United States Patent [19]

Kimzey et al.

[11] **3,837,038**

[45] **Sept. 24, 1974**

[54] **APPARATUS FOR CLEANING SURFACES**

[75] Inventors: **Paul W. Kimzey,** St. Louis Park; **Donald L. Olson,** Minnetonka; **Daniel A. Delmore,** Hopkins; **Keith N. Krier,** Minneapolis, all of Minn.

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

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

[21] Appl. No.: **316,476**

[52] **U.S. Cl.** **15/349,** 15/83, 15/340, 15/353

[51] **Int. Cl.** **A47l 5/30**

[58] **Field of Search** 15/82, 86, 98, 340, 347, 15/348, 349, 353, 83, 84, 85

[56] **References Cited**

UNITED STATES PATENTS

2,678,462	5/1954	Lison et al.	15/340 X
2,913,744	11/1959	Gregersen	15/340 X

FOREIGN PATENTS OR APPLICATIONS

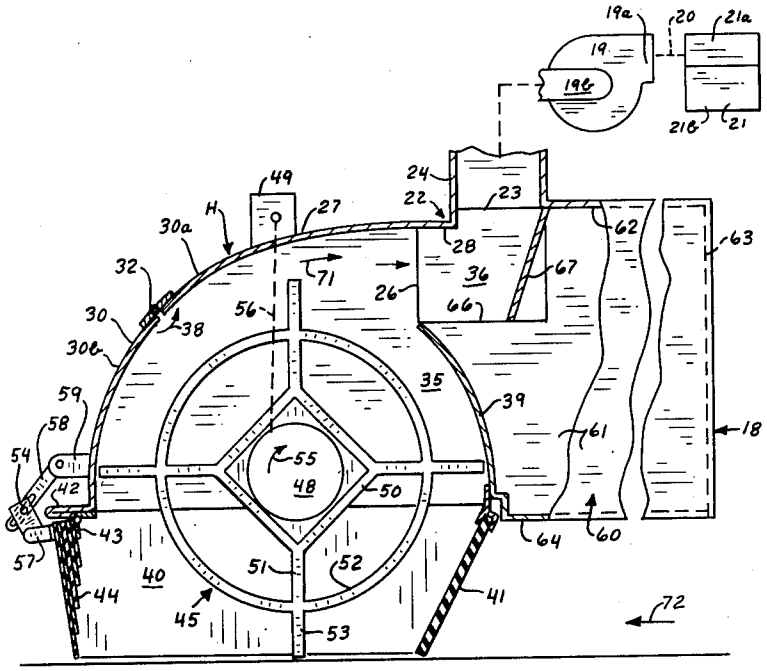
83,257	9/1895	Germany	15/349

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

[57] **ABSTRACT**

A cleaning machine that includes a mobile vehicle with a pick up assembly on the vehicle frame, said pick up assembly having a power driven paddle wheel mounted in a housing to extend closely adjacent the surface to be cleaned, the housing including dependingly mounted leaf flap mechanism, a duct 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, a combination filter and light debris container, and a suction blower having an inlet fluidly connected to the duct airstream outlet and an outlet fluidly connected to the light debris container. In one embodiment the heavy trash receptacle is mounted rearwardly of the paddle wheel relative the normal forward direction of movement of the vehicle and in the other embodiment the heavy trash receptacle is located forwardly of the paddle wheel.

