A material moving system has a separation tank for separating loose material entering the tank with a stream of air, from the stream of air, the separation tank comprising an inlet port and a vacuum port and an open lower end, a vacuum generation unit coupled to the vacuum port for evacuating air from the separation tank to create a partial vacuum, and a collection apparatus connected to the inlet port for collecting the loose material in a stream or air pulled into the collection apparatus by virtue of the partial vacuum in the separation tank. The system is characterized in that the separation tank is configured to rest on the ground at the lower extremity, the ground serving to substantially close the open lower extremity, such that the loose material separated falls to the ground within the separation tank.
To vacuum line 709
VACUUM-AIDED MATERIAL COLLECTING AND MOVING SYSTEM

FIELD OF THE INVENTION

[0001] The present invention is in the area of equipment and systems for moving dirt and other material and pertains more particularly to systems for collecting debris and moving dirt, gravel and sand.

BACKGROUND OF THE INVENTION

[0002] Manufacturers and developers have been active in the field of equipment for homeowners for performing maintenance tasks around the home and farm, and many functional systems are commercially available. There are however, problems and unmet needs, and improvement is always desirable.

[0003] There are a number of problems in the art which have never been adequately solved, for example, when one digs in the earth for whatever reason, there is always a problem of removing loosened soil from the developing hole. Further materials such as gravel, topsoil, sand and the like are typically delivered by such as dump trucks, and left in piles on the ground. When one needs to use these materials, they have to be shoveled into a wheelbarrow or other conveyance to be moved and spread.

[0004] In light of the state of the art and the shortcomings described above, what is clearly needed is a vacuum-aided device that can be used to remove loosened soil from holes, to load loose materials from the ground into conveyances, and to clean up debris loose on the ground.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0005] FIG. 1a is an elevation view of a vacuum-aided material moving system according to a preferred embodiment of the present invention.

[0006] FIG. 1b is a plan view of the system of FIG. 1a, to better illustrate some of the details and features of the system.

[0007] FIG. 2 is an elevation view of a tool in use in a hole in the ground, as an example of a use for the system of FIG. 1.

[0008] FIG. 3 is a perspective view of a special vacuuming tool for landscaping use in a preferred embodiment of the invention.

[0009] FIG. 4 is a perspective view of another tool useful with the apparatus of the invention in preferred embodiments.

[0010] FIG. 5 illustrates a tool with sled runners at least at the ends in an embodiment of the invention.

[0011] FIG. 6 is a perspective view of yet another tool for use with apparatus according to embodiments of the invention.

[0012] FIG. 7a is an elevation view of a split tank in an embodiment of the invention configured so one may place and fill lawn bags with collected debris.

[0013] FIG. 7b is an elevation view of the tank of FIG. 7a with the upper portion rotated on the hinge assembly to open the tank.

[0014] FIG. 7c is a partial section of the lower portion of the tank of FIG. 7a in a preferred embodiment of the present invention.

[0015] FIG. 8 is an elevation view of a system combining a special wheelbarrow and a collection tank.

SUMMARY OF THE INVENTION

[0016] In a preferred embodiment of the present invention a material moving system is provided, comprising a separation tank for separating loose material entering the tank with a stream of air, from the stream of air, the separation tank comprising an inlet port and a vacuum port and an open lower end, a vacuum generation unit coupled to the vacuum port for evacuating air from the separation tank to create a partial vacuum, and a collection apparatus connected to the inlet port for collecting the loose material in a stream or air pulled into the collection apparatus by virtue of the partial vacuum in the separation tank. The system is characterized in that the separation tank is configured to rest on the ground at the open lower end, the ground serving to substantially close the open lower extremity, such that the loose material separated falls to the ground within the separation tank.

[0017] In a preferred embodiment of this system the open lower end is coupled to a conformal skirt that conforms to the ground, and aids in sealing the lower end of the separation tank in use. Also in a preferred embodiment there is a throttle configured for selectively limiting the evacuation rate of the separation tank to limit the size and weight of loose material that will be entrained with an incoming air stream. In preferred embodiments the vacuum generation unit is coupled to the vacuum port by a vacuum line, and the throttle is located in the vacuum line.

