United States Patent

Brannon

[15] **3,704,482**

[45] **Dec. 5, 1972**

[54] **CLEANING DEVICE**

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[22] Filed: **Oct. 8, 1970**

[21] Appl. No.: **79,192**

[52] **U.S. Cl.** **15/348,** 15/351, 15/387, 15/409

[51] **Int. Cl.** **A47l 9/00**

[58] **Field of Search** ..55/261, 468; 15/336, 345, 346, 15/350, 351, 405, 409, 348

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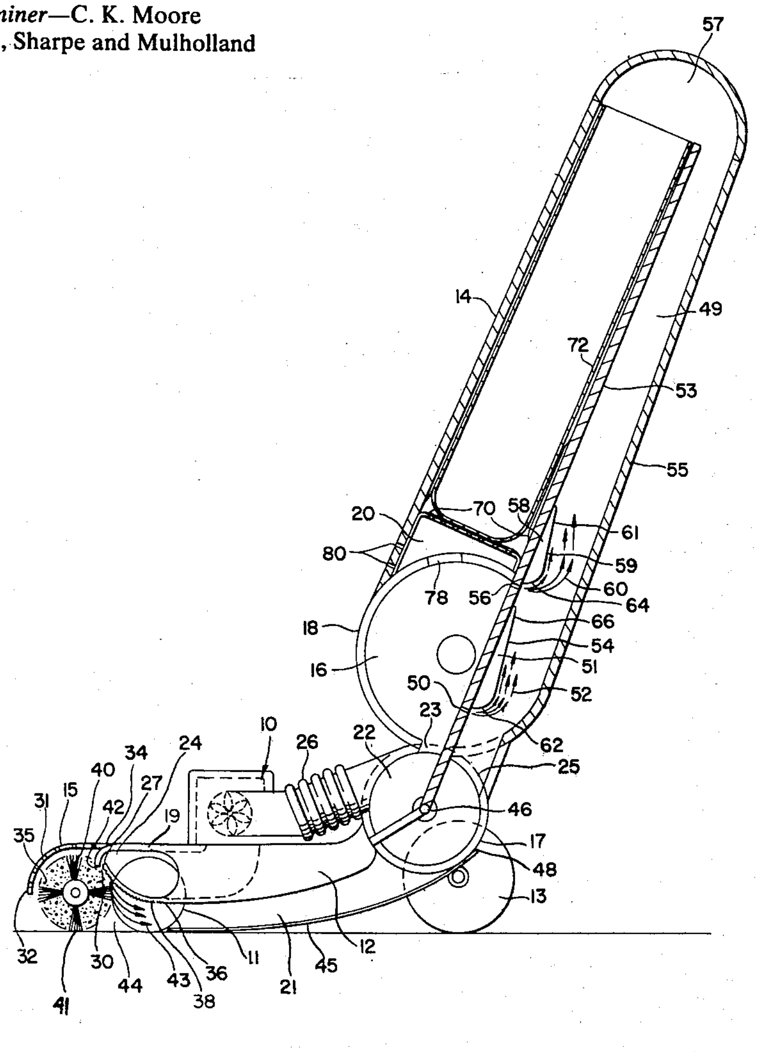
[57] **ABSTRACT**

A cleaning device utilizing the properties of a fluid at atmosphere plus pressure or above atmospheric pressure to effect a cleaning operation.

An electric motor on the cleaning device generates a small stream of atmosphere plus fluid such as, but not necessarily limited to, air, which stream of fluid is made to "bend" within the cleaning device, and reverse the direction of flow of the fluid stream. This design feature accomplishes three objectives: (1) it eliminates the need for the conventional and relatively inefficient vacuum type cleaner; (2) it forces a relatively small volume of fluid to attach itself to the underside of a horizontal surface; and (3) it encourages the relatively small volume fluid stream to entrain within its path substantially large volumes of dust-saturated fluid. Thus, instead of "sucking up" dirt as conventional cleaning devices of this nature do by means of vacuum or negative pressure, the cleaning device in this invention uses a stream of positive pressure fluid to push the dirt-and-dust-saturated fluid into a suitable receptacle.

