

Sept. 21, 1937.

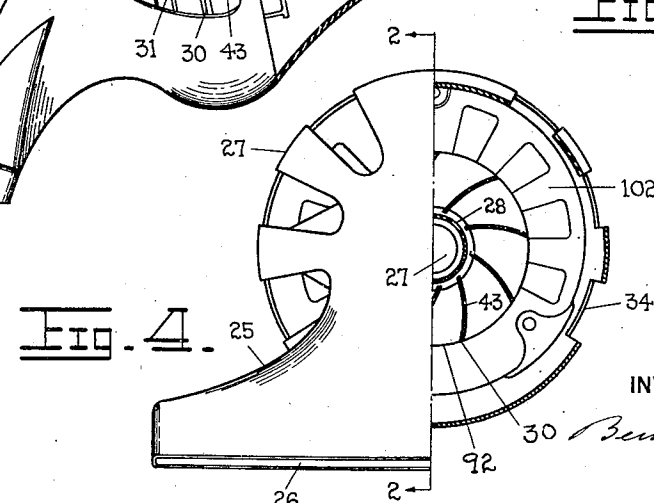
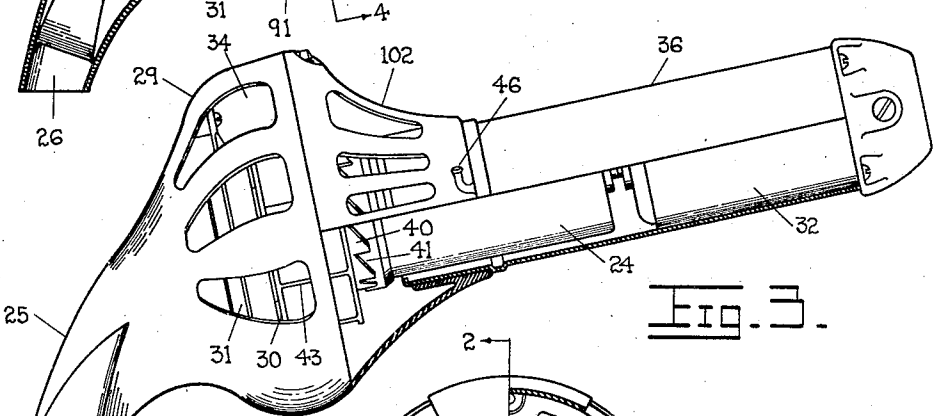
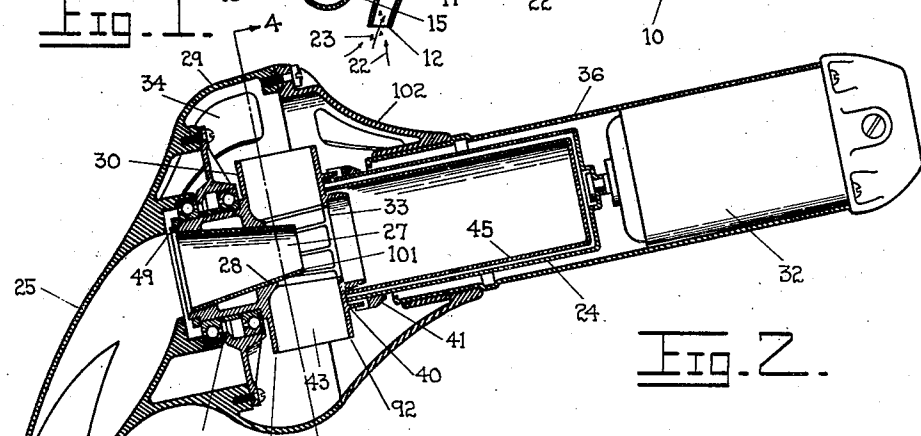
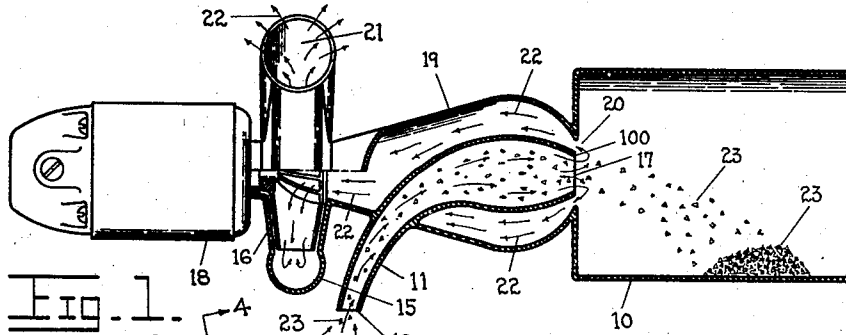
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2,093,748