[0018] In some preferred embodiments there is a wheeled trolley and a handle on one side of the separation tank, configured for a user to tip the tank by the handle onto the wheels of the trolley, to be moved from one position to another. In some embodiments the vacuum generation unit is a powered centrifugal blower coupled to the vacuum port at the inlet to the blower. Also in some embodiments the separation tank has a substantially circular cross section, and the inlet port enters the separation tank substantially tangentially, aiding in separation of the loose material from the air stream. In many cases the vacuum port enters the separation tank substantially at the center of an otherwise closed top end of the tank. Further, there may be a filter between the tank and the vacuum generation unit for filtering dust and debris from the air before the vacuum generation unit.

[0019] In some embodiments the collection apparatus comprises a tubing section coupled to a flexible line in turn coupled to the inlet port. In many cases the tubing section comprises handles for a user to grasp for manipulation. There may be two linear portions of the tubing section joined at an angle. In some cases the tubing section, at an end opposite the end coupled to the flexible line, is configured for loosening soil for ingestion by the tubing section. Also in many cases, the tubing section ends, opposite the end coupled to the flexible line, in an interface joinable to any one of several collection nozzles.
Some available nozzles have rake teeth for loosening soil to be collected by the nozzle. Others have wheels for spacing an inlet portion of the nozzle from a surface, to create space for ingesting air to entrain loose material. Still others have sled runners for spacing an inlet portion of the nozzle from a surface, to create space for ingesting air to entrain loose material. Still others have blades for cutting vegetation to be collected by the nozzle.

In another aspect of the invention a separation tank for a material moving system is provided, comprising an upper portion separable from a lower portion at an interface, the separation tank for separating loose material entering the tank with a stream of air, from the stream of air, the separation tank comprising an inlet port configured to couple to one or more collection tools and a vacuum port configured to couple to a vacuum source, both ports in the upper portion, characterized in that the lower portion is configured to contain and retain open a bag, the upper portion scaling to the lower portion at the interface in a manner that collected and separated material falls into the bag.

In preferred embodiments of the tank the upper portion is hinged to the lower portion such that open, the bag is retrievable by a user, the bag holding collected loose material. Also in preferred embodiments the lower portion has a bottom, at least one vertical wall, and an upper flange, and the bag is configured to sit in the lower portion with an upper part of the bag folded over the upper flange, such that the upper portion closes on the portion of the bag folded over the upper flange. Still further in preferred embodiments one or both of the bottom and at least one vertical wall comprise internal channels and openings coupled to a vacuum source in a manner that the pressure between the bottom or wall and the bag is less than the pressure in the separation tank, to retain the bag open in use for material collection.

In yet another aspect of the invention a material moving system is provided, comprising a separation tank for separating loose material entering the tank with a stream of air, from the stream of air, an inlet port for coupling to collection tools, a vacuum port for coupling to a vacuum source, and an open lower end configured to connect to an interface to a wheelbarrow in a manner that the vacuum source may create a partial vacuum in the separation tank and the wheelbarrow.

In embodiments of the invention described in enabling detail below, for the first time a material moving system is provided wherein loose material may be efficiently collected and moved without the excessive use of shovels and the like.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a elevation view of a vacuum-aided material moving system 101 according to a preferred embodiment of the present invention, and FIG. 15 is a plan view of the same system. In this embodiment there are three main parts. A central vacuum tank 103 having an inlet 107 is connected by a flexible hose 105 to a vacuum tool 102 configured for collecting debris from the ground (in this example), much like a tool for a household vacuum sweeper. Vacuum is provided in this embodiment by a stand-alone centrifugal blower 104 connected to tank 103 by a connector 108 to a suction pipe 109 that enters tank 103 at the center of the top of the tank. The system is very much like a large, high-powered shop vac, except for some unique features.

FIG. 2 is a elevation view of a tool 201 in use in a hole 205 in the ground, as an example of a use for the system of FIG. 1. Tool 202 is configured essentially as a metal tube cut at an angle on end 204 in this example. Two handles 202 and 203 are affixed to tool 201 for use in grasping and maneuvering the tool. Handle 202 is vertical and handle 203 is horizontal, and a user grasps the tool much as one grasps a scythe.

