids collection receptacle, said blower, said hollow structure and said first and second duct means providing a system for recirculation of gas in a flow path from said hollow structure through said second duct means, said solids collection receptacle, said blower and said first duct means back to said hollow structure and continuously over said path, the intake of said blower, said solids collection receptacle, said second duct means and a part of said hollow structure being under said relatively negative pressure, whereby some gas in addition to the recirculated gas enters into said flow path from outside said system; the improvement comprising gas bleeding means for preventing said addition of gas from outside said system from undesirably increasing the average gas pressure in said system, said gas bleeding means including a pressure relief plenum; a by-pass opening in said first duct means communicating with said pressure relief plenum; a gas bleed outlet in said plenum; and a valve in said plenum for variably controlling the flow of gas therethrough from said by-pass opening to and through said gas bleed outlet.

2. Apparatus according to claim 1 including a filter mounted to receive gas discharged through said gas bleed outlet.

3. Apparatus according to claim 2 including a port in said second duct means communicating with said plenum, said valve being operable for selectively placing said plenum respectively into communication with said by-pass opening in said first duct means and with said port in said second duct means, communication of said plenum with said port in said second duct means providing for reverse flow of gas through said filter to dislodge solid material therefrom and carry it entrained through said second duct means to said solids collection receptacle.

4. Apparatus according to claim 3 in which said filter comprises a foraminous bag into which gas is discharged through said gas bleed outlet.

5. Apparatus according to claim 1 in which said first duct means includes the casing of said blower, said by-pass opening being formed in said casing itself.

6. Apparatus according to claim 1 in which said plenum includes an outer cylindrical wall portion located to receive by-passed gas tangentially from said by-pass opening to establish a swirling movement of gas and entrained particulate solid matter in said plenum, said gas bleed outlet being at the central portion of said plenum; said apparatus further including a port in said second duct means communicating with said plenum at a zone spaced circumferentially from the tangential reception of by-passed gas by said plenum, said valve being selectively movable to two positions in one of which positions it establishes relatively free flow of gas from said by-pass opening into said plenum and substantially prevents free flow of by-pass gas from said plenum to said port, and in the other of which positions said valve substantially prevents flow of gas from said by-pass opening into said plenum and establishes relatively free flow of gas from said plenum to said port and thence to said second duct means and said solids collection receptacle.

7. Apparatus according to claim 6 including a foraminous bag filter mounted to receive gas discharged from said gas bleed outlet.

8. Apparatus according to claim 7 including means providing communication between said second duct means and the interior of said bag filter at a location spaced from said gas bleed outlet.

9. Apparatus according to claim 6 in which said valve comprises a segmental part substantially conforming to the shape of said outer cylindrical wall portion, and means mounting said valve to turn about the axis of said cylindrical wall portion and said segmental part.

10. Apparatus according to claim 9 in which, when said valve is in said one of said two positions, a portion of said segmental part mainly cuts off communication between said plenum and said port but an edge of said segmental portion is spaced slightly from said plenum wall to provide a skimmer slit through which particulate solids centrifugally concentrated adjacent the inner surface of said plenum wall by the swirling of the gas within the plenum are discharged together with a minor portion of the by-passed gas to said port and thence to said second duct means and said solids collection receptacle, the major portion of the by-passed gas being discharged through said gas bleed outlet.

11. Apparatus according to claim 10 including a hollow filter for receiving by-passed gas discharged through said gas bleed outlet; and solids return means for conducting a portion only of the gas and solids delivered to said filter to said second duct means for return to said solids collection receptacle.

12. Apparatus according to claim 11 in which said filter extends downwardly from said gas bleed outlet, and in which said solids reutrn means is connected to the lower portion of said filter.

13. Apparatus according to claim 12 in which said solids return means communicates with said second duct means via said hollow structure.

14. Apparatus according to claim 1 including a vertical screen partition in said solids collection receptacle dividing the latter into two sections one of which communicates with the blower intake and the other of which communicates with said second duct means.

