United States Patent [19]

Krier et al.

[11] **3,881,215**

[45] **May 6, 1975**

[54] **SURFACE CLEANING APPARATUS**

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[73] Assignee: **Tennant Company**, Minneapolis, Minn.

[22] Filed: **Dec. 19, 1972**

[21] Appl. No.: **316,457**

[52] **U.S. Cl.** **15/340;** 15/83; 15/230.16; 15/347

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

[58] **Field of Search** 15/82, 86, 98, 347, 348, 15/349, 340, 83, 230.16; 298/30

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Primary Examiner—Peter Feldman
Assistant Examiner—C. K. Moore
Attorney, Agent, or Firm—Dugger, Johnson & Westman

[57] **ABSTRACT**

A cleaning machine that includes a drive unit and a trailer unit joined by an articulated joint, the drive unit including a pick up assembly having a reversible power driven paddle wheel mounted in a housing to extend closely adjacent the surface to be cleaned, the housing including leaf flap mechanism mounted for movement between a downwardly extending position and an elevated position, a duct mounted on the drive unit frame and having an inlet for receiving raised material from the housing, an airstream outlet, and at a lower elevation than the airstream outlet, a heavy debris outlet opening to a heavy trash receptacle on the frame, the heavy trash receptacle having doors for discharging the heavy trash, a suction blower having an inlet fluidly connected to the duct airstream outlet and a door for selectively blocking fluid communication between the duct and suction blower, a motor for driving the drive unit and having a directly driven shaft with a brake disc thereon, and mechanism to move the housing to an elevated transport position; and that the trailer unit includes a frame having a dump container thereon, a discharge door at the rear of the container, the container having a top filter portion, a standard on the tractor frame for stationarily mounting one end of a duct for placing the container in fluid communication with the suction blower outlet when the container is in a debris receiving position, and a deflector adjacent the container inlet for deflecting air and debris downwardly.

9 Claims, 8 Drawing Figures

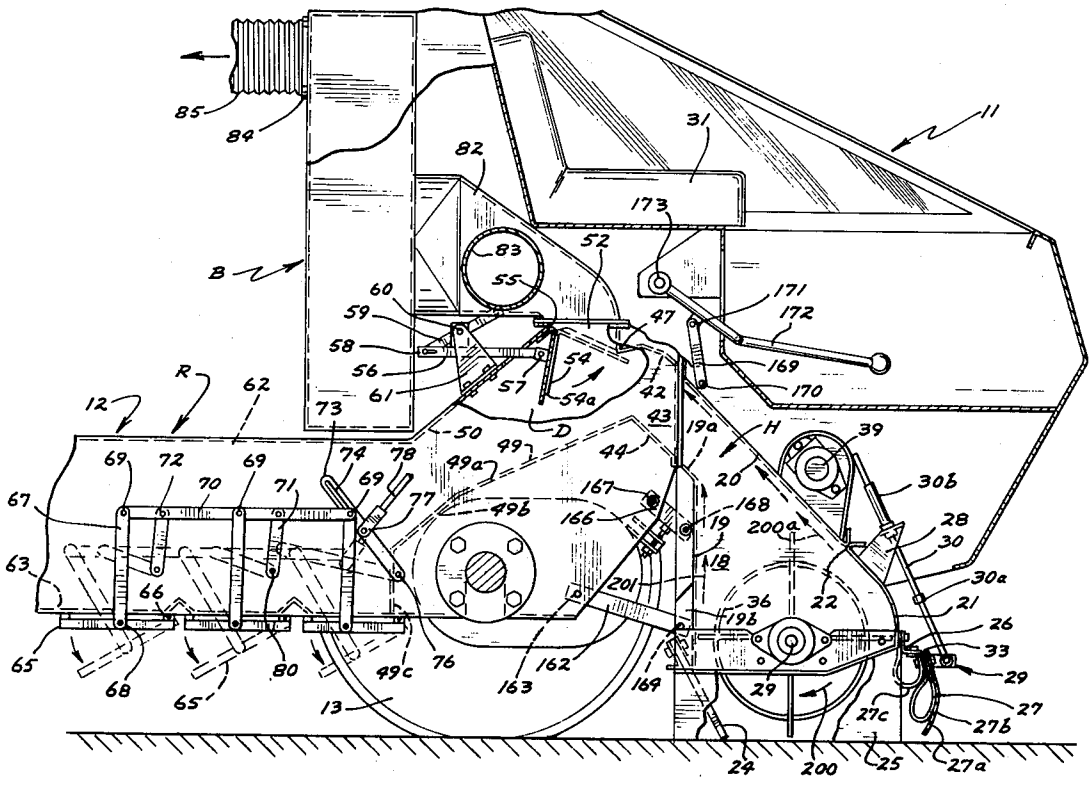
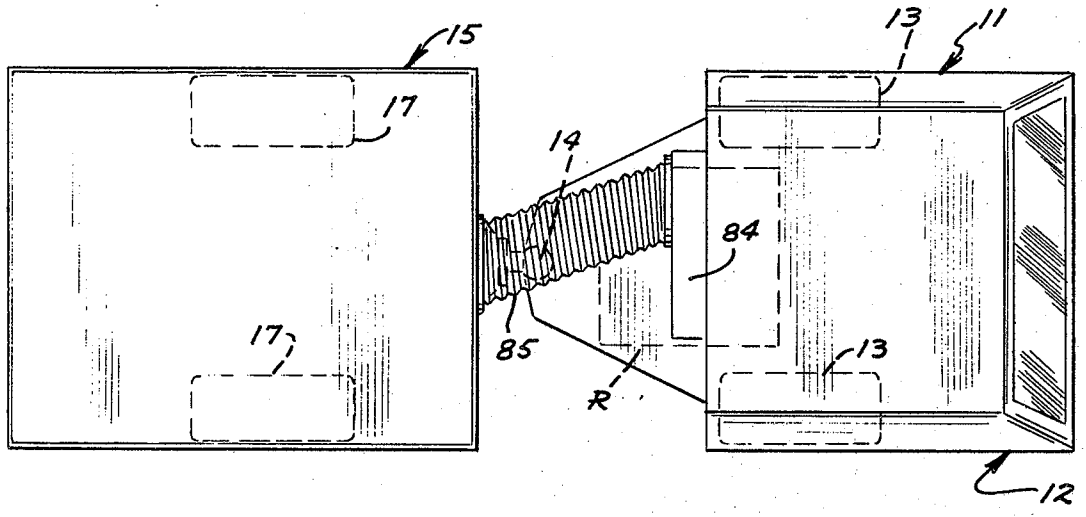