12 Claims, 5 Drawing Figures



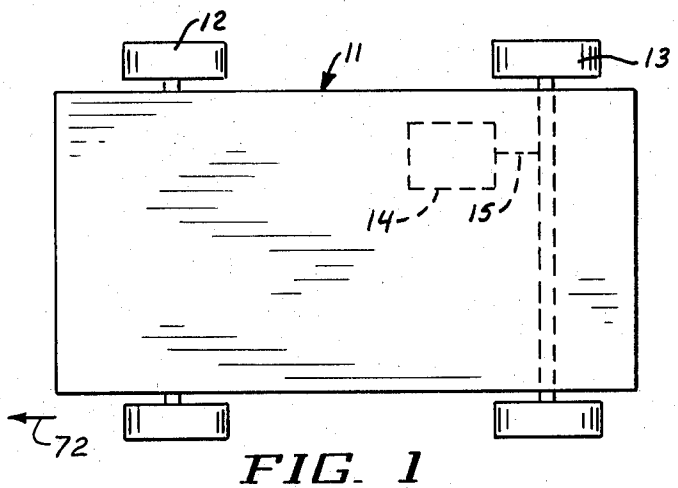

12
11
13
14
15
72

FIG. 1

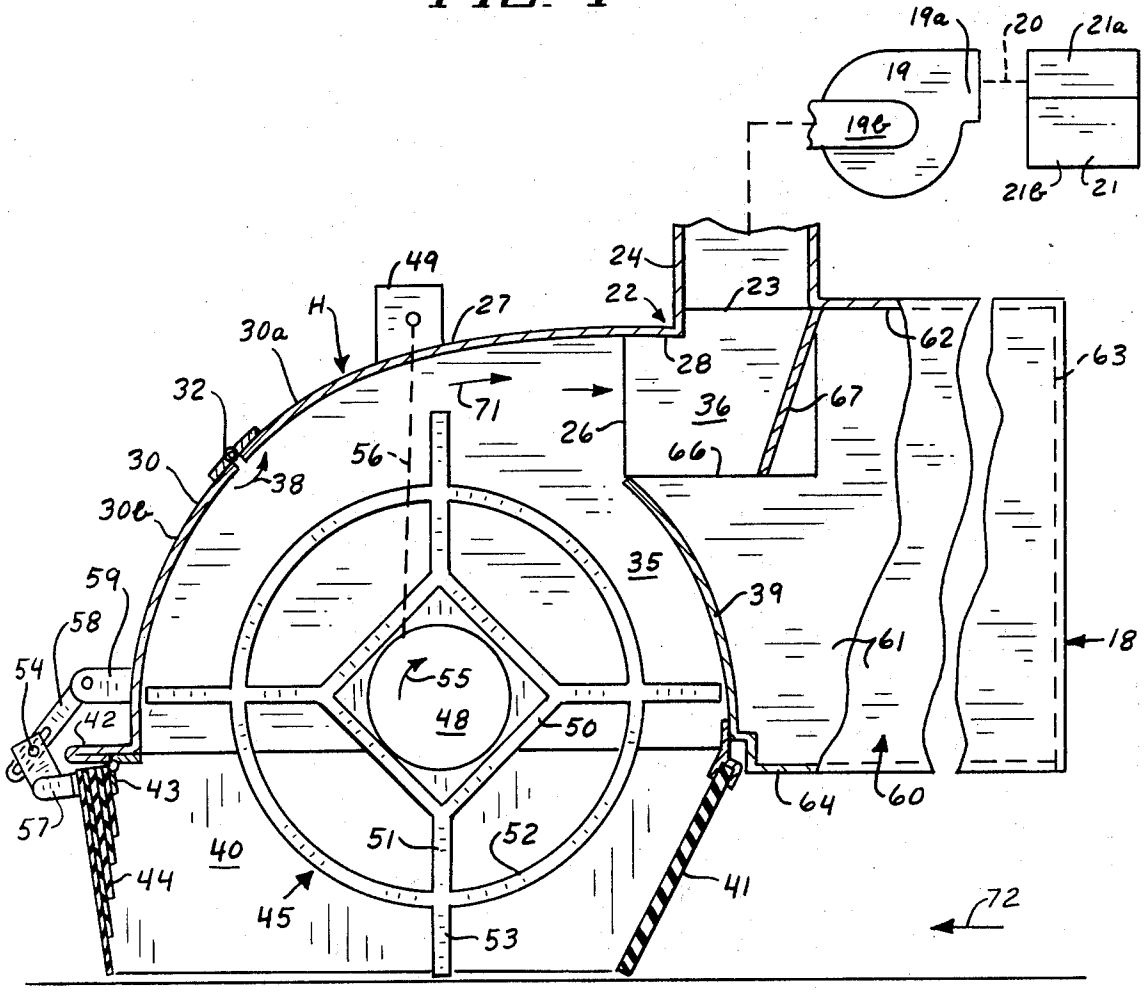

19a
20
21a
19
19b
21b
21
49
24
22
23
27
H
30a
28
62
63
32
71
36
67
26
66
56
30
38
30b
35
39
59
58
61
18
54
55
42
48
50
43
64
60
57
40
51
52
41
44
45
53
72