15. Apparatus according to claim 1 including a separation chamber having a curved wall in open communication with said collection receptacle; a blower inlet passage extending through a wall of said chamber to the blower intake; and a curved baffle in said chamber having one edge spaced relatively far from the adjacent chamber wal to provide relatively free flow of gas from said collection receptacle into said chamber for being swirled therein as it moves inwardly to said inlet passage, the opposite edge of said curved baffle being spaced from but relatively close to said chamber curved wall to provide a skimmer slit through which solid matter centrifugally concentrated in the outer portion of said chamber is returned to said collection receptacle.

16. Apparatus according to claim 15 in which said blower comprises an impeller rotatable about a horizontal axis, and in which said one edge of said curved baffle is spaced below the top of said separation chamber to provide the relatively free flow of gas from the upper portion of said collection receptacle into the upper portion of said separation chamber, and further in which said opposite edge of said curved baffle is at the lower portion of the separation chamber, whereby said skimmer slit is so located as to discharge into the lower portion of said collection receptacle.

17. In an air flow surface cleaning apparatus, a pick-up head mounted for movement in the direction of cleaning progress over and adjacent to the surface to be cleaned, said pick-up head including a pressure chamber; a suction chamber; an inclined partition between said chambers extending transversely of the direction of cleaning progress movement and having an inclined slit orifice for the discharge of high velocity blast air from said pressure chamber against said surface and into said suction chamber; and means at the ends of said slit orifice in the path of the high velocity blast air for directing blast air emerging from said slit orifice inwardly and away from the respectively adjacent ends of said suction chamber and toward the longitudinal center of said suction chamber.

18. Apparatus according to claim 17 in which said means at the ends of said slit orifice comprise spacers within said slit orifice.

19. Apparatus according to claim 17 in which said means at the ends of said slit orifice comprise members within said suction chamber at the opposite ends thereof and having horizontal webs with chamfered portions in the path of the blast air emerging from the ends of the slit orifice.

20. Apparatus according to claim 17 in which said pick-up head has a unitary top wall comprising a relatively high pressure chamber top wall part; a relatively low suction chamber top wall part; and an intervening step-down part.

21. Apparatus according to claim 20 in which said intervening step-down part is inclined at the same inclination as said inclined partition.

22. Apparatus according to claim 17 in which said pick-up head includes a horizontal wall forming the bottom of the pressure chamber and spaced above the level of the surface being cleaned, said horizontal wall having an inclined edge flange providing one side of said slit orifice.

23. In an air flow surface cleaning equipment, a mobile support; a pick-up head carried by said support and including a pressure chamber and a suction chamber; and apparatus for separating air from particulate solid matter picked up and entrained by air flowing in said pick-up head from said pressure chamber to said suction chamber, said apparatus being mounted on said mobile support and comprising a solids collection receptacle; a blower; means providing communication between the intake of said blower and said receptacle; first duct means affording communication of the blower discharge with said pick-up head pressure chamber; second duct means affording communication of said receptacle with said pick-up head suction chamber, said receptacle, said blower, said pressure chamber, said suction chamber and said first and second duct means providing a system for continuous recirculation of air in a flow path from said suction chamber through said second duct means, said receptacle, said blower and said first duct means to said pressure chamber and thence back to said suction chamber, the intake of said blower, said solids collection receptacle, said second duct means and said pick-up head suction chamber being under relatively negative pressure, said recirculation flow being accompanied by some air entering into said flow path from outside said system and being added to the recirculated air flowing in said flow path; a pressure relief plenum; a by-pass opening in said first duct means communicating with said pressure relief plenum; an air bleed outlet in said plenum; and a valve in said plenum for variably controlling the flow of air therethrough from said by-pass opening to and through said air bleed outlet.