FIG. 1


15
17
17
14
84
85
R
13
11
13
12

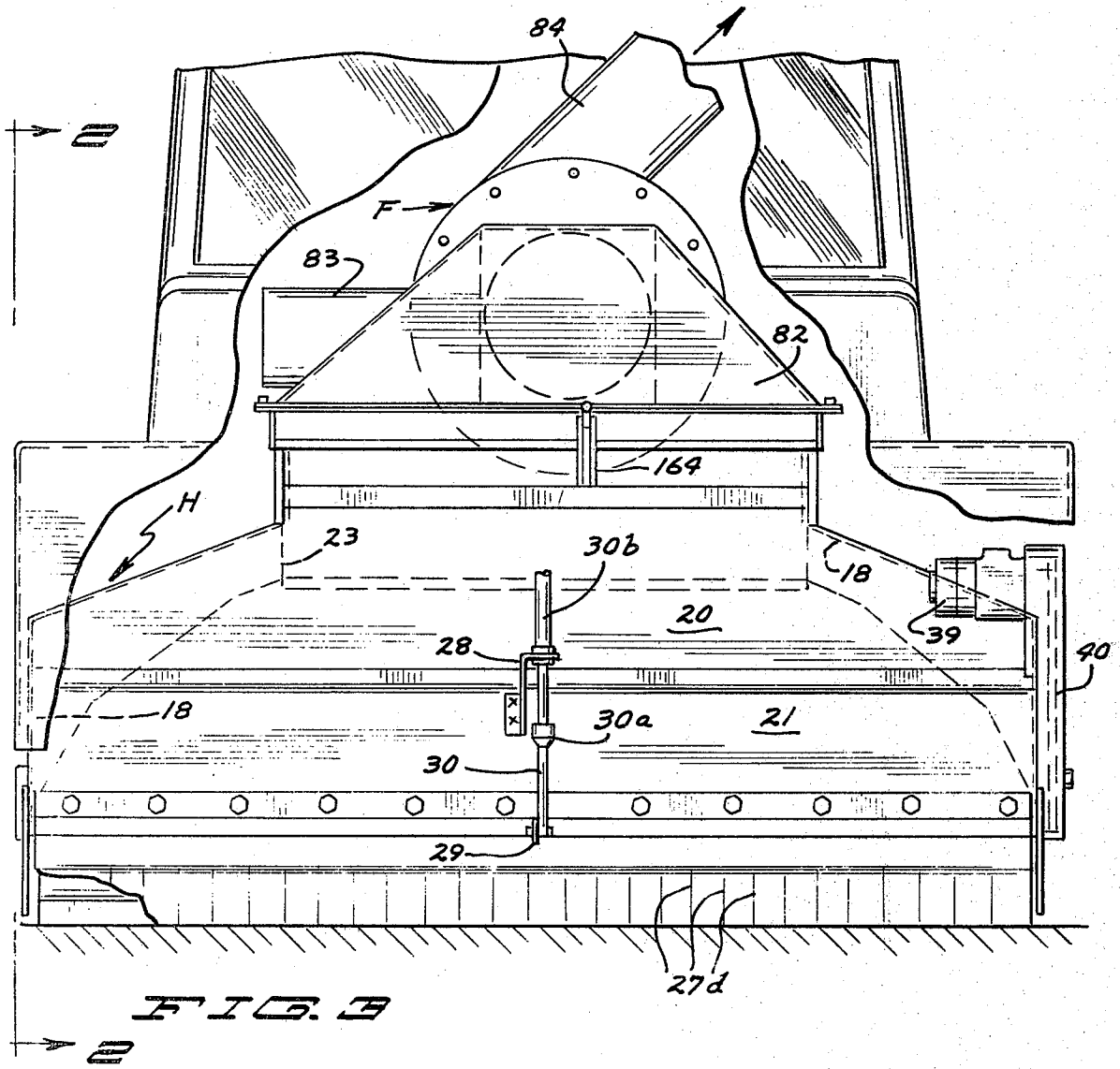
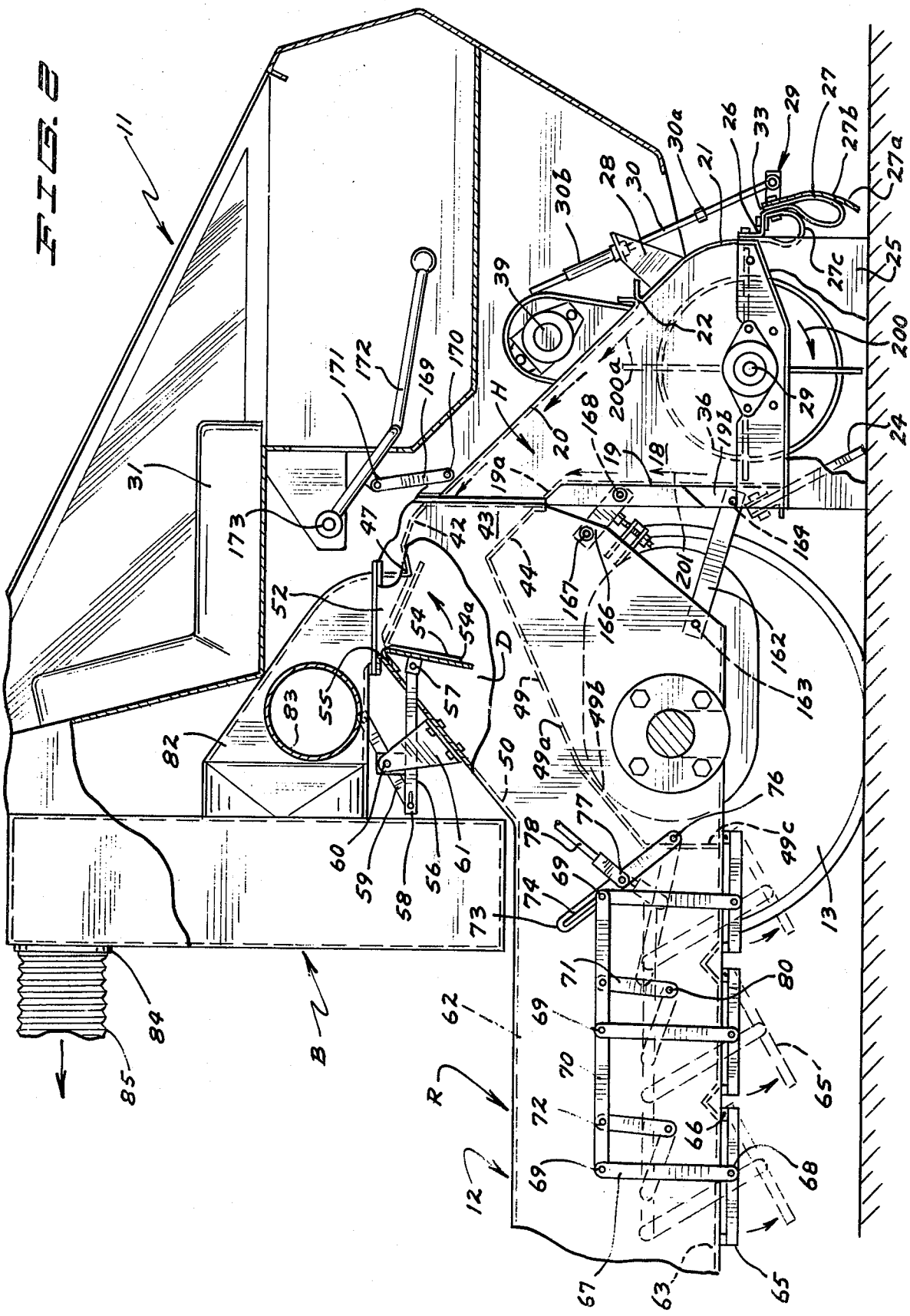

84
2
F
83
82
164
H
23
30b
18
20
39
40
28
18
30a
21
30
29
27d
2

FIG. 3

FIG. 2


11
31
173
171
172
169
170
H
39
306
28
30
30a
21
26
33
29
27
27a
27b
27c
25
200
200a
22
168
36
198
20
19
19a
18
24
47
42
43
44
167
166
201
169
52
54
54a
D
57
55
83
82
162
163
49
49a
49b
49c
50
76
77
78
69
74
73
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72
66
65
68
R
12
67
63

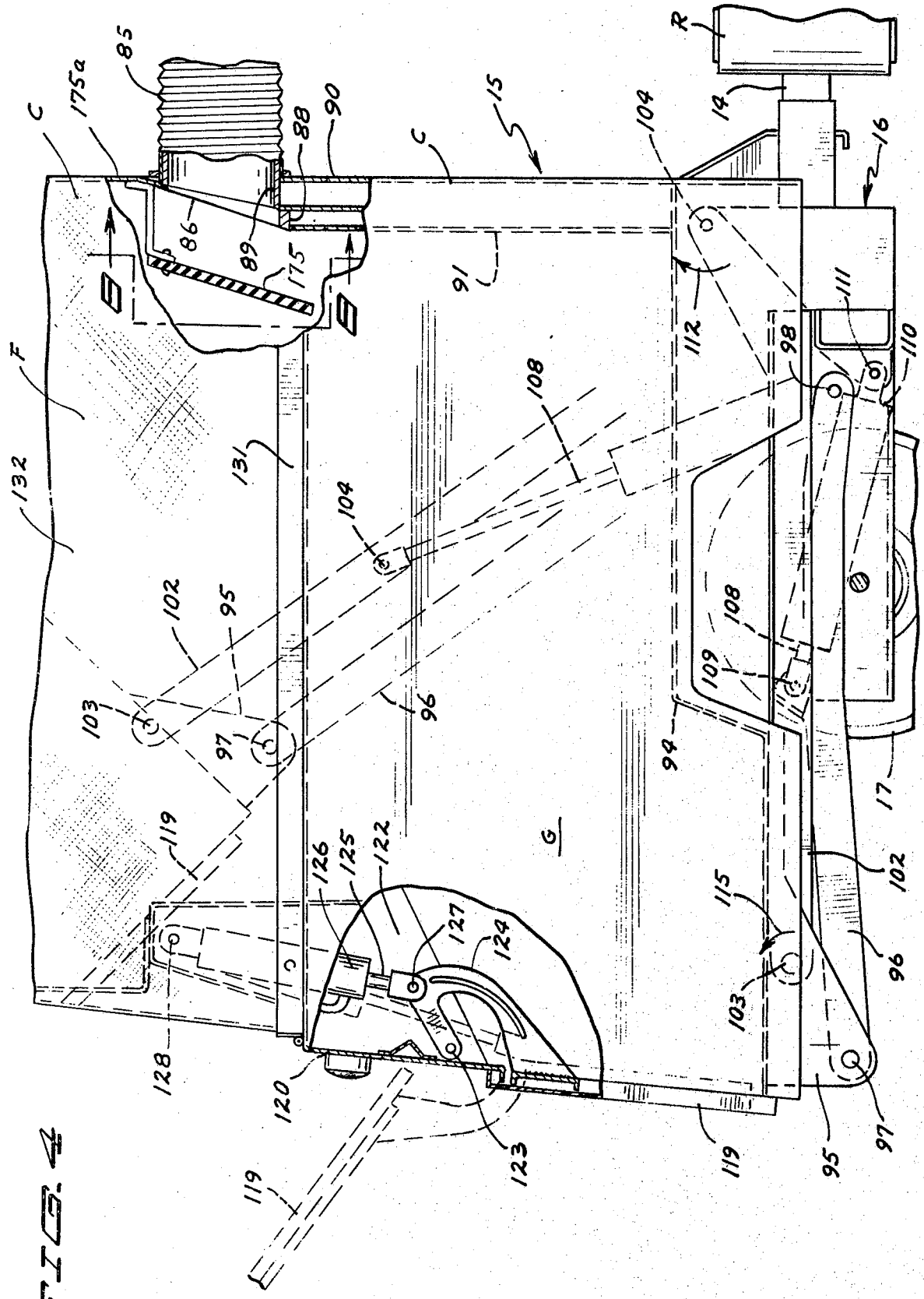

R
14
16
15
C
175a
85
88
90
86
89
175
91
104
112
111
98
110
108
F
132
131
104
102
95
103
97
96
109
99
17
119
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122
G
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102
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103
128
120
123
119
95
97