FIG. 2

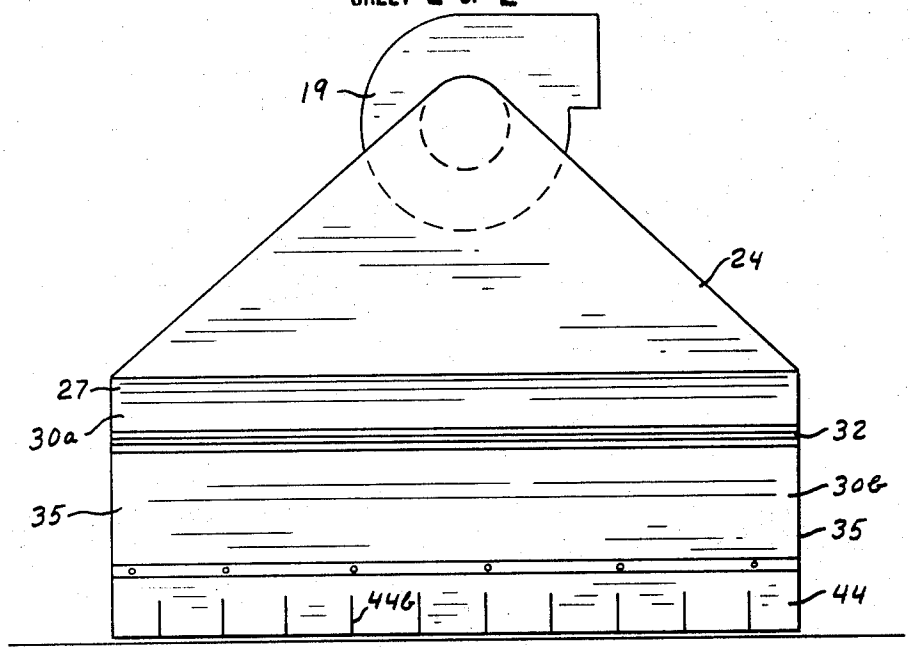


FIG. 4

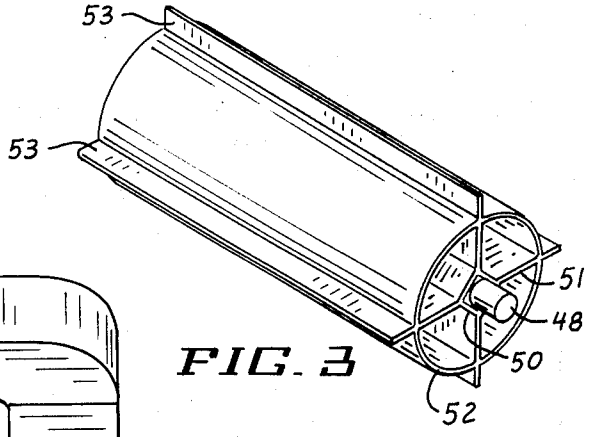


FIG. 3

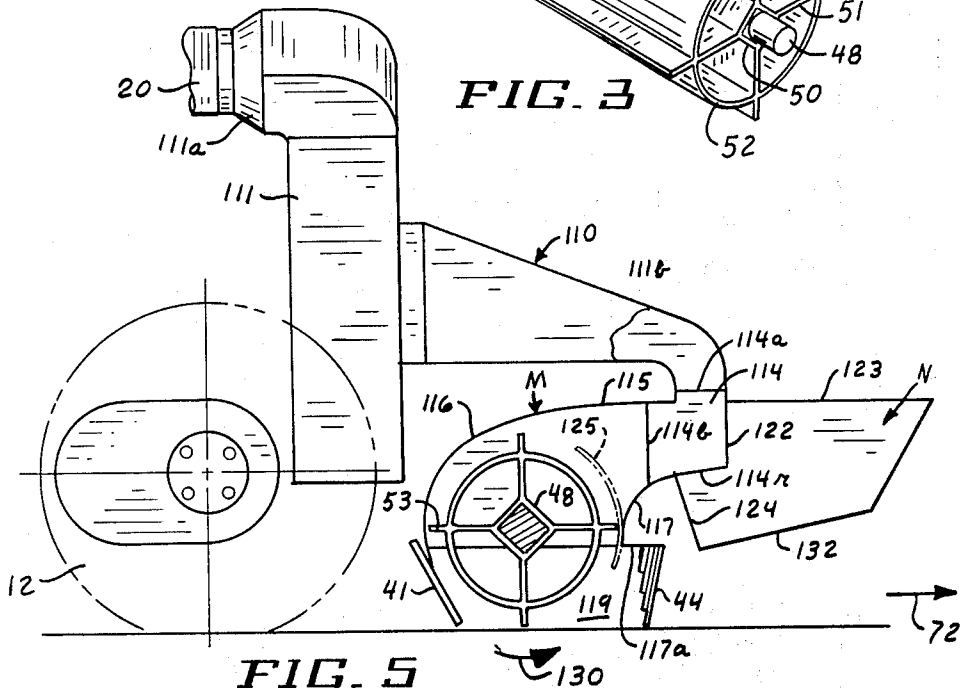


FIG. 5

APPARATUS FOR CLEANING SURFACES

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 a 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 driven paddle wheel rotatably mounted therein, a heavy trash receptacle, a light debris collection and filter container 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 in a surface cleaning machine, a new and novel surface paddle wheel for cleaning surfaces. Another object of this invention is to provide in a surface cleaning machine having a vacuumized pick up housing, a new and novel 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.