SUCTION CLEANER

Filed May 7, 1935

2 Sheets-Sheet 1



INVENTOR

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SUCTION CLEANER

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2 Sheets-Sheet 2

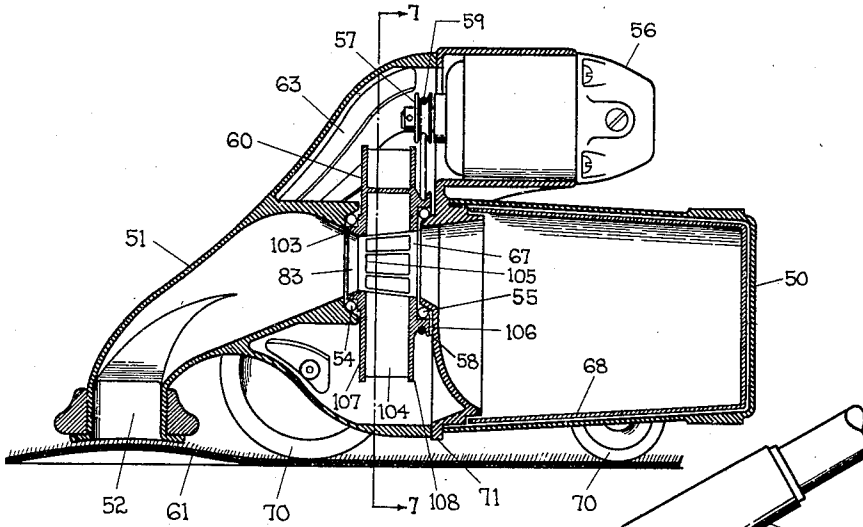


Fig. 5.

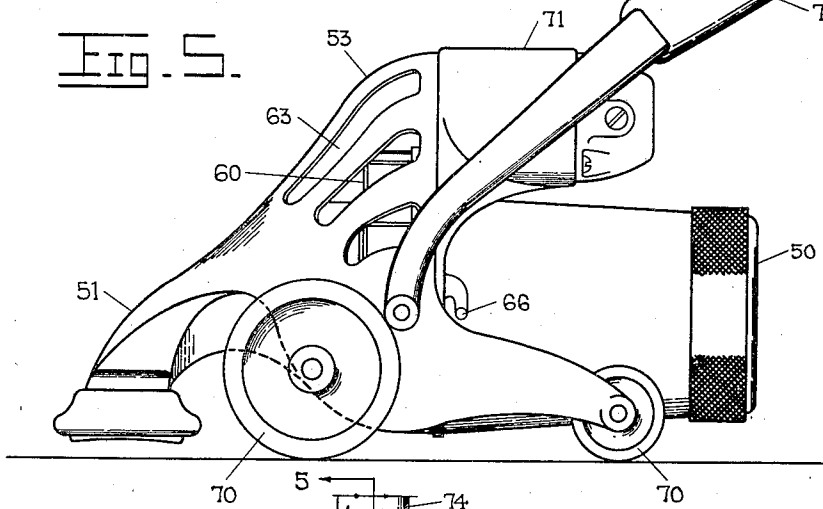


Fig. 6.

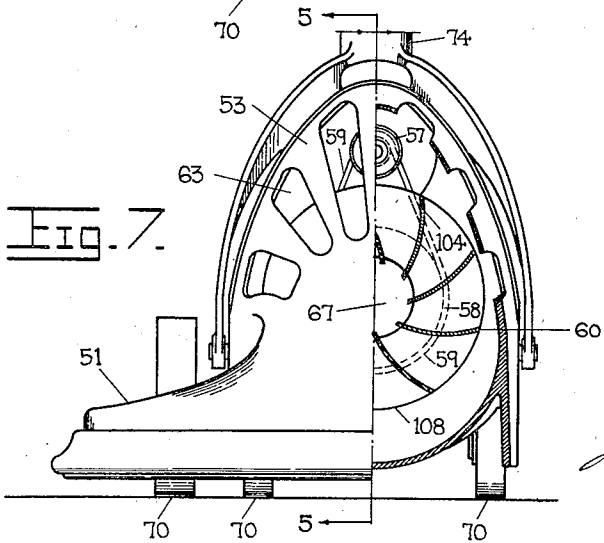


Fig. 7.