8 Claims, 6 Drawing Figures



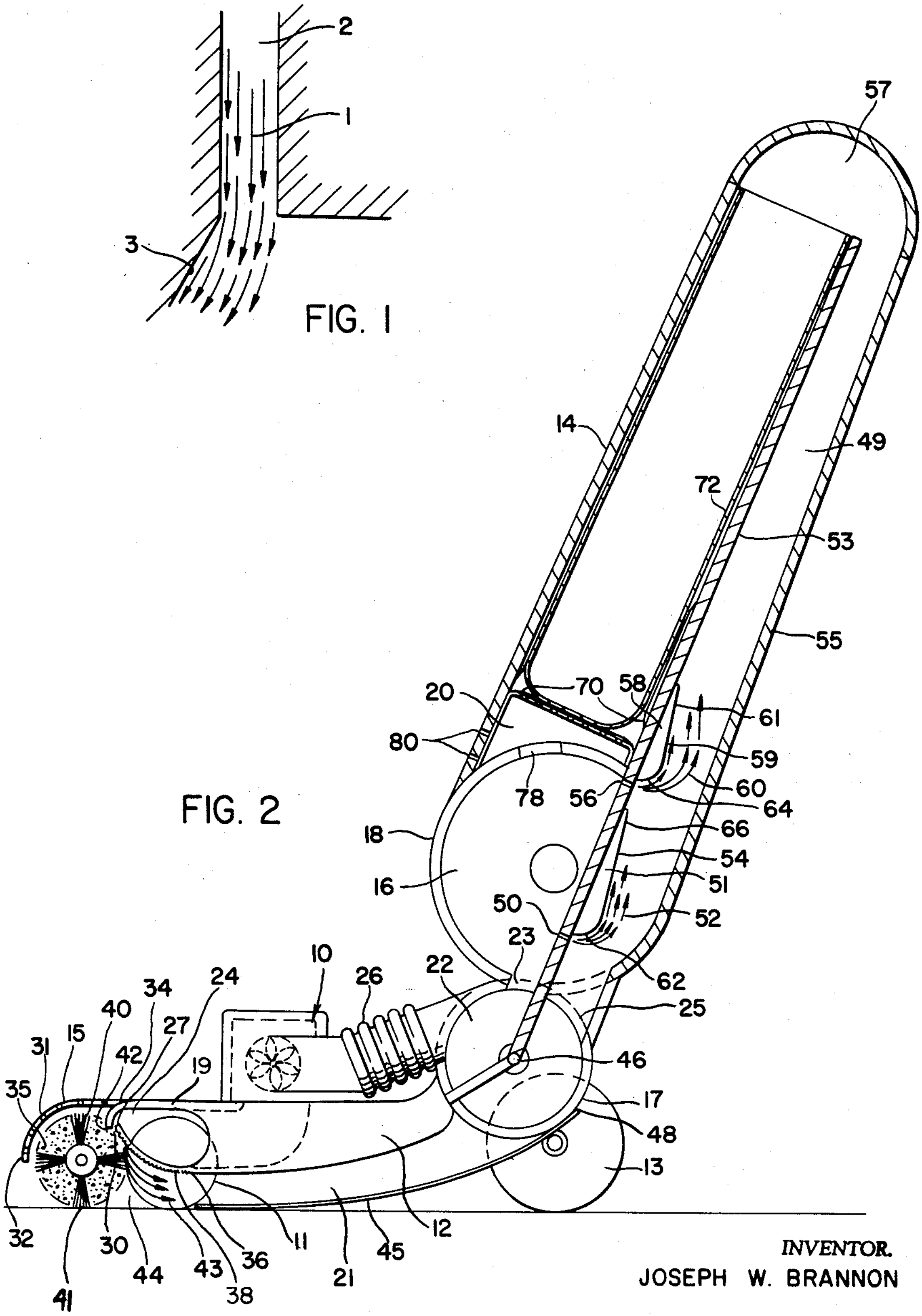


FIG. 1

FIG. 2

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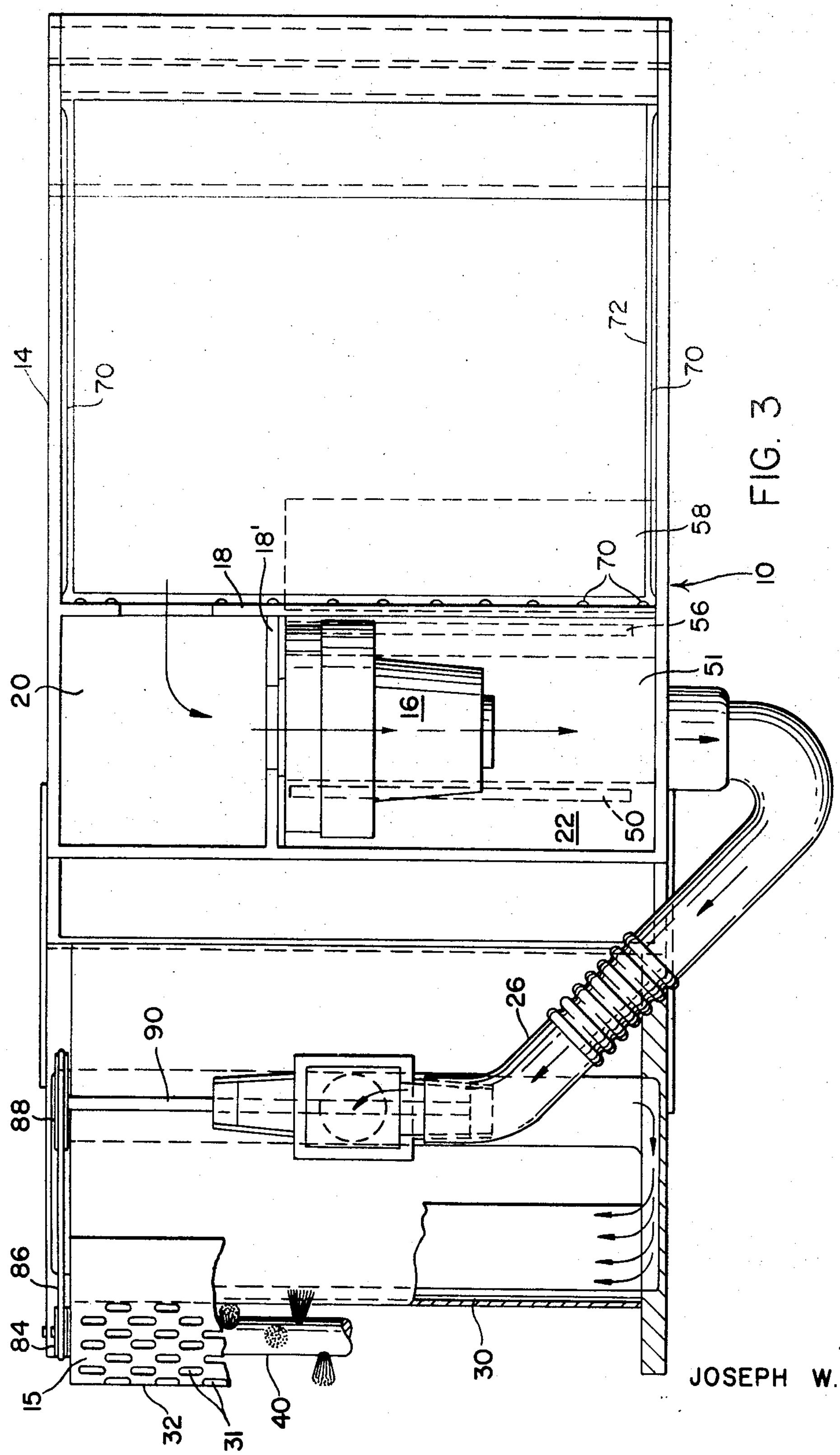

FIG. 3

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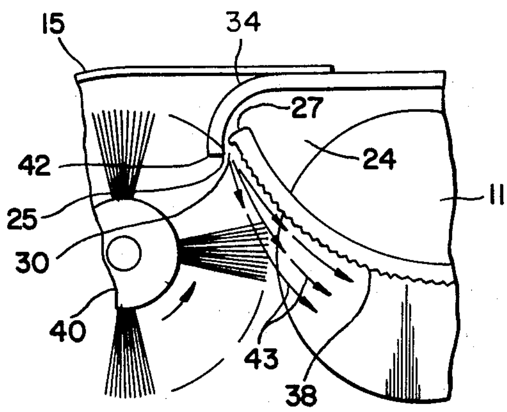
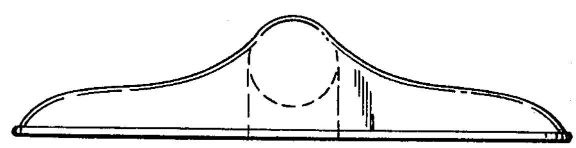