FIG. 4

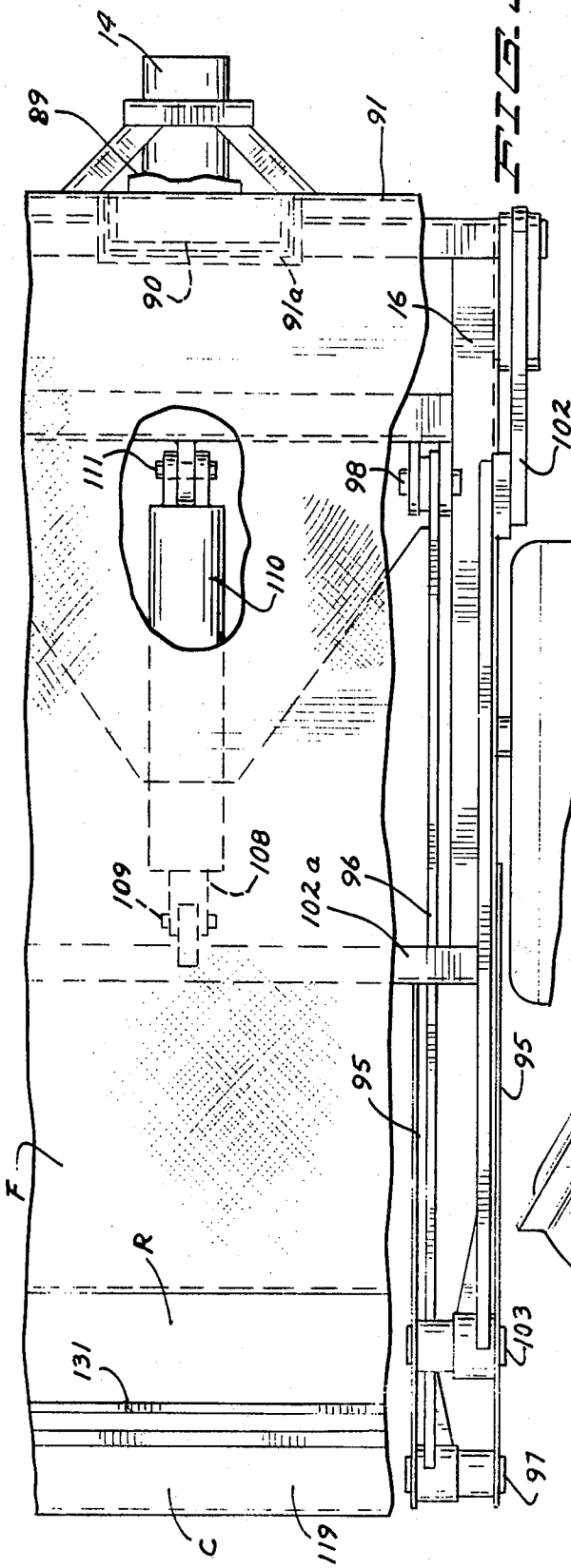


FIG. 5

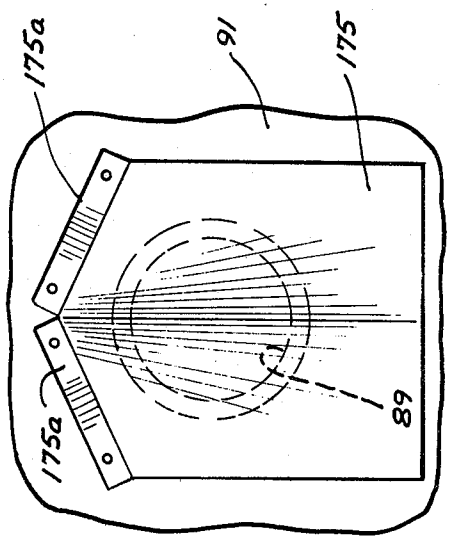


FIG. 8

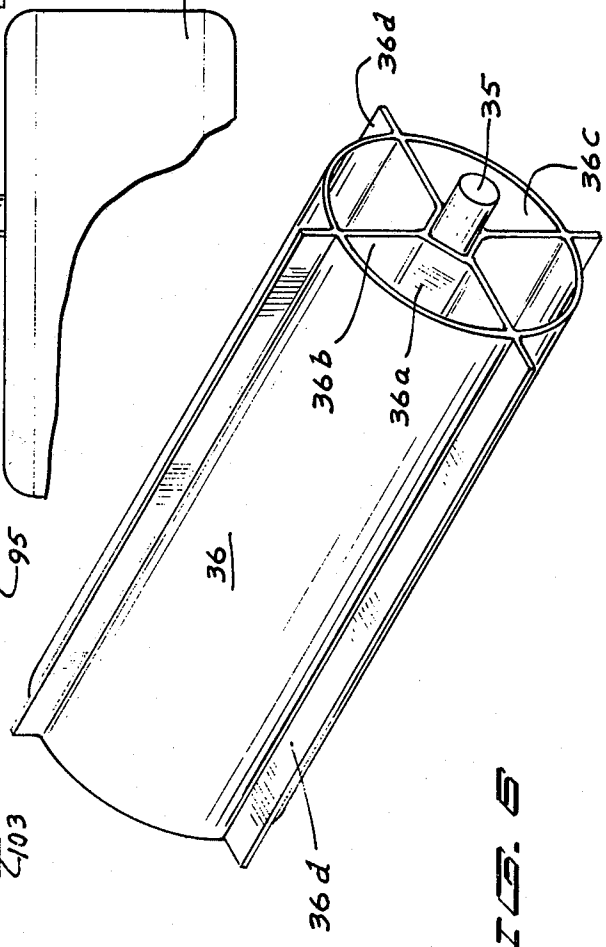
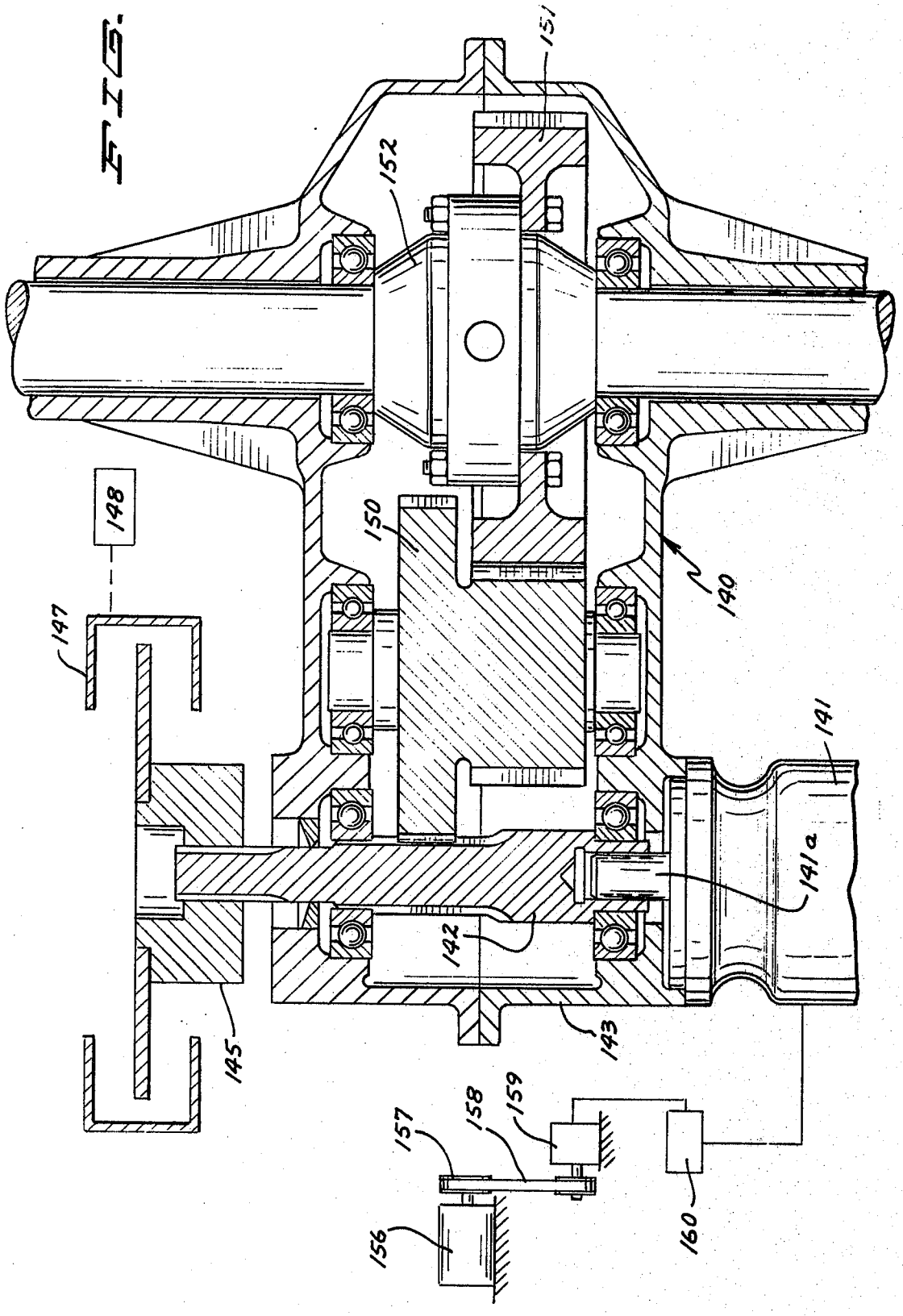