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 permits automatic clearing of the leaf flap when the leaf flap encounters relatively large debris items as the machine is moved forwardly in a material pick up position. 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.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic plan view of a vehicle of this invention;

FIG. **2** is partly a diagrammatic illustration and partly a side view of the first embodiment of the pick up unit, heavy trash receptacle and duct arrangement of this invention, part of said view being shown in longitudinal cross section;

FIG. **3** is a perspective view of the paddle wheel of this invention;

FIG. **4** is a front view of the structure of FIG. **2**; and

FIG. **5** is a fragmentary diagrammatic showing of the second embodiment of a pick up housing, heavy trash receptacle and duct arrangement.

Referring now to FIG. **1**, there is diagrammatically shown a vehicle that includes a main frame, generally designated **11** having front ground engaging wheels **12** and rear ground engaging wheels **13.** Even though FIG. **1** indicates the rear wheels are driven by a motor **14** that is drivingly connected thereto through conventional mechanism **15,** it is to be understood either or both the rear wheels and front wheels can be driven. FUrther, it is to be understood that the particular type vehicle does not form a part of this invention; however, advantageously the vehicle can be of a construction such as described in the copending Application Of Keith N. Krier and Paul W. Kimzey, U.S. Ser. No. 316,457, filed Dec. 19, 1972 and assigned to the same assignee as this application. The vehicle may include either the structure that will be described hereinafter of the first embodiment of FIGS. **2** and **4,** or that of FIG. **5.**

Referring now to FIGS. **2** and **4,** the first embodiment of the invention, generally designated **18,** includes a suction blower **19** having an outlet **19***a* that mounts the front end of a duct **20** which in turn has a rear end fluidly connected to the inlet of a combination filter and light debris container **21.** The container has an upper filter portion **21***a* that may be a fabric cover for the lower box portion **21***b*. The suction blower also has an inlet **19***b* that is fluidly connected to the outlet end of a conduit **24** which in turn is fluidly connected to the upwardly opening suction outlet port **23** of a heavy and light debris separation duct, generally designated **22.**

The duct **22** has a forwardly opening inlet port **26** that opens dierctly to the outlet of the housing H. The housing has a top wall **27** that at the rear edge is joined to the top wall **28** of duct **22** and that extends predominantly horizontally forwardly and is curved downwardly to be joined to the rear edge of the front wall portion **30***a* of the front wall **30.** The front wall portion **30***a* is curved downwardly and forwardly and the lower part thereof mounts a hinge **32** having a transverse hinge axis. The hinge mounts the front panel **30***b* of the front wall for pivotal movement about the hinge axis, the hinge being attached to the upper end portion of the front panel (assuming the panel is in its datum position). The panel in its datum position is arcuately curved and from the upper edge thereof, extends forwardly and predominantly downwardly.

The housing also includes side walls **35** that have upper edges joined to the front wall portion **30***a* and top wall **27,** rear edges that are joined to the side wall **36** of the duct **22** at the duct inlet **26** and front edges that limit the pivotal movement of the front panel in the direction of arrow **38** to the datum position of the panel illustrated in FIG. **2** and abut thereagainst. Further, the housing includes a predominantly downwardly extending, arcuately curved rear wall **39** extending transversely between and joined to the side walls, the upper edge of the rear wall defining the lower edge of the housing outlet port. The lower edges of front wall portion **30***b* in its datum position, side walls **35** and the rear wall are at about the same elevation. The side walls dependingly mount resilient side skirts **40** while the rear wall mounts a downwardly and forwardly inclined rear

skirt **41** that extends between the side wall skirts. A forwardly extending flange **42** is secured to the lower edge of the front panel to mount a hinge member **43** that has a transverse hinge axis. The hinge member dependingly mounts a resilient front flap (leaf seal) **44** that extends between the side walls and which in its vertical position, has a lower terminal edge at about the same elevation as the lower terminal edge of skirts **40** and **41**. Although the flaps of other constructions could be used, advantageously flap **44** is of a flexible laminated construction 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, generally designated **45**. Advantageously the flap **44** is provided with vertical slits **44***b* to permit one transverse part of the flap moving rearwardly relative the other, for example, if one of the parts between adjacent slits engages large objects, as the one part moves over the object the loss of vacuum is minimized from that which would have been lost if the slits were not provided.