24. Apparatus according to claim 23 including a filter mounted to receive air discharged thnough said air bleed outlet.

25. Apparatus according to claim 24 including a port in said second duct means communicating with said plenum, said valve being operable for selectively placing said plenum respectively into communication with said by-pass opening in said first duct means and with said port in said second duct means, communication of said plenum with said port in said second duct means providing for reverse flow of air through said filter to dislodge solid material therefrom and carry it entrained through said second duct means to said solids collection receptacle.

26. Apparatus according to claim 23 in which said first duct means includes the casing of said blower, said by-pass opening being formed in said casing itself.

27. Apparatus according to claim 23 in which said plenum includes an outer cylindrical wall portion located to receive by-passed air tangentially from said by-pass opening to establish a swirling movement of air and entrained particulate solid matter in said plenum, said air bleed outlet being at the central portion of said plenum; said apparatus further including a port in said second duct means communicating with said plenum at a zone spaced circumferentially from the tangential reception of by-passed air by said plenum, said valve being selectively movable to two positions in one of

which positions it establishes relatively free flow of air from said by-pass opening into said plenum and substantially prevents free flow of by-pass air from said plenum to said port, and in the other of which positions said valve substantially prevents flow of air from said by-pass opening into said plenum and establishes relatively free flow of air from said plenum to said port and thence to said second duct means and said solids collection receptacle.

28. Apparatus according to claim 27 in which said valve comprises a segmental part substantially conforming to the shape of said outer cylindrical wall portion, and means mounting said valve to turn about the axis of said cylindrical wall portion and said segmental part.

29. Apparatus according to claim 8 in which, when said valve is in said one of said two positions, a portion of said segmental part mainly cuts off communication between said plenum and said port but an edge of said segmental portion is spaced slightly from said plenum wall to provide a skimmer slit through which particulate solids centrifugally concentrated adjacent the inner surface of said plenum wall by the swirling of the air within the plenum are discharged together with a minor portion of the by-passed air to said port and thence to said second duct means and said solids collection receptacle, the major portion of the by-passed air being discharged through said air bleed outlet.

30. Apparatus according to claim 29 including a hollow filter for receiving by-passed air discharged through said air bleed outlet; and solids return means for conducting a portion only of the air and solids delivered to said filter to said second duct means for return to said solids collection receptacle.

31. Apparatus according to claim 30 in which said filter extends downwardly from said air bleed outlet, and in which said solids return means is connected to the lower portion of said filter.

32. Apparatus according to claim 31 in which said solids return means communicates with said second duct means via said pick-up head suction chamber.

33. In apparatus for separating gas from particulate solid matter entrained therein and having a solids collection receptacle; a blower; means providing communication between the intake of said blower and said solids collection receptacle whereby to place the interior of said solids collection receptacle under relatively negative pressure; a hollow structure for receiving particulate solid matter for entrainment in a gas flow stream; first duct means affording communication of the blower discharge with said hollow structure; and second duct means affording communication of said solids collection receptacle with said hollow structure; said solids collection receptacle, said blower, said hollow structure and said first and second duct means providing a system for recirculation of gas in a flow path from said hollow structure through said second duct means, said solids collection receptacle, said blower and said first duct means back to said hollow structure and continuously over said path, the intake of said blower, said solids collection receptacle, said second duct means and a part of said hollow structure being under said relatively negative pressure, whereby some gas in addition to the recirculated gas enters into said flow path from outside said system; the improvement comprising gas bleeding means for preventing said addition of gas from outside said system from undesirably increasing the average gas pressure in said system, said gas bleeding means including a by-pass opening in said first duct means; a gas bleed outlet communicating with said by-pass opening; a filter mounted vertically to receive therein gas and any entrained particles discharged through said gas bleed outlet; and solids return means for conducting a portion of the gas and solids delivered to said filter from the bottom of said filter to said second duct means for return to said solids collection receptacle, said solids return means comprising a restricted gas passage for causing said portion of gas and solids to flow at a high velocity so as to entrain particles collecting at the bottom of said filter and conduct them to said second duct means.

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