FIG. 6

FIG. 7



SURFACE CLEANING APPARATUS

RELATED APPLICATIONS

Part of the apparatus disclosed in this application is more broadly disclosed in the copending application of Paul W. Kimzey, Donald L. Olson, Daniel A. Delmore and Keith N. Krier, Ser. No. 316,476, filed the same day as this application and assigned to the same assignee as this application.

BACKGROUND OF THE INVENTION

A surface cleaning machine having a vacuumized pick up head for picking up debris and trash from streets, parking lots, parks and the like.

It is old in the prior art to provide an articulated machine having a cleaning head for cleaning areas such as lawns and parking lots, see U.S. Pat. No. 3,406,424 to Rush. However, such machines are not suitable for picking up relatively heavy trash; do not provide for separation of the relatively heavy picked up materials from the lighter materials and as a result both types of trash go through the suction blower which causes undue wearing of the fan housing and impeller; have relatively high air losses and a relatively low air velocity in housing adjacent the area of pick up for a given fan capacity; and require high flow rates of air and consequently relatively larger filter capacities. In order to overcome problems such as the above, this invention has been made.

SUMMARY OF THE INVENTION

A surface cleaning machine that includes a downwardly opening pick up head having an outlet and a paddle wheel rotatably mounted therein and selectively driven in either angular direction, a heavy trash receptacle, a light debris collection and filter container mounted for movement to a dumping position and a duct for separating heavier debris from lighter debris as the debris moves therethrough, said duct having an inlet fluidly connected to the head outlet, a light particle outlet branch, and a heavy trash outlet branch, and a suction blower having an inlet fluidly connected to the light particle outlet branch and an outlet fluidly connected to the container.

One of the objects of this invention is to provide a new and novel surfacing cleaning machine having a vacuumized pick up housing, and a paddle wheel to reduce air losses, maintain a relatively high air velocity in the areas between the paddle wheel and surface being cleaned and the paddle wheel and the housing, and pick up and throw material upwardly into the housing, and direct heavy trash into one receptacle and light trash into a light trash container.

An additional object of this invention is to provide in a surface cleaning machine having a pick up head, a new and novel leaf flap and paddle wheel combination that in operating the paddle wheel in one angular direction is especially adapted for picking up large, bulky, light materials including those in relatively large accumulations, and in the other angular direction for picking up lighter debris loads and small dense items such as rocks and pop bottles. In furtherance of the last mentioned object, it is another object of this invention to provide a leaf flap that may be selectively retained in an elevated position remote from the path of rotation of the paddle wheel.

A further object of this invention is to provide a new and novel debris deflector duct in a surface cleaning machine for separating heavier objects from lighter objects picked up by a vacuumized pick up head. With reference to the last mentioned object, it is another object of this invention to provide heavy trash receptacle having a new and novel trash discharge arrangement. An additional object of this invention is provide in a surface cleaning machine, a new and novel duct and heavy trash receptacle arrangement for reducing air flow rate requirements and the amount of air to be filtered, and also for separating heavy trash from lighter trash.

Further it is an additional object of this invention to provide a new and novel high dump arrangement for emptying a combination light particle collection receptacle and filter container, and a hydraulically operated discharge door assembly on the container. Another object of this invention is to provide in a surface cleaning machine, a new and novel combination filter-debris container having an inlet and a deflector for directing debris downwardly across the container and initially direct the air flow path away from the filter.

A different object of this invention is to provide on a surface cleaning machine, a new and novel ground engaging wheel driving and braking arrangement. An additional object of this invention is to provide a new and novel surface cleaning machine having a heavy trash receptacle, a suction blower, a vacuumized pick up head and a combination filter and light debris container arranged for good balance and weight distribution in a relatively compact machine.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the apparatus of this invention;

FIG. 2 is a longitudinal, cross-sectional view generally taken along the line and in the direction of the arrow 2—2 of FIG. 3 of the combination drive and pick up unit of this invention, various portions being broken away to show other structure;

FIG. 3 is a front view of the apparatus of this invention, portions of the vehicle body being broken away to show structure rearwardly thereof;

FIG. 4 is a fragmentary right side view of the trailer unit of this invention with portions thereof broken away, said view showing the refuse container and container outlet door in a datum position in solid lines, the door in a dump position relative container in a datum position in dotted lines, and part of the container in the dumping position in dotted lines together with the linkage for moving the container to said dumping position;

FIG. 5 is a fragmentary top view of the right side of the trailer unit, portions being broken away to more clearly illustrate the linkage for moving the container to a dumping position;

FIG. 6 is a perspective view of the paddle wheel;

FIG. 7 is a fragmentary cross-sectional view of the differential drive motor and brake for the drive unit of this invention together with a schematic showing of other drive components; and

FIG. 8 is a fragmentary vertical view generally taken along the line and in the direction of the arrows 8—8 of FIG. 4 to show the deflector that is rearwardly adjacent the container inlet port; and

Referring to FIG. 1, the apparatus of this invention includes a combination pick up head and drive unit,

generally designated **11**, having a main frame, generally designated **12** on which there is mounted a pair of motor driven, ground engaging wheels **13.** Connected to the drive unit by an articulated joint **14** is a trailer unit, generally designated **15,** that mounts a pair of ground engaging wheels **17.** Thus, the apparatus of this invention, includes an articulated vehicle. Since the manner of forming the articulated connection and the manner of steering the vehicle may be the same as that described in copending Application Ser. No. 255,612, filed May 22, 1972, details of the construction of the articulated joint and the steering mechanism will not be described herein.

Referring now in particular to FIGS. **2** and **3,** the combination pick up head and drive unit **11** includes a downwardly opening, pick up head housing, generally designated H, that includes side walls **18** which have vertical lower portions, upwardly and transversely inwardly inclined intermediate portions and vertical top portions. The housing also includes a rear wall **19** and an upwardly and rearwardly inclined front wall **20,** the walls **18–20** being joined to one another to form a generally rectangular rearward discharge opening **23.** The lower terminal edge of the front wall **20** is at a substantially higher elevation than the lower terminal edges of walls **18, 19**; there being provided a front panel **21** having its upper edge hingedly connected at **22** to the lower edge of the front panel for movement about a transverse axis. The movement of the front panel in a clockwise direction as viewed in FIG. **2** is limited by abutting against the front edges of the side walls **18.** The side walls dependingly mount resilient side skirts **25** while the rear wall mounts a downwardly and forwardly inclined rear skirt **24** that extends between the side wall skirts. Brackets **26** are secured to the lower edge of the front panel to mount a hinge member **33** that has a transverse hinge axis. The hinge member mounts a front flap (leaf seal) **27** that includes a flap portion **27***a* which in its lowermost (vertical) position has a lower terminal edge at about the same elevation as the lower terminal edge of skirts **24** and **25,** a reversely bent flap portion **27***b* that resists rearwardly movement of flap portion **27***a* and a flap portion **27***c* that substantially forms a fluid seal between panel **21** and flap portion **27***b*. Advantageously the flap portions **27***a*, **27***b* are provided with vertical slits **27***d* to permit one part of a flap portion moving rearwardly relative the other, for example, if one of the parts between adjacent slits engages large objects, the loss of vacuum is minimized as the one part moves over the object from that which would have been lost if the slits were not provided.