A bracket **59** is mounted on the front panel and pivotally mounts one end of a link **58**. A bracket **57** is mounted on the upper part of flap **44** and mounts a fastener **54** that is slidably extended through an elongated slot in link **58**. The fastener may be loosened and slid along the slot and thence tightened to hold the link in a fixed position relative bracket **57** to hold the flap in an adjusted pivoted position, the flap being pivotal about the hinge axis of hinge **43**.

A transverse shaft **48** driven by a motor **49** is rotatably mounted by the side walls **35**. inwardly of the side walls, the shaft is rectangular in cross section perpendicular to the central axis of elongation thereof. The shaft is extended through a rectangular tubular portion **50** of the paddle wheel **45** (see FIG. **3**). Radially extending flap portions (spokes) **51** that are of about the same axial length as the paddle wheel have their one edges integrally joined to the tubular portions **50** and their opposite edges integrally joined to the circular cylindrical tube **52** of the paddle wheel, the flap portions **51** being substantially angularly spaced from one another. A plurality of axially elongated, radially extending flap portions **53** have their inner edges integrally joined to the tube. The flap portions **53** are substantially angularly spaced from one another with each pair being diammetrically opposed. The outer edges of the diammetrically opposed pair of flaps **53** 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 **53** 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 **40, 41,** or to an elevation just slightly above the surface being cleaned. Thus flap portions **53** substantially form fluid seals with the housing as they are moved through horizontal planes to reduce the quantity of air drawn into housing, the front panel **30***b* being curved to be closely adjacent a substantial portion of the outer periphery of the path of travel of the paddle wheel. The angular length of each of the front panel and the rear wall portions that are of a curvature only slightly greater than the maximum radius of the paddle wheel is preferably greater than the angular spacing between the outer edges of adjacent flaps **53**. One reason to provide the walls of such curvature is to minimize the amount of air drawn into the housing between the rear wall **39** and the tube **52** as the paddle wheel is rotated in the direction of arrow **55**. Further skirt **41** is inclined at an angle to aid in the pick up of material when the paddle wheel is rotated in the direction of arrow **55** and minimize the amount of air drawn into the housing between it and the paddle wheel. The mounting member **50**, flap portions **51**, flaps **53** and cylindrical tube **52** are of substantially the same axial lengths. Even though four flap portions **51**, **53** are illustrated, it is to be understood a larger number may be provided.

The paddle wheel **45** 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 between the housing and tube, 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 **45** on shaft **48** in edge to edge abutting relationship instead of a single paddle wheel extending substantially the transverse distance between the side walls **35**. Further, if desired, the hollow space between members **50**, **52** may be filled with a flexible foam material.

Through the provision of the cylinder tube **52** that bisects the flaps at the juncture of flap portions **51, 53,** which is at a location intermediate the axially extending terminal edges of the flap portions **53** and the tubular portion **50,** the volume of air lost as the paddle is rotating is minimized. That is, the tube **52** cuts down the air loss and keeps the air velocity moving faster in the areas between the tube **52** 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 **52** were not provided. Further the flap portions **53** in moving angularly above a horizontal plane project or fling particles engaged thereby upwardly in the housing. Additionally, the tube **52** 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 wall.

In order to drive the paddle wheel in the angular direction **55,** a hydraulic motor **49** is mounted on the housing H and is drivingly connected to the paddle wheel shaft **48** through drive mechanism **56.** Suitable hydraulic circuitry, including a control (not shown) is provided for operating the motor **49.**