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# UNITED STATES PATENT OFFICE

2,093,748

## SUCTION CLEANER

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Application May 7, 1935, Serial No. 20,225

13 Claims. (Cl. 15-16)

This invention relates to suction cleaners, or more particularly to means for separating dirt from dirt-laden air.

The object is to suck the dirt-laden air through a conduit which is suitably restricted to attain a high velocity, and then to sharply divert its direction of flow; for instance, cause it to flow abruptly around a definite corner; whereas, the dirt contained therein being of greater density, will resist the turning influence of the air, due to inertia, and pass on in substantially a straight line direction, out of the air stream, and thus separate from the air. The object is to provide a receptacle to receive the dirt at the instant it separates from the air stream, and to maintain a partial vacuum within the receptacle during the operation of the cleaner, and thus facilitate the reception and settling of the dirt. Disturbing air currents within the receptacle are to be avoided. An object is to retain the dirt within the receptacle under ordinary manipulating conditions associated with the operation of suction cleaners, and in this respect to utilize the influence of centrifugal force. A further object is to provide a purely mechanical separation in contrast with filtration means, and accordingly attain a highly efficient fan performance or suction device. A particular object is to avoid back pressure on the exhaust side of the suction device, and in general to avoid resistance and restrictions to air flow throughout.

Other objects will be apparent throughout the following description, and the associated drawings in which:—

Fig. 1 is a schematic illustration of an arrangement for separating dirt from dirt-laden air according to my invention. The device as illustrated is shown partially in vertical sectional view.

Fig. 2 is a vertical sectional view taken on line 2-2 of Fig. 4; it illustrates a suction cleaner of such size that it may readily be carried in the hand and used for dusting furniture, draperies and clothes, or the like. It embodies the dirt separating features of Fig. 1, and centrifugal means for retaining the dirt in the dirt receptacle as above expressed in setting forth the various objects of this invention.

Fig. 3 illustrates a side elevation of the hand cleaner shown in Fig. 2; however, for the purpose of showing in full elevation, some of the internal elements which obviously are shown in sectional view in Fig. 2, it is shown partially in vertical sectional view, also taken on line 2-2 of Fig. 4.

Fig. 4 is a combination front elevation and vertical sectional view of the hand cleaner illus-

trated in Figs. 2 and 3. With respect to either view (front elevation or sectional) the cleaner construction may be considered as being symmetrical to the vertical line 2-2. The sectional view is taken on line 4-4 of Fig. 2.

Fig. 5 is a vertical sectional view taken on line 5-5 of Fig. 7; it illustrates a suction cleaner of larger size than that shown in Figs. 2, 3 and 4; it is transportable over the floor and suitable for cleaning the floor or floor coverings, and the like. It embodies the dirt separating features of Fig. 1, but not the centrifugal means for retaining the dirt in the dirt receptacle.

Fig. 6 illustrates a side elevation of the floor cleaner shown in Fig. 5.

Fig. 7 is a combination front elevation and vertical sectional view of the floor cleaner illustrated in Figs. 5 and 6. With respect to either view (front elevation or sectional) the cleaner construction may be considered as being symmetrical to the vertical line 5-5. The sectional view is taken on line 7-7 of Fig. 5.

In carrying out this invention as illustrated in Fig. 1, a nozzle 11 is provided which has a relatively sharp edged termination as at 100, and is formed to provide a restricted opening as at 17. This nozzle is inclosed within a casing 19, and this casing forms a suction chamber which is in open communication with an exhausting means in the form of a suction fan 16; or in other words, it forms the suction side of a suction device which comprises a fan casing 15, said suction fan 16, and an electric motor 18. The fan is mounted on the motor shaft and accordingly may rotate within the fan casing.