In order to selectively pivot flap **27** about hinge **33** from the generally vertical position of FIG. **2** to an elevated, generally forwardly extending position, the sheath and adjustment nut portion **30***b* of a conventional push-pull cable assembly **30** are mounted by a bracket **28** that is fixedly attached to the front panel **21,** portion **30***b* permitting downward movement of the cable operated rod portion 30*a* to a position the flap extends generally vertically. The rod portion is pivotally connected to a bracket **29** that is bolted to the hinge **33** opposite the hinge axis from the hing portion secured to panel **21.** The push-pull cable may be operated to selectively move the flap **27** to its elevated position and retain the flap in said position, while a stop (not shown) is mounted on bracket **26** to limit the hinging movement of the flap in a clockwise direction to the vertical position shown in FIG. **2.**

Although it is preferred that a flap **27** such as disclosed be used, it is to be understood other flap constructions could be used. For example, a flexible laminated flap could be used wherein the front laminate extends the furthest downwardly and each successively rearward laminate lower edge terminates at a progressively higher elevation so that lowermost parts of the flap can more readily bend rearwardly than higher parts of the flap to aid in normally retaining the flap out of the path of movement of a paddle wheel **36.**

In order to mount the housing H for movement between its datum position shown in solid lines in FIG. **2** and an elevated transport position, links **162** at their first ends are pivotally connected at **164** to a flange **19***b* secured to the housing rear wall **19,** while the second ends of the links are pivotally connected at **163** to the lower front corner portions of the side walls **43.** At a higher elevation than links **162,** there are provided links **166** that are pivotally connected at **167** to the side walls **43** and at **168** to the flanges **19***b*. A stop is mounted for limiting clockwise movement of links **166** as shown in FIG. **2.** As a result of the locations of the pivots **163, 164, 167, 168** and the lengths of the links **162, 166,** the housing H is mounted for vertical transatory movement. In order to move the housing between its positions, one end of an arm **169** is pivotally connected at **170** to the housing front wall **20** adjacent the central upper edge portion thereof and the opposite end is pivotally connected at **171** to an intermediate portion of an operator control lever **172** that is operable by operator sitting on the seat **31.** One end of the lever **172** is pivotally connected at **173** to the drive unit frame. Suitable latch mechanism (not shown) is provided for selectively retaining the lever in the housing elevated position.

A driven shaft **29** is rotatably mounted by the side walls **18** and inwardly of the side walls, the shaft being rectangular in cross section perpendicular to the central axis of elongation thereof. The shaft is extended through a rectangular tubular portion **36***a* of the paddle wheel **36** (see FIG. **6**). Flap portions (spokes) **36***a* that are of about the same axial length as the paddle wheel have their one edges integrally joined to the tubular portions **36***a* and their opposite edges integrally joined to the circular cylindrical tube **36***c* of the paddle wheel, the flap portions **36***b* being substantially angularly spaced from one another. A plurality of axially elongated, radially extending flap portions **36***d* have their inner edges integrally joined to the tube. The flap portions **36***d* are substantially angularly spaced from one another with each pair being diammetrically opposed. The outer edges of the diammetrically opposed pair of flaps **36***d* in a horizontal position are spaced by a distance only slightly less than the horizontal spacing of the rear wall from the lower portion of the front panel in its datum position shown in FIG. **2** while when a pair of diammetrically opposed flaps **36***d* are in a vertical condition, the lower edge of the lowermost flap extends to about the same elevation as the lower terminal edges of skirts **24, 25,** or to an elevation just slightly above the surface being cleaned. Thus flap portions **36***d* substantially form fluid seals with the housing as they are moved through horizontal planes to reduce the quantity of air drawn into the housing, the front panel **21** being curved to be closely adjacent a substantial por-

tion of the outer periphery of the path of travel of the paddle wheel. Further skirt **24** is inclined at an angle to aid in the pick up of material when the paddle wheel is rotated in the direction of arrow **200** and minimize the amount of air drawn into the housing between it and the paddle wheel. The mounting member **36***a*, flap portions **36***b*, flaps **36***d* and cylindrical tube **36***c* are of substantially the same axial lengths.

The paddle wheel **36** is made of material sufficiently resilient that the cylindrical portion thereof may bulge radially inwardly when an object, for example a can, is moved between the housing and the cylindrical tube that has a greater dimension than the normal spacing therebetween, and will resiliently return to its original condition when the object has been moved upwardly into the housing. This aids in moving large objects upwardly in the housing. Advantageously there may be provided a plurality of paddle wheels **36** on each shaft **35** in edge to edge abutting relationship instead of a single paddle wheel extending substantially the transverse distance between the side walls **18.** Further, if desired, the hollow space between members **36***a*, **36***c* may be filled with a flexible foam material.

Through the provision of the cylinder tube **36***c* that bisects the flaps at the juncture of flap portions **36***b*, **36***d*, which is at a location intermediate the axially extending terminal edges of the flap portions **36***d* and the tubular portion **36***a*, the volume of air lost as the paddle is rotating is minimized. That is, the tube **36***c* cuts down the air loss and keeps the air velocity moving faster in the areas between the tube **36***c* and the ground and the housing as the paddle wheel is rotated for picking up debris. As a result the total quantity of air drawn into the housing for picking up debris is substantially less from that which would be required if tube **36***c* were not provided. Further the flap portions **36***d* in moving angularly above a horizontal plane project or fling particles engaged thereby upwardly in the housing. Additionally, the tube **36***c* acts as a stabilizer and strengthener for the flaps and serve to control the stiffness of the flaps. The paddle wheel may be formed by molding and may be made of rubber, neoprene, urethane or other suitable flexible material. Since the tube is made of flexible material, the tube in rotating and engaging large objects between itself and the ground will start to move the object for pick up in either angular direction of rotation of the tube, and in rotating can flex inwardly to permit passage of objects of a greater longitudinal dimension than the normal corresponding dimension between the tube and the adjacent part of the housing front and rear wall respectively, depending on the direction of rotation.

In order to drive the paddle wheel in either one angular direction or in an angular direction opposite thereto, a hydraulic motor **39** is mounted on the housing H and has a sprocket (not shown) keyed to the motor shaft thereof for driving a chain **40** which in turn drives a sprocket (not shown) keyed to the paddle wheel shaft **35.** Suitable hydraulic circuitry, including a control (not shown) located adjacent the operator's seat **31,** is provided for operating the motor **39** in the selected angular direction.

A duct, generally designated D, has side walls **43,** and a bottom wall **44** that is upwardly and rearwardly inclined at a relatively steep angle, for example over 45°, and located in substantially the same plane as the rear inclined portion **19***a* of the housing wall **19** when the housing is in a datum surface cleaning position of FIG. **2,** wall **44** and wall portion **19***a* being substantially parallel to the housing front wall **20.** The perpendicular spacing of wall portion **19***a* from wall **20** is substantially less than the diameter of the tube **36***c*. Further, the duct includes a top wall **42,** that is predominately horizontal in a rearward direction and initially curves upwardly and subsequently downwardly, walls **42–44** being joined together to form an opening of substantially the same size and shape as opening **23** to receive material discharged through opening **23.** Joined to the rear edge of the top wall **42** to extend upwardly therefrom is a wall **47,** the wall **47** being located longitudinally rearwardly of the upper transverse edge of wall **44.** A bottom wall **49** has its front edge joined to the upper edge of the wall **44** and is downwardly and rearwardly inclined along portion **49***a*, then extends downwardly and rearwardly along section **49***b*, and thereafter has a generally vertical portion **49***c*. The duct also includes a rearwardly and downwardly inclined top wall **50** in overlying relationship to the rearward part of wall portion **49***a* and the front part of section **49***b*.

The upper front transverse edge of wall **50** is a substantial distance rearwardly of wall **47** whereby walls **50, 47** in connection with the adjacent parts of the side walls **43** form a suction port **52.** The front edge of wall **50** is located closely adjacent the plane of wall **44.**

In order to selectively close the suction port to prevent movement of fluid or other material therethrough, there is provided a door **54** having an upper edge hingedly connected at **55** to the front portion of wall **50** so that the door, in its open, depending position, is located a substantial distance rearwardly of the junction of walls **44, 49,** and has its lower terminal edge a substantial distance above the vertically adjacent part of wall **49.** An arm **56** has one end pivotally connected at **57** to the mid-portion of the door **54,** an intermediate portion slidably extended through a narrow slot in wall **50,** and an opposite end pivotally connected at **58** to one end of an arm **59.** The mid-portion of arm **59** is pivotally connected at **60** to bracket **61** that is mounted on the exterior surface of wall **50.** The opposite end of arm **59** is connected through a suitable linkage (not shown) to be operated by an operator sitting on the seat **31.** The connections of the arms **56, 59** to one another and to the door are loose to permit the door pivoting a limited amount in a clockwise direction as viewed in FIG. **2** to minimize damage to the door when hit by heavy debris.