Extending rearwardly of the housing is a heavy trash receptacle, generally designated **60,** that has side walls **61** having edges joined to side walls **35, 36.** The side walls **35, 36, 61** on each side may be formed of a single

planar continuous member. Receptacle **60** has a top wall **62** extending rearwardly of the duct **24** and between the side walls, and a rear wall **63** and a bottom wall **64** joined to each other and extending between the side walls **61.** One of the walls **61, 64** is provided with an access door (not shown) for removing trash from the receptacle. In the particular construction of the first embodiment illustrated, the rear wall **39** of the housing also forms the front wall of the receptacle. However, it is to be understood that the receptacle may have a front wall located rearwardly of the housing rear wall. In such a case, the side and top walls of the duct **22** would be of longer longitudinal lengths than illustrated and the duct **22** would have a bottom wall extending between the housing rear wall and the receptacle front wall. For the structure illustrated in FIG. **2,** the top wall **62** and the duct **24** at the juncture thereof, the duct side walls **236** at the junctures with side walls **61** and the top edge of the receptacle front wall **39** define the receptacle inlet port **66.**

An impact member (deflector) **67** is dependingly secured to the receptacle top wall at a location just rearwardly of the rear edge of outlet **23,** extends between the side walls **61,** and extends to a substantially lower elevation than the duct outlet **23** to be in the trajectory of heavy debris passing through the inlet **26.** The transverse widths of the deflector, the paddle wheel, and port **23** are substantially the same. The deflector may extend forwardly in a downward direction, the lower terminal edge of the deflector being a substantial distance rearwardly of the receptacle front wall top edge whereby heavy trash striking the deflector wall will fall into the receptacle. Advantageously the deflector is of sufficient resiliency that it may bend rearwardly when struck by heavy trash, but not of sufficient resiliency that the air flow into duct **24** will bend the deflector upwardly to block the flow of light debris to the conduit **24.**

In using the apparatus of this invention with the vehicle being driven in its normal forward direction (arrow **72**), the paddle wheel being driven in the direction of arrow **55** and the suction blower operating, the air drawn into the housing will bend the lower part of the leaf seal **44** a short distance rearwardly whereby the lower edge of the seal will be at a slightly higher elevation than when the leaf seal is in its vertical condition, but an insufficient distance rearwardly to be in the path of movement of the paddle wheel. At this time, as the unit moves forwardly into a pile of debris, the paddle wheel flaps **53** and the flexible tube **52** will start accelerating material to initially wedge the material between the tube and the ground and thence push it around and up the leaf flap 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 by the paddle wheel to move said debris rearwardly of the upper edge of the housing rear wall, the general trajectory of the debris being indicated by the arrows **71.** The very light debris flows upwardly through port **23,** with the airstream without contacting deflector **67.** However, the trajectory of the other material is such to strike deflector **67,** the heavy trash thence falling downwardly into the heavy trash receptacle while the remainder of the material striking the deflector is air conveyed through the suction port **23.** For example, large light objects such as popcorn boxes frequently would be of sufficient weight not to be carried directly into port **23,** but rather would strike deflector **67,** and thereafter would be carried by the airstream upwardly through port **23.**

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 **53** of the paddle wheel, the panel **30b** and leaf seal attached thereto will hinge about the axis of the clearing hinge **32** in a clockwise direction as viewed in FIG. **2** to move the leaf seal forwardly and upwardly sufficiently to clear the leaf seal from engagement with the paddle wheel. Thereupon the panel and leaf seal returns to the vertical position under the action of gravity and suction from fan **19.** As a result the clearing of the leaf seal is automatic.

The debris in moving upwardly through the housing and into the duct **22** will result in a separation of the heavier objects from the lighter particles, the lighter particles being carried up to port **23** and into the suction blower housing to be discharged from the outlet **19*a*.** Material passing through the outlet **19*a*** passes through the conduit **20** and into the container **21.** In the container, the debris laden airstream in expanding deposits the heavier debris carried in the stream over the container floor while the lighter debris is retained in the container by filter **21a** as the air passes outwardly through the filter. The heavier objects moving into the duct **22** either strike the deflector **67** to fall downwardly into the heavy debris receptacle **60** or pass between the deflector and the top edge of the receptacle front wall. As a result, a separation of the heavier and lighter materials takes place in the duct **22.**

Ribs (not shown) may be provided on the deflector **67** (forward side of the deflector) to permit air to flow behind objects such as paper and thereby discourage large light articles such as paper or cardboard from becoming attached thereto.

With reference to the above, it is to be noted that the vertical spacing of housing top wall from the path of movement of the paddle wheel progressively increases in a rearward direction while the separation duct inlet **26** is located above and rearwardly of the axis of rotation of the paddle wheel. Further, the lower edge of the inlet **26** is located at a higher elevation than the axis of rotation of the paddle wheel. The duct **22** provides a chamber where the separation of heavy trash from the lighter trash takes place.