A dirt receptacle 10 is provided for receiving the dirt as it separates from the air; it has a restricted opening 20 through which, as one instance, open communication is effected between the interior of the dirt receptacle and the suction chamber formed by casing 19; however, as another instance, open communication is also effected between the interior of this dirt receptacle and the interior of the nozzle 11, through its restricted opening 17. All of this should be arranged substantially as shown, in that the nozzle 11 points directly into the dirt receptacle 10, with the termination 100 thereof at proper spaced relation with respect to the rim of said restricted opening 20, whereas the same is also inclosed within the casing 19.

The air stream and its direction of flow is indicated by small arrows 22, and the dirt particles by small lumps as at 23.

The mode of operation is as follows:—As the

motor 18 rotates the fan 16, a suction is created throughout the system; that is to say, it tends to exhaust the system of air. When dirt-laden air is permitted to enter the nozzle intake opening 12, it is sucked up to move towards the exhausting means 16, and in the course of its travel must pass through the restricted opening 17, which is more or less restricted to attain a proper high velocity at this point. Here the air turns abruptly around the relatively sharp edged nozzle termination 100 to pass through the suction device where it is exhausted into the atmosphere through the exhaust port 21. The dirt particles however will resist the turning influence of the air as it passes abruptly around said nozzle termination, this obviously being due to inertia, and accordingly will leave the air stream to move more or less in a straight line direction and enter the dirt receptacle and settle therein. The exhausting means, while sucking the air through the system, also maintains a partial vacuum within the dirt receptacle and accordingly the movement and settling of the dirt therein is facilitated.

The main air stream should not enter the dirt receptacle to any such extent that it would disturb the proper settling of the dirt; nor should the nozzle termination 100 extend through the opening 20 to such extent that proper abrupt turning of the air is defeated. The space between the nozzle termination 100 and the rim of the opening 20 should be more or less according to the character of the dirt-laden air to be separated; but a reasonable amount of ordinary judgment and skill will readily determine what, in this respect, the relation of these two elements should be; however the capacity of the exhausting means and the area of the nozzle opening 17 should, in this connection, be given due consideration.

On the whole, the essential features are to get high velocity and sharp and abrupt turning movement for the air as it passes around the nozzle termination 100; then to have the dirt receptacle appropriately situated to receive the dirt as it leaves the air stream; and further, to maintain a partial vacuum and avoid air currents within the receptacle.

With reference to Figs. 2, 3 and 4;—the hand cleaner. The same features described with reference to Fig. 1, are embodied within this arrangement. The suction nozzle for the cleaner is indicated by 25 and leads directly into the nozzle element 28 which is provided with a relatively sharp edged termination 101 and formed to provide a restricted opening 27; in effect the nozzle element 28 forms a continuation or extension of the suction nozzle 25. An exhausting means in the form of a suction fan 30 surrounds the nozzle termination 101, thus forming a suction chamber thereabout. The suction fan is carried by the suction nozzle 25 in a fashion free to rotate as shown, and within a fan casing 29 as formed jointly by the suction nozzle element 25 and the main casing element 102.

The tubular casing 36 forms a handle for the cleaner and carries the electric motor 32. A dirt receptacle 24 is inclosed within said handle and is connected at one end to the motor shaft, while the other end thereof connects with the suction fan 30 through the clutching arrangement 40 and 41; hence when the motor shaft rotates, the dirt receptacle and suction fan also rotate.

The restricted opening 33, as one instance,

provides open communication between the dirt receptacle and the suction side of the fan 30, and further, as another instance, it provides open communication between said dirt receptacle and the suction nozzle 25 through the restricted opening 27 of nozzle element 28. And here again the arrangement should be such so that the nozzle element 28 points directly into the dirt receptacle 24, with the termination 101 thereof at proper spaced relation with respect to the rim of said restricted opening 33; and accordingly the nozzle element termination 101 is inclosed within a suction chamber formed by the suction fan 30.

In this illustration the spaced relation between the nozzle termination 101 and the rim of the restricted opening 33 is somewhat greater, relatively, than the relation of corresponding parts in Fig. 1. This however illustrates permissible, or desirable, deviations for the purposes heretofore explained with reference to Fig. 1.