In some cases, for example where the earth is soft and loose, the tool may be used to create the hole as well as to remove loose dirt. The angle cut on the business end of tool 201 aids in this respect, and may be used in the manner of the edge of a shovel for the purpose. Some embodiments attachments (not shown in FIG. 2) to the business end, such as rakes and claws, may be used as well. In other cases, other tools may be used to loosen dirt in the hole, and tool 201 may be used to remove the loosened dirt. In the latter case, for simple removal of otherwise loosened dirt, the end of tool 201 may be at right angles to the axis of the tube. In some embodiments the end of the tube forming the body of tool 201 is reduced in area over the cross-section elsewhere, which performs a dual function. Firstly, the size of rocks or other chunks that may enter will always be smaller than the diameter of the conveyance (tube and hose) to tank 103, and the entering air velocity at the end of the tube will be increased, aiding in acquiring debris for transport.

In either case above it is not necessary to lift dirt from the hole with a shovel. This operation has particular merit for such as clearing dirt around lateral roots of stumps so the laterals may be cut with a saw in a stump-removal process.

The inventor is aware that it is well-known in the art to use a vacuum wand to remove dirt from a hole as shown in FIG. 2. A significant and non-obvious difference in the system of FIG. 1 however, is that the dirt removed is deposited directly on the ground because of the open bottom of tank 103. Referring again to FIG. 1, tank 103 has a wheeled trolley 112 attached to one side of the tank and a handle 113. There is also in a preferred embodiment a transparent port such as port 115 in FIG. 1 for indicating to a user when collected material has reached such a height in the tank that the tank should be moved.

When the user has decided for whatever reason that the collection at one point for tank 103 is sufficient, such as because the level of debris in the tank has reached a maximum, the user may discontinue the collection operation and move the tank, leaving the pile of dirt or debris collected...
on the ground where the tank previously stood. To move the tank and leave behind a pole of debris or dirt, the user simply grasps handle 113 and tips the tank up on the wheels of wheeled trolley 112, leaving the collected material on the ground. The user then wheels the tank to a new position and repeats the process.

[0032] There are some interesting ramifications to the operation just described. Consider, for example, the operation of removing dirt around laterals of a stumps so the laterals may be conveniently cut by a chain saw. If the system described is used, one may pile the removed dirt right beside the hole that the stump will leave when the laterals are cut and the stump is pulled from the hole. The dirt may then nearly effortlessly be replaced in the hole. In another aspect, the user may place the tank over the hole, if the hole is small enough in diameter, or in the hole in a manner that the canvas skirt can seal, and then use the tool 201 to collect the dirt from the pile and return it to the hole.

[0033] There are of course many variations of the system shown in FIGS. 1 and 2 that may be made without departing from the spirit and scope of the invention. For example, the size of tank 103 may vary widely in different embodiments. The tank may be made of a variety of materials, such as metal or reinforced plastic, such as fiberglass material. Preferably inlet 107 to the tank enters tank 103 tangentially, as is shown in FIG. 1a. This causes debris to be separated by centrifugal force, and to fall more readily to the ground. But this entry configuration is not limiting.

[0034] In preferred embodiments a filter is used between tank 103 and blower 104 to avoid damaging the blower. The filter may take any one of several forms, such as a folded cylindrical filter as well-known in the art for such as shop vacs and water filters. In this case the filter may be disposed in the tank, as is done in shop vacs, outside the tank with access provided for changing, or somewhere in the suction line to the blower.

[0035] In other embodiments other sorts of filtering material may be used, such as porous panels and the like. Filters may be selected and used according to the kind of material to be moved with the system. For example, when moving clean gravel, one may select a very porous filter to maximize vacuum capability for the system.

[0036] Further to the above, blower 104 may be implemented on the tank itself. Stand-alone implementation as shown in FIG. 1 is preferable for large and high-powered blowers, however. Still further, flexible line 105 from inlet 107 to tool 102 or 201 may take any one of many forms as well, such as a wire reinforced plastic or rubber hose, a heavy-duty reinforced canvas hose, a metal flexible tubing, and any one of several other options.