FIG. 4

FIG. 5



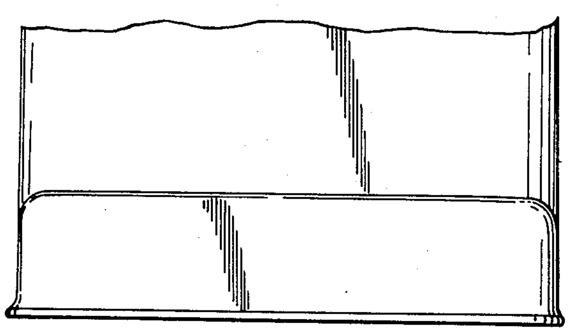


FIG. 6

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CLEANING DEVICE

BACKGROUND OF THE INVENTION

Most cleaning devices currently available commercially (generically referred to as "vacuum cleaners") rely on the principle of vacuum or negative pressure to lift dirt particles to be removed from a certain area, keep them in s state of temporary suspension, and transport the dirt particles to be removed away from the area to be cleaned.

One of the major drawbacks of these cleaning devices is their limited ability to create sufficiently high vacuums. The main reason for this limitation is primarily the difficulty in creating an effective seal between the surface to be cleaned and that portion of the vacuum cleaner that comes into direct contact with the surface to be cleaned.

Manufacturers of vacuum cleaners have long recognized this problem and are acutely aware of it. They have continually striven to create higher and more nearly perfect and efficient vacuums to produce higher and more evenly distributed negative pressures to carry larger quantities of dirt particles over greater distances. Instead of depending on rather inefficient vacuum, this cleaning device relies on a stream of positive pressure fluid to hold dirt particles in temporary suspension in a stream of positive pressure fluid and transport these particles to a suitable receptacle.

SUMMARY OF THE INVENTION

This invention relates to a cleaning device wherein a stream of positive pressure fluid is utilized in effecting the cleaning operation and function of the device. An electric motor connected to the cleaning device generates a stream of positive pressure fluid which is channeled towards an exit slot. The exit slot is designed in such a manner as to cause the stream of positive pressure fluid to reverse its direction of flow and attach itself to the underside of an attachment surface. The relatively small volume of pressurized fluid has the ability to entrain within its flowing stream a substantially large volume of ambient, dirt-saturated fluid, carrying the said dirt-saturated fluid to a suitable receptacle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic representation of the fundamental principle of the wall attachment phenomenon or Coanda effect.

FIG. **2** is a longitudinal cross section view of the cleaning device.

FIG. **3** is a plan view of the cleaning device.

FIG. **4** is an enlarged view of the exit slot area.

FIG. **5** shows a typical profile of the "pick-up" efficiency of a conventional vacuum cleaner.

FIG. **6** shows a typical profile of the "pick-up" efficiency of the positive pressure fluid stream cleaning device.

When a high speed stream of fluid —such as air for instance, although it must be emphasized that this invention is by no means limited to the use of air —is injected through a nozzle into a wide container of fluid, the stream of high speed fluid will entrain ambient fluid in its path and will become broader, carrying more fluid toward the open end of the container.

As this stream of pressurized fluid entrains ambient fluid along its path, it creates a pressure drop in the zones between the walls of the container and the stream of fluid. The resulting pressure differential creates an unstable situation; the higher pressure of the surroundings (actually the ambient pressure) pushes air back into the low pressure zones on both sides of the stream of fluid to equalize the pressures.

Assume there is a disturbance or asymmetry that causes the equalizing return flow to push the stream toward one of the walls. As the zone between the stream and that wall narrows, there will be less room to admit counterflow to replace the fluid being entrained by the stream on that side and, therefore, the comparative pressure in the zone will drop further. Quickly, the stream moves over against that wall and attaches itself to it. The stream of fluid remains attached or locked to that wall as long as the stream of air keeps flowing. The reason for this is that on the wall side there is a region of low pressure fluid that persists near the nozzle, whereas on the opposite side of the stream, the ambient pressure pushes the stream toward that region.