Located rearwardly of the duct D is a heavy trash receptacle, generally designated R, that in part is formed by the rearward portions of the side walls **43** of the duct D and wall portions **49***c*, and the rearward part of wall portion **49***b*. Further, the heavy trash receptacle R includes a top wall **62** that has a front edge joined to the lower rear edge of wall **50,** a bottom framework **63** and a rear wall (not shown). Thus walls **50, 62** adjacent the juncture thereof, wall portion **49***b* and the adjacent parts of the side walls form a throat that serves as an inlet to the trash receptacle R. The framework **63** provides a plurality of discharge openings (not shown), each discharge opening being closed by a door **65** that has a front end portion hingedly connected at **66** to the framework to permit the doors to be hingedly moved toward an open position extending in a downard and forward direction. Other than for the inlet throat and the discharge openings, the receptacle is closed.

In order to move the doors between their open and closed positions, the mid-portions of each of the transverse opposite edges of the doors has the lower end of an arm **67** pivotally connected thereto at **68**, the opposite end of each arm being pivotally connected at **69** to a horizontal bar **70**. To each bar **70** there is pivotally connected at **72**, the one ends of parallel arms **71**, the opposite ends of the parallel arms being pivotally connected at **80** to the side walls **43**. The front pivots **69** are slidably extended through elongated slots **74** in the control arms **73** to form a lost motion connection. The ends of the control arms opposite the slots **73** are pivotally connected at **76** to the side walls while the mid-portion of one of the arms is pivotally connected at **77** to a control rod **78** that extends upwardly to adjacent the operator seat **31**.

Through the above mentioned structure, the doors **65** may be pivoted from their discharge opening closing position (solid line position of FIG. **2**) to a downwardly and rearwardly or even forwardly extending opening position by moving the control rod **78** to pivot the control arms **73** in a counterclockwise direction about pivot **76** as viewed in FIG. **2**. As the control arms are pivoted in a counterclockwise direction, the horizontal bars **70** are forced rearwardly and at the same time pivot in a counterclockwise direction about the respective pivot **80** whereby the horizontal arms **70** moves to a lower elevation. As the arms **70** move to progressively lower elevations, the doors are pivoted downwardly and forwardly and may be pivoted to positions that the doors extend downwardly and forwardly from their respective pivot **66** as viewed in FIG. **2**. Thus, the plurality of doors **65** are simultaneously movable between a closed position and an open position. Advantageously resilient gaskets are provided around the discharge openings of the receptacle R or on the doors to form the fluid seals between the doors and the bottom wall **63**.

A suction blower, generally designated B is mounted on the main frame and has an inlet **82** that opens into the suction port **52**. A vacuum take off duct **83** opens to the inlet **82** and extends transversely outwardly to permit attachment of suitable devices to be operated by the vacuum. A closure (not shown) is provided for closing the duct **83**. The suction blower B has an outlet **84** that is fluidly connected to the forward end of the corrugated fluid conduit **85** which extends rearwardly to be in fluid communication with the inlet port **86** of the debris container C of the trailer unit **15** (See FIG. **4**). The port **86** is provided in the front wall **91** of the container C, a resilient gasket **88** being provided around the port to form a matching fit with the discharge opening of the duct **89** on which rearward end of the conduit **85** is mounted. The duct **89** is mounted at the upper end of a vertical standard **90**, the lower end in turn being mounted on the main frame **16** of the trailer unit in a stationary position. In this connection, the adjacent surfaces of duct **89** and the front wall are sloped upwardly and forwardly to permit the container C being moved to an emptying position without having to disconnect the duct **85** as will become more apparent hereinafter. The front wall **91** of the container C is provided with a vertically elongated front slot **91***a* in which the standard **90** extends when the container is in its datum position.

The container includes a lower, metal receptacle portion G and an upper filter portion F, lower debris receptacle portion G having a bottom wall **94**. Dependingly secured to the rear corner portions of the bottom wall are transversely spaced brackets **95**, longitudinally elongated arms **96** each having one end pivotally connected at **97** to the brackets and an opposite end pivotally connected at **98** to the frame **16** forwardly of the wheels **17** but rearwardly of the container front wall **91**. A second set of arms **102** are pivotally connected to the brackets **95** at locations that are forwardly and above pivots **97** when the container is in its solid line datum position, the forward ends of the arms **102** being pivotally connected to the frame **16** at **104**. The pivot axis of the pivots **104** is at a substantially higher elevation and forwardly of the pivots **98**. A piston cylinder combination has a piston rod **108** pivotally connected at **109** to a transverse member **102***a* that has opposite ends secured to arms **102** at a location that is longitudinally intermediate pivots **103** and **104**, and a cylinder **110** that is pivotally connected to the frame **16** at **111**. Pivot member **111** is located below and generally transversely between pivot members **98**. Due to the location of the pivotal connections, the arms **96**, **102** and the piston cylinder combination relative to each other and the frame and the container, as the piston rod is moved toward its extended position, arms **102** are pivoted about pivot members **104** in the direction of the arrow **112** while arms **96** are pivoted in a corresponding direction about pivots **98**. Since this results in pivot members **103** moving vertically upwardly at a slightly faster rate than pivot members **97** are moved vertically upwardly, the brackets **95** pivot about pivot members **103** in a direction of arrow **115** while said brackets pivot in a corresponding direction about pivot members **97**. That is, as viewed in FIG. **4**, as the arms are pivoted in a clockwise direction about the pivot members connecting said arms to the frame, the container pivots about pivot members **97**, **103** in the counterclockwise direction. Accordingly, since the arms in the container datum position extend predominantly horizontally, the initial movement of the container is predominantly vertical while upon the piston rod approaching its extended condition, the container is pivoted in a counterclockwise direction at progressively increasingly larger angular increments for the same increments of progressively vertical movement of the pivot **97**. As a result, upon container reaching the elevated dumping dotted line position of FIG. **4**, the floor of the container is inclined at a substantial angle downwardly and rearwardly with the rear end of the floor being rearwardly of the frame **16** which terminates adjacent rear portion of the wheels **17**.

In order to facilitate dumping the container, there is provided a door **119** for removably closing the bottom discharge opening provided in the rear wall **120** of the container receptacle. In order to mount the door for movement between its solid line closed position and its dotted line open position illustrated in FIG. **4**, a bracket **122** is mounted within the receptacle on the rear wall, a pivot member **123** mounted by the bracket pivotally mounting one end of the somewhat U-shaped arm **124**. An intermediate portion of the arm has a piston rod **125** pivotally connected thereto at **127**. The piston rod forms part of a piston cylinder combination **125**, **126** that includes a two-way acting cylinder **126** and is pivotally attached to the bracket **122** at **128**. In the door closed position, the pivot **127** is located vertically and longitudinally intermediate pivots **123**, **128**. The oppo-

site end of the arm **124** is welded to the upper rear portion of the door **119.** Upon applying fluid under pressure to the upper end of cylinder **126,** pivot **127** is swung through a downwardly extending arc while the door is swung through an arc in a rearward and upward direction, the foregoing assuming the receptacle in its datum solid line position of FIG. **4.** By the above described structure, the door can be retained in its closed position till the container C has been moved to its dumping position, and then fluid under pressure applied to one end of the cylinder for moving the door relative the receptacle to open the discharge outlet of the receptacle. Thereafter, fluid under pressure may be applied to the opposite end of the cylinder for moving the door to its closed position and retaining the door in the closed position.

A generally rectangular frame **131** is attached to the upper peripheral edge of the receptacle for mounting the fabric filter **132** to extend thereabove and in fluid sealing relationship with the receptacle. Suitable support members (not shown) may be provided to prevent collapse of the fabric filter when air under pressure is not being discharged into the container. Other filters can be used, for example, an envelope filter.

In order to prevent debris in the airstream from directly impinging on the filter, to diffuse the air flow and to deflect the debris to spread throughout the receptacle so as not to bunch in one pile, there is provided a deflector **175.** Advantageously the deflector may be made from a single sheet of flexible material, for example, rubber, that has vertical slits to form upper edge portions **175***a* that are secured to the container front wall vertically above the container inlet port **86.** The remainder of the deflector depends from the upper edge portion to have a lower terminal edge at a substantially lower elevation than the inlet port, the deflector being of a substantially greater width than the inlet port. When air under pressure is discharged from duct **85,** the deflector lower end portion is forced further away from the container inlet **86** to direct the airstream generally downwardly and transversely outwardly, the degree of flexibility and weight of the deflector being such to prevent the deflector from bending to a position in which the airstream could flow directly rearwardly from the inlet port **86.**

Referring now to FIG. **7,** the drive and brake mechanism, generally designated **140** will now be set forth. The mechanism **140** includes a hydraulic motor **141** having a motor shaft **141***a* to which there is keyed a shaft **142,** the shaft being rotatably mounted in the differential casing **143.** To the opposite end portion of the shaft **142** there is keyed a brake disc **145** that extends within the confines of an axially movable brake housing **147.** The brake housing is mounted for axial movement by conventional mechanism **148** that includes mechanical and/or hydraulic linkages to the brake pedal adjacent the operator's seat for moving the brake housing to brakingly engage the brake disc.