[0037] Still further a variety of ends elements may be provided for tools 102 or 201. Some have already been described, such as digging aids as shown in FIG. 2 and vacuuming nozzles as shown in FIG. 1. FIG. 3 is a perspective view of a special vacuuming tool 301 made to fit on the business end of tool 102 for landscaping use. Tool 301 has a body 302 much like that of a garden nozzle for a household vacuum, but larger. In some cases width W will be as much as three feet. There is an attachment interface for the tube of a tool 102, which has handles as shown for a user to grasp to maneuver the apparatus. Tool 301 also comprises at least one row of teeth such as tooth 304, providing a combination rake and vacuum collection apparatus. In preferred embodiments there is a like row of teeth on the backside of body 302 as shown, and there may be teeth on ends as well, and in some cases more than one row of teeth side-by-side.

[0038] A principle of tool 301 is in leveling ground areas. By resting the teeth on the surface of an area and working the tool back and forth over a larger area, high spots are leveled and excess material is collected and transferred to tank 103.

[0039] FIG. 4 is a perspective view of another tool 401 useful with the apparatus of the invention. Tool 401 has a body 402 and an interface 403 equivalent to the similar elements of tool 301 of FIG. 3. Tool 401, however, has no teeth. It has instead a wheeled carriage 404 implemented on each end so a user may apply the tool to surfaces to be cleaned, and the wheels will keep the tool at a fixed a predetermined height above the surface.

[0040] In an alternative embodiment shown in FIG. 5 a tool 501 with a body 502 and an interface 503 has sled runners 504 at least at the ends, and in some cases in the center or other places, to space the tool above a surface to be swept. The sled runners in many cases are more durable than wheels and less vulnerable to jamming and damage.

[0041] FIG. 6 is a perspective view of yet another tool 601 for use with apparatus according to embodiments of the invention. Tool 601 has similar elements to tools 301, 401 and 501 but also has cutting blades 605 implemented under the tool for cutting grass and weeds, which are then swept away by the vacuum sweeper apparatus into tank 103. Blades as shown preferably run the full length of the tool (Width W of FIG. 3), but may in some embodiments be shorter and staggered. There may be one or more blades, and the blades may face in either forward or reverse direction, or both.

[0042] There is another unique feature of system 101, which is particularly useful with surface tools such as those shown in FIGS. 3 through 6. This is a throttle valve, or damper, 114 implemented in line 109 from tank 103 to blower 104. A user may adjust this throttle to vary the vacuum level in tank 103 to particular conditions and for special purposes. One may wish, for example, to collect leaves and trash from a gravel driveway. One may adjust throttle 114 such that the system will pick up the leaves and other debris, but not the gravel of the driveway. One may also use this feature to separate gravel and other materials into piles of various size aggregates. By adjusting 114 to a low vac level for a pile of gravel and stones of various sizes, one may collect only the smallest, then somewhat larger, and then larger still, and so on.

[0043] A Collector for Filling Trash Bags

[0044] In another aspect of the invention a collector is provided that fills trash bags. FIG. 7a is an elevation view of a split tank 701 configured so one may place and fill lawn bags with collected debris, rather than depositing the debris on the ground as described above. Tank 701 has an upper portion 702 and a lower portion 703 joined by a hinge assembly 705. Lower portion 703 is closed on the bottom, unlike tank 103 of FIG. 1, but open at the top, having a flange 707. Portion 702 has most of the elements described
for tank 103, and is open at the bottom, but in most cases foreshortened from the height of tank 103. Portion 702 has a flange 706 at its open bottom, matching flange 707 of lower portion 703.

[0045] Portions 702 sits atop portion 703, joined by hinge assembly 705, with flanges 706 and 707 in contact, providing thereby a closed tank for drawing a vacuum by action of a blowout equivalent to blower 704 of FIG. 1, but not shown in FIG. 7a, attaching to suction pipe 709. With the portions joined as shown a tank equivalent to tank 103 of FIG. 1 is provided, by which one can collect dirt and debris just as described above for embodiments using tank 103.

[0046] FIG. 7b is an elevation view of tank 701 of FIG. 7a with the upper portion 702 rotated on hinge assembly 705 to open the tank at the interface of flanges 706 and 707. By closing damper 704 or by turning off the blower providing vacuum in the tank, vacuum level is removed in the tank, and it may be easily opened as shown in FIG. 7b. The skilled artisan will recognize that upper portion 702 may be opened far enough to rest on the ground, or a support may be provided either separately or as a part of the tank to support the upper portion when opened. Further, the direction of attachment of the inlet and outlet have been changed in direction to allow the flexible connectors to rotate when the tank is opened. Alternatively, the collection tool (102, 201) and the blower (104) may be disconnected to open the tank.