This phenomenon is known as the Coanda effect, so named after the man who was the first to observe and study this phenomenon in 1930, the Romanian engineer Henri Coanda (Fluid Control Devices, by Stanley W. Angrist in the Dec. 1964 issue of Scientific American). This well established scientific principle is the underlying design concept on which the operation of the cleaning device of this invention is based: instead of relying on negative pressure (vacuum) as do currently available cleaning devices of this nature, this cleaning device relies on the use of positive pressure (not vacuum) to effect the cleaning operation.

One of the major drawbacks of vacuum type cleaners is the relatively small area of high vacuum that can be created immediately around the intake throat of the cleaning nozzle. The vacuum diminishes rapidly as the distance from the brush nozzle increases to both sides from the intake throat, leaving a relatively small efficient cleaning area.

The cleaning device of this invention is equipped with a narrow slit through which the fluid must flow. This design feature makes it possible for the cleaner to provide more constant and evenly distributed flows of fluid.

FIG. **1** illustrates the basic concept of wall attachment. A stream of fluid **1** is supplied through a passageway **2**. The stream **1** is shown attached to the wall **3**. As long as the stream of fluid **1** continues to flow, it will remain attached to the wall **3**. The angle of the wall **3** can be designed so that no matter how frequently the flow of the stream **1** is interrupted, the stream will always attach itself to the wall **3** each time flow resumes.

Referring to FIG. **2**, the cleaning device **10** has a body housing **12** connected pivotally to a filter bag housing **14**. The body housing **12** has a front portion **15** and a rear portion **17** and is disposed in a generally horizontal plane. The body housing **12** is supported by a set of conventional wheels; one of the front wheels is shown at **11**, and one of the rear wheels is shown at **13**. A conventional electric motor **16** is shrouded within an enclosure **18**, which in effect by means of wall **18'** separates the vacuum or input end **20** of the motor from the pressure end or output end **22**. The pressure end will hereafter also be referred to as the "atmosphere plus" end. The atmosphere plus end **22** communicates with a reservoir **24** located near the forward end of the body housing **12** through a horizontally disposed interconnecting passageway **26**.

The body housing **12** comprises a horizontally disposed upper member **19**, a scoop shield member **45** disposed in a plane generally parallel beneath the upper member **19** and a member **36** disposed intermediate the upper member **19** and the scoop shield member **45**.

The body housing **12** comprises at its foremost forward end **15** a downwardly curved shield **32** which is perforated with a plurality of apertures **31**. Rearward of the perforated shield **32** and forward of the front wheels **11**, a portion of the upper member **19** terminates in a downwardly curved section **34** which tends to overlap an upwardly curved portion **38** of the intermediate member **36**. Excepting the upwardly disposed portion **38**, the member **36** is disposed in a plane generally parallel to that of the upper member **19**.

The overlapping, downwardly curved member **34** and the upwardly curved member **38** create a passageway therebetween which forms a transverse exit slot **30** between the lip **25** and the step **27**, as shown more clearly in FIG. **4**. As the fluid flows from the reservoir **24**, the fluid must pass between the lip **25** and the step **27**. The positional interrelationship between the lip and the step is such as to cause the fluid stream passing through the exit slot **30** to "bend" downward and to attach itself to the underside of the upwardly curved surface **38**. The texture of the curved surface **38** which surface can be smooth or irregular and the geometric configuration of the surface **38** insure that the fluid stream **43** attaches itself and remains attached to the underside of the curved surface **38**.

The positive fluid stream flowing through the slot **30** entrains in succession the fluid flowing through the perforated shield **32** and then through a rotative spiral bristled brush **40** which is in continuous contact with an impact edge **42** of the curved member **34**. A small driven pulley **84** is attached to the rotative brush and a large drive pulley **88** is attached to a rotative shaft **90**. The pulleys are held in rotative relationship through an interconnecting drive member **86**, such as for instance a belt which thus turns the rotative brush **40** as the drive pulley **88** turns the driven pulley **84** by means of the drive member **86**. The purpose of the impact edge **42** is to dislodge from the bristled brush **40** any dirt or contaminant particles which may adhere to the brush and to place these particles into suspension in the ambient fluid within the area **44** wherein the concentration of dirt particles will be near the saturation point.