The mode of operation of this hand cleaner is as follows:—As the motor 32 drives the fan 30 as heretofore described, a suction is created throughout the system. When the nozzle intake opening 25 is applied to the article to be cleaned, dirt-laden air is sucked up to move towards the exhausting means 30, and in the course of its travel it must pass through the restricted opening 27 at high velocity. The air turns abruptly around the nozzle termination 101 to pass through the suction fan and exhaust into the atmosphere through exhaust ports 34. The dirt particles however will resist the turning influence of the air, as heretofore described with reference to Fig. 1, and settle within the dirt receptacle 24 where a partial vacuum is maintained.

As cleaning operations proceed, the dirt receptacle becomes filled with dirt, which sooner or later of course must be emptied. To accomplish this the handle 36 is separably connected to the main casing 102 through an interlocking means in the form of a bayonet connection 46, and accordingly when this connection is separated, the handle 36 containing the motor 32, and the dirt receptacle 24, forms one unit; while the fan casing 29 to which is fixed the suction fan 30 through the ball bearing mounting 31, forms the other unit. To make this separation complete an interlocking connection between the suction fan 30 and the dirt receptacle 24 is also necessary, and this connection must be capable of transmitting rotating motion from the dirt receptacle to the suction fan.

The separable connection between the suction fan 30 and the dirt receptacle 24, comprises a clutching arrangement formed by a saw-toothed ring 41 as shown, and definitely fixed to the dirt receptacle 24, and a corresponding ring 40 as forming part of the suction fan 30. Hence, the saw-toothed rings readily engage and separate and form a clutching device capable of transmitting rotating motion from the dirt receptacle 24 to the suction fan 30. After the handle unit is separated from the fan casing unit, the dirt may be emptied from the dirt receptacle in an ordinary fashion, however, as a convenience there is provided a container 45, made preferably of paper of a reasonable stiff quality so as to retain its shape, and formed to fit snug within the dirt receptacle; this container may be removed bodily with the dirt contained therein, and the whole disposed of as may be desired.

Inasmuch as a hand cleaner of this sort is turned in most every conceivable position during

the cleaning operations, the dirt within the dirt receptacle would ordinarily under favorable conditions fall through the opening 33 and be blown out through the exhaust ports 34 by the action of the fan 30; but since the dirt receptacle rotates in this case the dirt will readily contact with the inner rotating surface thereof, and cling thereto through the influence of centrifugal force, and accordingly will not fall from the receptacle, or in other words, will not spill out during the cleaning operations.

With reference to the suction fan construction;—This fan comprises two disks 91 and 92, with a hole at the center of each; they are connected by the fan blades 43 and thereby held in definite coaxial relation. The blades extend radially towards the periphery of said disks and away from said holes, as particularly shown in the sectional view portion of Fig. 4; and accordingly inlet and exhaust ports are provided, respectively, at the center and periphery of the fan.

With reference to the suction fan mounting;—A hub 49 extends from one of said disks to ride in the ball bearing mounting 31 which is carried by the nozzle element 25; and thus the fan is rotatably mounted. This hub has a hole through the center thereof in coaxial relation with the holes at the centers of said disks, and accordingly an unobstructed, through, and straightway opening is provided at the axis of the fan; hence, the dirt contained in the dirt-laden air may enter the dirt receptacle 24, from the suction nozzle 25—28, by moving in a straight line direction, while the clean air turns abruptly to enter the channels formed by the fan blades 43 in conjunction with the disks 91 and 92, and thence to be exhausted into the atmosphere.

With reference to Figs. 5, 6 and 7;—floor cleaner. The same features described with reference to Fig. 1, are embodied within this arrangement. However in contrast with the hand cleaner of Figs. 2, 3 and 4, there is no centrifugal influence to retain the dirt within the dirt receptacle. This cleaner is provided with four wheels 70 to permit traction thereof over the floor. A handle 74 is provided for guiding and pushing the same as may be required to bring the suction nozzle opening 52 over those portions of the rug or floor which are to be cleaned. The rug is illustrated at 61 as it normally would be lifted from the floor to span over the nozzle opening 52 by the action of the suction device, and thus permit air to be sucked through from beneath and dislodge the dirt.

The suction nozzle is indicated by 51 and leads directly into the hollow hub 103 of the exhausting means 60, and which is formed to provide a restricted opening 83, and a relatively sharp edged termination 105 for the suction nozzle; for in effect the hub 103 forms substantially a continuation or extension of the suction nozzle 51.