[0047] An object of the openable tank is to allow a lawn or leaf bag to be placed inside the lower portion, lining the inside of the lower portion and extending over flange 707, such that the bag is held open when upper portion 702 is rotated back upright and the tank is thus closed. With the tank closed a portion of the lawn or leaf bag (not shown) will be trapped between flanges 706 and 707. In some cases there will be a resilient sealing element, such as an o-ring, between the flanges when closed to help seal the tank against leaks.

[0048] With the bag in place and the tank closed, vacuum may be drawn on the tank, and dirt and debris may be collected, which, by falling to the bottom of the tank will fall into the bag. Then when the tank is again opened, a user may grasp the bag and lift it from lower portion 703, close the top of the bag and set it aside to be discarded. An empty bag is then put in place in lower portion 703.

[0049] FIG. 7c is a partial section of lower portion 703 of tank 701 in a preferred embodiment of the present invention. Portion 703 in this embodiment has a cylindrical side part 710 and a flat bottom part 711. An arrangement of passages 712 are provided throughout the cylindrical side part and the bottom part, all interconnected to a suction port 713 which communicates with vacuum pipe 709 (FIG. 7a). The internal passages open to the inside of tank portion 703 in a plurality of locations on the inside wall and bottom. With a bag 714 in place, port 713 and passages 712 provide a higher vacuum in a volume behind bag 714 than is attainable in the tank generally. This is because vacuum pipe 709 is acted upon directly by blower 104, and evacuates tank 701 through a filter. There is a pressure drop across the filter, and the tank is open to tools 201 or 102, or other tools. The net effect is that a plastic bag 714, or other conformal bag, is held in place against the inside of tank portion 703 in operation. Port 713 may be implemented in a number of different ways, and will, in most cases, have a flexible line in the connection to pipe 709, to allow for tank 701 to be opened to remove bags of debris and to install empty bags.

[0050] FIG. 8 is an elevation view of a system 801 combining a special wheelbarrow 803 and a collection tank 802 of the general sort described in other embodiments above. In this embodiment tank 802 is foreshortened much like the upper portion 702 of the hinged tank 701 described above with reference to FIGS. 7a and 7b. The lower portion in this particular case is the wheelbarrow itself, which has a top 807 configured to mate with a flange 806 at the lower part of tank 802. In some cases the mating of flange 806 to wheelbarrow top 807 is secured by clamps 805, which may be implemented in a number of different ways known in the art. There are an inlet 808, a vacuum line 809, and a throttle valve 804, as in the other embodiments described above.

[0051] System 801 is particularly applicable to loading loose materials from piles on the ground into a wheelbarrow for movement and distribution at other places. Typically, for example, when one buys a yard of topsoil, or gravel, or sand, the selling party delivers the material in a dump truck and dumps it on the ground. Then when the user wants to use the stuff, he/she must load the wheelbarrow with a shovel. With the system of FIG. 8, one may use a hose and tool connected to inlet 808, or just a hose, to ingest the loose material from a pile on the ground, and to place it in the wheelbarrow. Tank 802 in this embodiment need not have a relatively large volume, as no material is retained in the tank, and tank 802 serves simply as a separation device for separating a stream of loose material from the incoming hose and dropping it in the wheelbarrow.

[0052] It will be apparent to the skilled artisan that there are a variety of changes that may be made to the embodiments described above without departing from the spirit and scope of the invention. For example, tanks can be implemented in a variety of materials and sizes, and with different combinations of features. Many different sorts of tools may be devised and used with such a vacuum system, and many other variations may be made. The invention is to be accorded the breadth of the claims below.