The intermediate portion of the shaft **142** is provided with teeth for driving a larger diameter gear **150** that is rotatably mounted by the casing **143,** the gear in turn driving the gear **151** that is bolted to the differential **152** that drives the front axle **152***a*. The axle **152***a* in turn has the drive unit wheels **13** mounted thereon for being driven by the axle. With the aforementioned structure, the braking action is directly applied to the motor driven shaft, rather than to the wheel axle **152***a*, for increasing the braking efficiency.

The hydraulic motor **141** is a fluid driven, bidirectional, in line, variable piston motor with a two positioned swash plate lever control for selectively operating the motor to drive the shaft **142.** For driving motor **141** and the suction blower, there is provided an engine **156** on the drive unit frame that has a pulley **157** on the engine shaft for driving the V-belt **158.** The V-belt drives the variable volume, over-center, in-line piston pump **159** which through suitable hydraulic circuitry **160** drives the motor **141** at variable speeds and in either angular direction.

In using the apparatus of this invention for collecting deep or high accumulations of bulky material, in the preferred type of operation the leaf seal flap **27** is moved to and retained in its elevated position by the push-pull cable assembly **30** and the paddle wheel motor rotates the paddle wheel in the direction of the arrow **200.** At this time, as the unit moves forwardly into the pile of debris, the paddle wheel flaps **36***d* and the flexible tube **36***c* will start accelerating material to initially wedge the material between the tube and the ground and thence push it around and up the skirt **24** and into the airstream provided by operating the suction blower. The airstream is of a sufficiently high velocity to convey most of the debris thrown upwardly into the housing H by the paddle wheel to move said debris rearwardly of the upper edge of plate **44,** the general trajectory of the debris being indicated by the arrows **201.** The very light debris flows upwardly through port **52** with the airstream without contacting door **54.** However the trajectory of the other material is such to strike door **54,** the heavy thence falling downwardly to wal **49** and into the heavy trash receptacle while the remainder of the material striking the door is air conveyed through the suction port **52.** For example, large light objects such as popcorn boxes frequently would be of sufficient weight not to be carried directly into port **52,** but rather would strike door **54,** and thereafter would be carried by the airstream upwardly through port **52.** This mode of operation especially lends itself to picking up large, bulky and light material. However, this mode of operation does not do as good a job of picking up heavier objects as when the flap **27** is in its solid line position of FIG. **2** and the paddle wheel is rotated in the direction opposite arrow **200.**

When the leaf seal **27** is lowered to its solid line position of FIG. **2** and the paddle wheel rotated in the direction opposite arrow **200,** upon moving the machine across surface having debris thereon, the objects that pass under the leaf seal **27** are engaged between the flaps of the paddle wheel and are carried up the back side of the leaf seal between the paddle wheel and the leaf seal and panel **21** to be thrown by the paddle wheel into the airstream. The flexible tube **36***c* can engage large objects and carry them around the back side of the leaf seal and adjacent panel **21,** and in part the throwing action of the paddle wheel tends to throw the objects upwardly between walls **42, 44** of the ducts, the trajectory of the material being generally along and adjacent the front wall **20** indicated by arrows **202.** As a result, this mode of operation is better for heavy objects than that described in the preceding paragraph. If sufficiently large debris items are encountered on the surface so as to cause the leaf seal to bend backwardly into the path of travel of the flaps **36** *d* of the paddle

wheel, the panel **21** and leaf seal attached thereto will hinge about the axis of the clearing hinge **22** in a counterclockwise direction as viewed in FIG. **2** to move the leaf seal upwardly sufficiently to clear the leaf seal from engagement with a large object. Thereupon the panel and leaf seal returns to the vertical position under the action of gravity. As a result the clearing of the leaf seal is automatic. To be noted is that the cable assembly permits the flap **27** and panel **21** pivoting as a single unit. The rotation of the paddle wheel in the direction opposite arrow **200** and leaf seal in the datum position of FIG. **2** is not only good for picking up light debris loads but also for picking up small dense items such as rocks, nuts, bolts and pop bottles.

The debris in moving upwardly through the housing and into the duct D will result in a separation of the heavier objects from the lighter particles, the lighter particles being carried up to port **52** and into the suction blower housing to be discharged from the outlet **84.** Material passing through the outlet **84** passes through the conduit **85** and into the container C. In the container, the debris laden airstream in passing beneath deflector **175** and in expanding deposits the heavier debris carried in the stream over the floor **94** while the lighter debris is retained in the container by filter F as the air passes outwardly through the filter. The heavier objects moving into the duct D either strike the door **54** to fall downwardly onto the wall **49** and thence pass into the heavy debris receptacle R or pass between the door in its open position and the bottom wall **49.** As a result, a separation of the heavier and lighter materials takes place in the duct D.

Ribs **54***a* are provided on the door **54** (forward side of the door in an open position) to permit air to flow behind objects such as paper and thereby discourage the large light articles such as paper or cardboard from becoming attached thereto. During the time the apparatus of this invention is being moved from one location that has been cleaned to another location, the door **54** advantageously is closed and the lever **172** pivoted for moving the housing to its elevated position. Also, it is advantageous to close the door **54** during the dumping of debris from the container C to prevent an airstream flowing into the container and blower material in the container into the area exterior of the container when the container is dumped. Further, if it is desired to use the vacuum for another device that is connected to the duct **83,** the door **54** is advantageously moved to its closed position.

At the time it is desired to empty the receptacle R, the lever **78** is operated to move the arms **70** and thereby the doors to their open condition in the manner previously described.

It is to be understood that the container C may be mounted for dumping by conventional mechanism in place of that described herein; and that other mechanism may be used for mounting the door **119.**

It is to be understood that wall **49** could be vertical and the receptacle R located further forwardly than that shown in FIG. **2** as long as the modified wall **49** was rearwardly of wall **44** and forwardly of door **54.** Further it is to be understood that in place of door **54,** the duct D could be provided with a generally vertical impact wall at the location of door **54** in its open position. However door **54** is preferred as it may be used to closed port **52** for reasons previously set forth.

Instead of making the paddle wheel with portions **36***d* axially across tube **36***c* substantially parallel to a plane of the axis of rotation of the paddle wheel, the flap portions may be a spiral configuration. However, flap portions that are substantially parallel to said plane are preferred as they cut down the air losses.

For some cleaning opeations, a brush could be rotatably mounted in housing H. A brush would be better for picking up debris such as sand, but would not be nearly as good as the paddle wheel of this invention for picking up debris such as leaves and paper.

Also, in place of the paddle wheel a rotary rake may be mounted in the housing H. A rake would be better for picking up objects such as cans, pop bottles and paper in relatively tall grass than the paddle wheel of this invention. However, for cleaning areas such as parking lots, paddle wheel **36** is preferred.

With this invention, the heavy trash falls into the receptacle R. As a result the heavy trash does not pass through the suction blower, and accordingly there is less wearing of the blower impeller and blower housing. Further, as the heavy trash is not air conveyed to the container C, a lower rate of air flow is required for picking up heavy trash than if both heavy and lighter trash were air conveyed to container C. As a result, there is less air to be filtered and less power is required for driving the blower.

Since the trash in container C is generally of relative light nature, for example paper and leaves, after being dumped, it may be easily compacted, the receptacle C being of a substantially larger capacity than the receptacle R. The trash in receptacle R is generally of a dense, heavy nature.

With this invention, the housing H is located forwardly of the axis of rotation of the front wheels **13** while the heavy trash receptacle is located rearwardly of said axis and the suction blower is located above the heavy trash receptacle. With the heavy trash receptacle being between the trailer unit and the axis of rotation of the front wheels, part of the weight of the receptacle is supported by the rear wheels. As a result, the power unit is of a shorter length and the front wheels of a smaller size than if both the heavy trash receptacle and the pick up unit were located forwardly of the axis of rotation of said wheels. Additionally with the heavy trash receptacle being on the opposite side of the axis of rotation of the front wheels from the pick up unit, a good balance and weight distribution, part on each side of the axis, is obtained, and the machine is more maneuverable than if both were located forwardly of said axis. The center of gravity of the container C in its datum position is located above the rear wheels. Additionally with the trailer unit and a power unit being connected by an articulated joint, the vehicle is particularly suitable for use over relative rough terrain.