Referring to FIG. **5,** there is somewhat diagrammatically shown a portion of a second embodiment, generally designated **110,** of the invention. The second embodiment includes the vehicle of FIG. **1** together with a suction blower **111** that has its outlet **111a** fluidly connected by duct **20** to receptacle **21.** The suction blower inlet **111b** is fluidly connected to the upwardly opening suction port **114a** of the separation duct **114.**

The duct has a rearwardly opening inlet port **114b** that opens directly to the outlet of the housing M. The housing has a top wall **115** that extends predominantly horizontally rearwardly and curves downwardly to be joined to a curved rear wall **116** that extends predominantly vertically and extends rearwardly of the top wall. The housing includes a front wall **117** that extends rearwardly of the duct **114** and predominantly downwardly and side walls **118** joined to walls **116** and walls **115, 117** to form the housing outlet. Rear skirt **41** and side skirts **119** are dependingly secured to rear wall **116** and

side walls **118** respectively. Front flap **44** is mounted by the bottom, forwardly extending flange of wall **117** to depend from the front wall **117.**

A power driven shaft **48** is rotatably mounted by the side walls **118** to mount the paddle wheel **48** in the housing M and drive said paddle wheel. The axis of rotation of the paddle wheel is located at a substantially lower elevation than the lower edge of housing outlet. Diametrically opposed flap portions **53** in a horizonal position have terminal edges closely adjacent the horizontal adjacent parts of rear wall **116** and front wall **117** respectively.

The duct **114** has a second outlet **114***r* forwardly of inlet **114***b* and at a lower elevation than outlet **114***a*, outlet **114***r* opening directly to the heavy trash receptacle N that extends forwardly of duct **114.** An impact wall (deflector) **122** is dependingly secured to the receptacle top wall **123** just forwardly of the front edge of the outlet **114***a*, and extends to a substantially lower elevation than the top edge of the duct inlet **114***b* to be in the trajectory path of heavy debris passing through inlet **114***b*. The receptacle has a rear wall **124** that has an upper edge that is joined to front wall **117** and is longitudinally rearward of wall **122.** Wall **122** may be a door that is hingedly mounted on wall **123** for movement to a position to close suction port **114***a*. The receptacle is mounted on the vehicle frame and is provided with an access door (not shown) for emptying the receptacle.

Mounted in the housing is a movable air sealing plate **125** that has a radius of curvature slightly greater than the spacing of outer terminal edges of flap portions **53** from the axis of rotation of paddle wheel **45,** and is mounted by arms (not shown) for pivotal movement about said axis. Advantageously the plate **125** extends through an arc of at least 45°, and has a radially outer surface that forms a close fit with the lower portion of the front wall when it is positioned such as illustrated in FIG. **5.** Suitable mechanism is provided for pivoting plate **125** from a position shown in FIG. **5** to a position to be located radially adjacent wall **116,** i.e., completely rearward of a flap portion **53***d* in a vertical upwardly extending position.

For picking up heavy dense debris such as pop bottles, bolts, etc, it is preferred that the paddle wheel be rotated in the direction of arrow **130** as the flap portions **53** act to fling such debris in a trajectory directly toward inlet **114***b*, and the plate **125** is in the position shown in FIG. **5** to minimize the amount of air being drawn in between the paddle wheel and front wall **117.**

For picking up debris such as leaves and paper, it is preferred that plate **125** be pivotally moved and retained adjacent wall **116,** and the paddle wheel driven to rotate in a direction opposite arrow **130.** The paddle wheel in rotating in the last mentioned direction has better action for lifting paper and leaves from the surface being cleaned.

The very light material passing through inlet **114***b* is carried by the airstream directly up and through port **114***a* while the somewhat heavier material will first strike wall **122** and then be carried through port **114***a* by airstream.

The heavy trash either passes directly between walls **122, 124** to fall into the receptacle N, or else first strikes plate **122** and thence falls into the receptacle.

With this invention, the heavy trash falls into the receptacle **60** or N. 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 **21,** a lower rate of air flow is required for picking up heavy trash than if both heavy and lighter trash were conveyed to container **21.** As a result, there is less air to be filtered and less power is required for driving the blower.

Since the trash in container **21** is generally of relative light nature, for example paper and leaves, after being dumped, it may be easily compacted, the container **21** being of a substantially larger capacity than the receptacle **60** or N. The trash in receptacle **60** or N is generally of a dense, heavy nature.