What is claimed is:

1. A material moving system, comprising:
   a separation tank for separating loose material entering the tank with a stream of air, from the stream of air, the separation tank comprising an inlet port and a vacuum port and an open lower end;
   a vacuum generation unit coupled to the vacuum port for evacuating air from the separation tank to create a partial vacuum; and
   a collection apparatus connected to the inlet port for collecting the loose material in a stream or air pulled into the collection apparatus by virtue of the partial vacuum in the separation tank;
   characterized in that the separation tank is configured to rest on the ground at the open lower end, the ground serving to substantially close the open lower extremity, such that the loose material separated falls to the ground within the separation tank.
2. The moving system of claim 1 wherein the open lower end is coupled to a conformal skirt that conforms to the ground, and aids in sealing the lower end of the separation tank in use.

3. The moving system of claim 1 further comprising a throttle configured for selectively limiting the evacuation rate of the separation tank to limit the size and weight of loose material that will be entrained with an incoming air stream.

4. The moving system of claim 3 wherein the vacuum generation unit is coupled to the vacuum port by a vacuum line, and the throttle is located in the vacuum line.

5. The moving system of claim 1 further comprising a wheeled trolley and a handle on one side of the separation tank, configured for a user to tip the tank by the handle onto the wheels of the trolley, to be moved from one position to another.

6. The moving system of claim 1 wherein the vacuum generation unit is a powered centrifugal blower coupled to the vacuum port at the inlet to the blower.

7. The moving system of claim 1 wherein the separation tank has a substantially circular cross section, and the inlet port enters the separation tank substantially tangentially, aiding in separation of the loose material from the air stream.

8. The moving system of claim 7 wherein the vacuum port enters the separation tank substantially at the center of an otherwise closed top end of the tank.

9. The moving system of claim 1 further comprising a filter between the tank and the vacuum generation unit for filtering dust and debris from the air before the vacuum generation unit.

10. The moving system of claim 1 wherein the collection apparatus comprises a tubing section coupled to a flexible line in turn coupled to the inlet port.

11. The moving system of claim 10 wherein the tubing section comprises handles for a user to grasp for manipulation.

12. The moving system of claim 11 wherein the tubing section has two linear portions joined at an angle.

13. The moving system of claim 10 wherein the tubing section, at an end opposite the end coupled to the flexible line, is configured for loosening soil for ingestion by the tubing section.

14. The moving system of claim 10 wherein the tubing section ends, opposite the end coupled to the flexible line, in an interface joinable to any one of several collection nozzles.

15. The moving system of claim 14 further comprising a nozzle having rake teeth for loosening soil to be collected by the nozzle.

16. The moving system of claim 14 further comprising a nozzle having wheels for spacing an inlet portion of the nozzle from a surface, to create space for ingesting air to entrain loose material.

17. The moving system of claim 14 further comprising a nozzle having sled runners for spacing an inlet portion of the nozzle from a surface, to create space for ingesting air to entrain loose material.

18. The moving system of claim 14 further comprising a nozzle having blades for cutting vegetation to be collected by the nozzle.

19. A separation tank for a material moving system, comprising an upper portion separable from a lower portion at an interface, the separation tank for separating loose material entering the tank with a stream of air, from the stream of air, the separation tank comprising an inlet port configured to couple to one or more collection tools and a vacuum port configured to couple to a vacuum source, both ports in the upper portion; characterized in that the lower portion is configured to contain and retain open a bag, the upper portion sealing to the lower portion at the interface in a manner that collected and separated material falls into the bag.

20. The tank of claim 19 wherein the upper portion is hinged to the lower portion such that open, the bag is retrievable by a user, the bag holding collected loose material.

21. The tank of claim 19 wherein the lower portion has a bottom, at least one vertical wall, and an upper flange, and the bag is configured to sit in the lower portion with an upper part of the bag folded over the upper flange, such that the upper portion closes on the portion of the bag folded over the upper flange.

22. The tank of claim 21 wherein one or both of the bottom and at least one vertical wall comprise internal channels and openings coupled to a vacuum source in a manner that the pressure between the bottom or wall and the bag is less than the pressure in the separation tank, to retain the bag open in use for material collection.

23. A material moving system, comprising:

- a separation tank for separating loose material entering the tank with a stream of air, from the stream of air; an inlet port for coupling to collection tools;
- a vacuum port for coupling to a vacuum source; and an open lower end configured to connect to an interface to a wheelbarrow in a manner that the vacuum source may create a partial vacuum in the separation tank and the wheelbarrow.

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