We claim:

1. A surface cleaning machine comprising a mobile vehicle having a frame, a downwardly opening debris pick up housing, said housing having a debris outlet, first means for mounting said housing on the frame, a power driven surface cleaning tool rotatably mounted in the housing adjacent the surface to be cleaned for raising debris from the surface, a combination filter and light debris collection container, second means for mounting the container on the frame, a suction blower having a discharge outlet and an inlet, third means for fluidly connecting the blower outlet to the container, a

heavy trash receptacle mounted on the frame and having an inlet, and duct means for deflecting material passing therethrough to separate heavier material from lighter material, said duct means including a duct inlet fluidly connected to the housing outlet, a duct first outlet fluidly connected to the blower inlet, a second duct outlet at a lower elevation than the first duct outlet opening to the trash receptacle inlet, a bottom wall sloped upwardly and rearwardly of the housing inlet, a duct branch having the second duct outlet, a bottom wall and a top wall sloped downwardly and rearwardly from the first duct outlet, the first duct outlet being at a substantially higher elevation than the first mentioned bottom wall and extending rearwardly thereof, a transverse, vertically extending impact surface member adjacent the duct first outlet on the opposite side thereof from the duct inlet, extending to at least substantially the same elevation as the duct first outlet, and having a lower edge at a higher elevation than the lowermost part of the trash receptable inlet, and means hingedly mounting the impact member on the top wall to depend therefrom to permit pivoting of the impact member for minimizing damage to the door when hit by heavy debris.

2. A surface cleaning machine normally driven in a forward direction, comprising a mobile vehicle having a frame, a downwardly opening debris pick up unit having a debris outlet, first means for mounting the unit on the frame, a combination filter-debris container mounted on the frame, and second means, including a suction blower, fluidly connected to the unit outlet for drawing air and air entrained debris from the unit and discharging the air and entrained debris in the container, the unit including a housing having front, rear and side walls joined together, a rear skirt dependingly mounted on the rear wall, side skirts dependingly mounted on the side walls, a front panel having an upper edge portion hingedly connected to the front wall for movement between a depending position abutting against the side walls and a forwardly extending position, a leaf flap, third means dependingly hingedly connecting the leaf flap to the front panel for movement between a generally vertically extending position and a generally forwardly extending position, control means mounted on the housing for selectively retaining the leaf seal in its generally horizontal extending position, and power driven rotary means mounted in the housing adjacent the surface for moving material upwardly into the housing.

3. The apparatus of claim **2** further characterized in that the leaf flap in its generally vertical position includes a reversely bent, transversely extending first flap portion, and a generally vertical second flap portion abutting against the first flap portion on the forward side thereof and extending to a substantially lower elevation than the first flap portion, said first and second flap portion having transversely spaced, vertical slits extending through the lower parts thereof.

4. A surface cleaning machine comprising a mobile vehicle having a frame, a downwardly opening debris pick up housing, said housing having a debris outlet, first means for mounting said housing on the frame, a power driven surface cleaning tool rotatably mounted in the housing adjacent the surface to be cleaned for raising debris from the surface, a combination filter and a light debris collection container, second means for mounting the container on the frame, a suction blower having a discharge outlet and an inlet, third means for fluidly connecting the blower outlet to the container, a heavy trash receptacle mounted on the frame and having an inlet, and duct means for deflecting material passing therethrough to separate heavier material from lighter material, said duct means including a duct having an inlet fluidly connected to the housing outlet, a duct first outlet fluidly connected to the blower inlet and a second duct outlet at a lower elevation than the first duct outlet opening to the trash receptacle inlet, a bottom wall sloped upwardly and rearwardly of the housing inlet, and a duct branch having the second duct outlet, a bottom wall sloped downwardly and rearwardly from the first mentioned bottom wall and a top wall sloped downwardly and rearwardly from the first duct outlet, the first duct outlet being at a substantially higher elevation than the first mentioned bottom wall and extending rearwardly thereof, said tool comprising a paddle wheel, said housing including a front wall, a front panel having an upper edge portion and a lower edge portion fourth means connecting the upper edge portion to the front wall for mounting the panel for limited pivotal upward movement from a datum position, said fourth means comprising first hinge means having a transverse hinge axis for mounting the front panel for movement, a flexible front flap, and fifth means for dependingly mounting the front flap on the panel lower edge portion to extend closely adjacent and normally forwardly of the path of angular movement of the paddle wheel; said front flap being of sufficient flexibility to be bendable into said path of movement by relatively heavy debris on the surface being cleaned as the machine moves forwardly, said fifth means comprising second hinge means having a transverse hinge axis for mounting the front flap for movement between a depending position and a generally horizontally extending position, and sixth means mounted on the housing for selectively retaining the front flap in the generally horizontally extending position.

5. The apparatus of claim **4** further characterized in that the sixth means includes a mounting bracket mounted on the front panel and means mounted by the bracket and connected to the front flap to permit a force being transmitted from the paddle wheel to the front flap to pivot both the front flap and front panel as a single unit about the front panel hinge axis.

6. A surface cleaning maching normally driven in a forward direction, comprising a mobile vehicle having a frame, a downwardly opening debris pick up unit having a debris outlet, first means for mounting said unit on the frame, a combination filter-debris container mounted on the frame, and second means fluidly connected to the unit outlet for drawing air and air entrained debris from the unit and discharging the air and entrained debris in the container, said unit including a housing having said debris outlet, said housing including joined side, rear and front walls, a rear skirt mounted on the rear wall to extend downwardly and forwardly thereof, side skirts mounted on the side walls, and leaf seal means mounted on the front wall, the leaf seal means including a front panel, third means to hingedly connect the front panel to the front wall for movement between a predominantly downwardly extending datum position and a substantially more forwardly extending position, a resilient leaf flap, fourth means for dependingly hingedly mounting the leaf flap on the front panel for movement between a generally

downwardly depending position and a generally forwardly extending position, and fifth means mounted on the housing for selectively retaining the leaf flap in its generally forwardly extending position, said front wall being inclined upwardly and rearwardly, the rear wall having an upper wall portion inclined at about the same angle as the front wall, said first means including a duct having an inlet branch in fluid communication with the unit outlet, said inlet branch having a bottom wall in substantially the same plane as the housing rear wall portion, an airstream outlet port having a rear edge located substantially rearwardly and above the inlet branch bottom wall and closely adjacent the plane of the inlet branch bottom wall, and a heavy trash outlet branch having a bottom wall extending downwardly of the outlet port, a heavy trash receptacle opening to the heavy trash branch, a paddle wheel made of resilient material and having diametrically opposed flap portions that in a horizontal position have outer edges spaced slightly less than the corresponding horizontal spacing of the rear wall and the leaf seal mean, and means including a shaft mounted in the housing for mounting the paddle wheel adjacent the surface to be cleaned and drivingly rotating the paddle wheel, and power means drivingly connected to the shaft for rotating the shaft, the second means including a suction blower having an inlet fluidly connected to the outlet port, a door for closing the blower inlet and means for mounting the door to hingedly depend adjacent the outlet port rear edge and said door being selectively movable to close said blower inlet.

7. The apparatus of claim **6** further characterized in that the leaf flap has a lower portion bendable into the path of rotary movement of the paddle wheel, the fourth means hingedly connecting the flap to the front panel to move the front panel and leaf flap as a single unit about the third means hinge axis in a direction away from the paddle wheel when the paddle wheel engages the lower portion and is rotating in a direction that the lower part of the paddle wheel is rotating toward the flap.

8. The apparatus of claim **6** further characterized in that said power means is bi-directional for selectively rotating the shaft in either angular direction.

9. A surface cleaning machine comprising a mobile vehicle having a frame, a downwardly opening debris pick up housing, said housing having a debris outlet, first means for mounting said housing on the frame, a power driven surface cleaning tool rotatably mounted in the housing adjacent the surface to be cleaned for raising debris from the surface, a combination filter and light debris collection container, second means for mounting the container on the frame, a suction blower having a discharge outlet and an inlet, third means for fluidly connecting the blower outlet to the container, a heavy trash receptacle mounted on the frame and having an inlet, and duct means for deflecting material passing therethrough to separate heavier material from lighter material, said duct means including a duct inlet fluidly connected to the housing outlet, a duct first outlet fluidly connected to the blower inlet, a second duct outlet at a lower elevation than the first duct outlet opening to the trash receptacle inlet, a bottom wall sloped upwardly and rearwardly of the housing inlet, a duct branch having the second duct outlet, a bottom wall and a top wall sloped downwardly and rearwardly from the first duct outlet, the first duct outlet being at a substantially higher elevation than the first mentioned bottom wall and extending rearwardly thereof, a transverse, vertically extending impact surface member adjacent the duct first outlet on the opposite side thereof from the duct inlet, extending to at least substantially the same elevation as the duct first outlet, and having a lower edge at a higher elevation than the lowermost part of the trash receptacle inlet, means hingedly mounting the impact member on the top wall to depend therefrom, said impact member comprising a door for closing the first duct outlet to block the flow of debris therethrough, and means for selectively moving the door between a position depending relative the top wall and a position closing the first duct outlet, the last mentioned means being connected to the door to permit limited hinged movement thereof when the door is in depending relationship to the top wall.

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