The brush **40** is also in continuous contact with the surface to be cleaned **41**. This condition of continuous contact of the brush onto the surface to be cleaned creates a continuous whipping action on the surface to be cleaned, which action has the effect of dislodging dirt particles imbedded into or resting upon the surface to be cleaned **41** and suspending the said particles temporarily in the highly dirt-saturated area **44**.

The dirt particles that are temporarily in suspension in the area **44** are carried within the fluid stream **43** into the area **21** between the intermediate member **36** and the scoop shield **45** which is positioned in close

proximity to the surface to be cleaned **41**. The scoop shield **45** prevents dirt particles from escaping.

It is important to note that the attachment or locking effect of the fluid stream **43** onto the underside of the member **36** is wholly independent of the presence of the scoop shield **45**. The fluid stream **43** attaches itself to the underside of the member **36** because of the aforementioned and described Coanda effect and the attachment of the fluid stream **43** is neither dependent upon nor contained within an area that might be construed as being defined by the upper member **36** and the scoop shield **45**.

The fluid stream **43** would continue to adhere to the underside of the member **36** even in the absence of the scoop shield **45**. The scoop shield **45** functions primarily as a catch-all for larger and heavier particles which may become entrained by the positive pressure fluid stream **43**. The presence of the scoop shield **45** is not needed to attach the fluid stream **43** to the underside of the upper member **36**.

The fluid stream **43**, the entrained ambient fluid **44** and the trapped dirt particles **35** are now confined within the transport area **21** and carried along in the positive, atmosphere plus pressure stream to a pivotable connector **46**. The pivotable connector **46** is sealed from the environmental fluid outside of the body housing **12** by a low pressure seal **48**. After the dirt-laden stream of pressurized fluid flows through the pivotable connector **46**, the fluid stream is carried into a passageway guide area **49**, through the opening **25**.

While the bulk of the pressurized fluid flows into the interconnecting passageway **26** through the opening **23**, a small portion of the pressurized fluid stream escapes from the pressure end of the electric motor **16** through one or more apertures, one of which is shown at **50**. As this stream of pressurized fluid **52** emerges from the aperture **50**, it comes into contact with a curved attachment member **51** which is comprised of an upwardly curved leading edge **62** blending into a gradually diminishing attachment surface **54**. The leading edge **62** of the attachment member **51** is disposed in close proximity to the aperture **50**. The pressure fluid stream **52** flows through the aperture **50** and attaches itself to the underside of the upwardly curved leading edge **62**. The fluid stream **52** continues to remain attached to the underside of the attachment member **51** as long as the fluid stream flows by the diminishing attachment surface **54**, toward the rearwardly disposed trailing edge **66**.

A second aperture is shown at **56**, disposed in close proximity to a second curved attachment member **58**. The upwardly curved attachment member **58** is comprised of an upwardly curved leading edge **64**, a diminishing attachment surface **59** and a trailing edge **61**. A second emerging positive fluid stream is shown at **60**.

As the fluid stream **60** emerges from the aperture **56**, it attaches itself to the underside of the upwardly curved leading edge **64**. The fluid stream **60** continues to remain attached to the underside of the curved attachment member **58** as it flows along the diminishing attachment surface **59**, toward the rearwardly disposed trailing edge **61**.

Although only the two apertures **50** and **56** are illustrated in this embodiment in conjunction with two curved attachment members **51** and **58** respectively, the design is by no means limited to this particular number of apertures and curved attachment surfaces. The principle controlling the attachment of the fluid streams **52** and **60** to their respective attachment surfaces is governed by the aforementioned Coanda effect.

It is thus evident that a series of more than two apertures such as shown at **50** and **56** and interrelated attachment members such as shown at **51** and **58** could each create an atmosphere plus at the leading edges **62** and **64**, entraining additional fluid flowing through the pivotable connector **46**.