Instead of making the paddle wheel with portions **53** axially across tube **52** substantially parallel to a plane of the axis of rotation of the paddle wheel, the flap portions may be of a spiral configuration. However, flap portions that are substantially parallel to said plane are preferred as they cut down the air losses.

We claim:

1. A surface cleaning machine normally driven in a forward direction, comprising a mobile vehicle having a frame, a downwardly opening debris pick up unit mounted on the frame and having a debris outlet, a combination filter-debris container mounted on the frame, and first 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, a paddle wheel made of resilient material, means including a shaft mounted in the housing for mounting the paddle wheel adjacent the surface to be cleaned, and power means drivingly connected to the shaft, said paddle wheel having a mounting portion rotatably driven by the shaft to rotate therewith, a tube in surrounding concentric relationship to the mounting portion, a plurality of angularly spaced first flap portions each having one end joined to the mounting portion and an opposite end joined to the tube, and a plurality of second flap portions extending generally radially outwardly of the tube, said second flap portions each having a first end joined to said tube in angularly spaced relationship.

2. The apparatus of claim **1** further characterized in that said housing includes 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, said paddle wheel having diametrically opposed second 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 means.

3. The apparatus of claim **2** further characterized in that the first flap portions extend generally radially relative to the tube, are integrally joined to the tube angular adjacent the second flap portions, and are of radial dimensions at least as great as the radial dimensions of the second flap portions.

4. The apparatus of claim **2** further characterized in that the front wall includes a front panel, a front wall portion and second means to hingedly connect the front panel to the front wall portion for movement between a predominately downwardly extending datum

position and a substantially more forwardly extending position, and that the leaf seal means includes a resilient leaf flap, and third means for dependingly mounting the leaf flap on the front panel.

5. The apparatus of claim **4** further characterized in that the leaf flap has a lower portion bendable into the path of rotary movement of the paddle wheel, the third means mounting the leaf flap to the front panel to move the front panel and leaf flap as a single unit about the second means hinge axis in a direction away from the paddle wheel when the paddle wheel engages the lower portion of the leaf flap and is rotating in a direction such that the lower part of the paddle wheel is rotating toward the leaf flap.

6. A surface cleaning machine normally driven in a forward direction, comprising a mobile vehicle having a frame, a downwardly opening debris pick up unit mounted on the frame and having a debris outlet, a combination filter-debris container mounted on the frame, and first 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 to have the debris outlet and a rear skirt dependingly mounted on the rear wall, and 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 resilient leaf flap, second means dependingly mounting the leaf flap on the front panel and power driven rotary means mounted in the housing adjacent the surface for moving material upwardly into the housing.

7. A surface cleaning machine comprising a mobile vehicle having a frame, a downwardly opening debris pick up housing mounted on the frame, said housing having a debris outlet, 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 mounted on the frame, a suction blower having a discharge outlet and an inlet, first 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 and a second duct outlet at a lower elevation than the first duct outlet opening to the trash receptacle inlet, said tool comprising a paddle wheel, said paddle wheel comprising an axially elongated mounting member, an axially elongated tube surrounding the mounting member, a plurality of angularly spaced first flap portions having first edges joined to the mounting member and second edges joined to the tube, and a plurality of angularly spaced second flap portions extending radially outwardly of the tube and having first edges joined to said tube.

8. A surface cleaning machine comprising a mobile vehicle having a frame, a downwardly opening debris pick up housing mounted on the frame, said housing having a debris outlet, 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 mounted on the frame, a suction blower having a discharge outlet and an inlet, first 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 and a second duct outlet at a lower elevation than the first duct outlet opening to the trash receptacle inlet, 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, second means connecting the upper edge portion to the front wall for mounting the panel for limited pivotal forward and upward movement from a datum position, a flexible front flap, third 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.

9. The apparatus of claim **7** further characterized in that said paddle wheel is made of flexible material, and that the flap portions, the tube and mounting member are of about the same axial lengths.

10. The apparatus of claim **8** further characterized in that the second means comprises hinge means having a transverse hinge axis for mounting the front panel for movement away from the paddle wheel.

11. The apparatus of claim **10** further characterized in that the third means comprises means for mounting the front flap on the panel to transmit a force from the paddle wheel when the front flap is bent into the path of rotation of the paddle wheel to pivot the front flap and front panel as a single unit about the second means hinge axis in a direction to move the front flap out of the path of movement of the paddle wheel.

12. The apparatus of claim **11** further characterized in that the front flap includes a plurality of laminates, each successive laminate having a lower edge terminating at a higher elevation than the laminate forwardly thereof.

* * * * *