These additional streams of positive pressure fluid, **52** and **60**, further help carry larger contaminant particles along the passageway guide area **49**. This design which causes the fluid stream of atmosphere plus fluid to attach itself to the interior wall **53** of the passageway guide area **49** would enable the cleaning device to operate properly even if the outer wall **55** were to be removed. As the particles are carried along the trailing edges **66** and **61** respectively, they permit the pressurized fluid stream to carry larger particles any given distance by cascading them from one aperture and attachment surface to each succeeding aperture and attachment surface.

It bears emphasizing that the outer wall member **55** is merely a structural support and is not needed to act as a particle retaining wall for a confining chamber. The particles in the area **49** would remain attached or locked to the interior wall **53** even in the absence of the outer wall member **55**.

After the particles are carried upward by the successive attachment members, in cascading fashion, the stream of atmosphere plus fluid passes through a passageway **57** which reverses the direction of flow of the stream which then flows into a filter bag **72** contained within the filter bag housing **14**. The filter housing **14** comprises a plurality of longitudinally disposed ribs **70** which help keep the dust bag **72** away from the filter bag housing **14**, thereby insuring and providing a greater, unobstructed filtering surface area for the filtering bag **72**. The ribs **70** also keep the exit port **78** unobstructed by the dust bag **72**.

The exit port **78** also supplies filtered fluid to the input end **20** of the electric motor **16**. Controllable vents **80** allow that entrained fluid which is not required as an input supply for electric motor **16** to escape.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The described embodiments are thus intended to be illustrative and not restrictive. The scope of the invention is indicated by the appended claims.

What is claimed is:

1. A cleaning device comprising a bottomless body housing having a front, a rear, and side walls and an upper member, an intermediate member having a curved underside, the intermediate member being connected to the inside of the body housing beneath and spaced from the upper member in such a manner as to define between said upper member and said intermediate member a reservoir chamber and a first fluid reservoir outlet passageway terminating in a narrow slot directing a stream of fluid rearwardly and downwardly along the curved underside of said intermediate member, a scoop shield member extending rearwardly from a point beneath and spaced from the intermediate member to define therewith a rearwardly extending second passageway having at its forward end an opening adapted to receive fluid discharged from said first passageway, pressure creating means in fluid communication with the reservoir chamber urging a stream of fluid to flow into the reservoir chamber and through the reservoir outlet passageway along the curved underside of the intermediate member into the second passageway toward the rear of the body housing, a rotary surface agitator mounted forwardly of the intermediate member and the opening of said second passageway to suspend the contaminant particles within the stream of fluid in said second passageway for discharge rearwardly therefrom, means for driving said agitator and means for exposing said agitator over the greater portion of its circumference to ambient pressure.

2. The cleaning device of claim **1**, wherein a portion of the upper member opposingly faces said curved underside of said intermediate member and defines therewith a portion of the reservoir outlet passageway.

3. The cleaning device of claim **2**, wherein the portion of the upper member facing the curved underside of the intermediate member overlaps the downwardly and rearwardly curved underside of the intermediate member in the vicinity of the front portion of the body housing, in such a manner as to define the reservoir outlet as a transverse slot.

4. The cleaning device of claim **3**, wherein the opposing relationship of the upper and intermediate members causes the underside of the intermediate member to become a boundary layer attachment surface for the fluid being discharged through the transverse exit slot urging the stream of pressurized fluid emerging from the transverse slot to attach itself to the underside of the intermediate member.

5. The cleaning device of claim **4**, wherein the attachment surface is smooth.

6. The cleaning device of claim **4**, wherein the attachment surface is irregular.

7. The cleaning device of claim **1**, wherein the rotary agitator is a brush mounted within a portion of the body housing.

8. The cleaning device of claim **1** which includes means for moving the cleaning device along a surface to be cleaned, means connected to the body housing for maintaining the cleaning device in spaced relationship with respect to the surface to be cleaned, a filter bag housing pivotally connected to the rear portion of the body housing, the filter bag housing being divided internally by an interior wall to define a filter bag receptacle and a third passageway having one end in communication with the second passageway and its opposite end in communication with an opening in the filter bag, said interior wall having at least one aperture providing communication between said pressure generating means and said third passageway and at least one curved surface portion on said interior wall within said third passageway adjacent to and downstream of said aperture to urge the stream and contaminant particles to flow through the third passageway into said filter bag.

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