The exhausting means in the form of a suction fan 60 comprises two disks 107 and 108, with radially disposed blades 104 to form a suction chamber at the axis of the fan and around the restricted opening 83 of the suction nozzle. This fan is provided with a second hub 106 which is also hollow and coaxial in relation to the axis of the fan. All of this should be arranged substantially as shown to provide an unobstructed conduit from the point of nozzle opening 52 to the sealed or closed end of the dirt receptacle 50. This conduit should be straightway for a portion of its length at least, and where it passes through the suction chamber as formed at the axis of the

fan 60, and it should have a gap in its running length within this suction chamber, or otherwise be provided with suitable openings at this point so as to effect open communication therebetween, and also to provide an abrupt turning point for the air as it passes from the interior of the suction nozzle 51, through said suction chamber and out through the channels formed by the fan blades 104 and disks 107 and 108, and thence to be exhausted by the action of the fan to pass through the exhaust ports 63 and into the exterior atmosphere; while the dirt however, separates from the air at this abrupt turning point, due to inertia, and settles in the rear end of said conduit, or in other words, within the sealed dirt receptacle 50.

The suction nozzle 51 is provided with a shroud 53 to form a fan casing or protecting cage around the fan. This shroud as forming part of the suction nozzle is connected to a main frame structure 71. The dirt receptacle 50 is connected to the opposite side of this frame structure by a separable connection in the form of a bayonet joint 66, so that the same may readily be removed for emptying the dirt; it is also provided with an auxiliary container 68 for the same purpose, and of similar fashion, as prescribed for the paper container 45 of Fig. 2.

The motor 56 for driving the fan is mounted in the upper portion of the main frame structure 71, and is provided with a driving pulley 57, which in connection with the driven pulley 58 forming part of the fan hub 106, rotates the fan 60 in cooperation with the endless belt 59.

The fan 60 is rotatably mounted through the ball bearing mountings 54 and 55, which on the one side is carried by the suction nozzle 51, and on the other by the main frame structure 71.

In this illustration the spaced relation between the nozzle termination 105 and the rim of the opening 67 is somewhat greater, relatively, than the relation of corresponding parts in both Fig. 1, and Fig. 2. Here again permissible deviations are presented to bring out that such proportions may be utilized for the purpose of getting more or less perfect separation of dirt from the air; but in consequence however, of obtaining a somewhat poorer or better fan performance, or motor power consumption, or quietness of operation in view of the high velocity of the air around the prescribed abrupt corner. However the more sudden and abrupt the air is turned in its direction of flow around the nozzle termination, the more perfect will be the air and dirt separation, in the absence of other disturbing features. In the three arrangements herein shown and described, the dirt receptacle should be substantially sealed against air leakage by suitable mechanical fitting, or otherwise, and thus avoid disturbing air currents within the receptacle.

Having thus described my invention, what I claim, and desire to secure by United States Letters Patent is as follows:—

1. Means for separating dirt from dirt-laden air, comprising a nozzle having a sharp edged termination and restricted opening; a suction device comprising a suction chamber and exhausting means, said suction chamber forming the suction end of the suction device and inclosing said nozzle termination, said exhausting means having its intake in communication with the suction chamber but in no way obstructing a straight line exit of dirt from said nozzle; and a dirt receptacle having communication with said suction chamber through a restricted opening and mounted directly

in front of said nozzle termination whereby said nozzle points directly into the receptacle through said restricted opening with a definite space between said nozzle termination and the rim of said  
 5 receptacle opening so that air drawn through said nozzle, through the action of said suction device, must turn abruptly around said sharp edged  
 10 nozzle termination to pass through said exhausting means, while the dirt by force of inertia leaves the air stream as it exits from said nozzle to move in substantially a straight line and enter said  
 15 receptacle.

2. Means for separating dirt from dirt-laden air, comprising a suction chamber; a dirt recep-  
 15 tacle having communication with said suction chamber through a restricted opening; a suction nozzle provided with a sharp edged termination which forms a restricted opening therefor, and projecting through said suction chamber to point  
 20 directly into said receptacle with said termination thereof situated within the rim of said restricted receptacle opening, but in spaced relation with respect thereto; and a suction device comprising  
 25 exhausting means having its intake in communication with said suction chamber and serving to draw air through said nozzle, abruptly around the sharp edged termination thereof and into said suction chamber, and thence to exhaust the air.

3. Means for separating dirt from dirt-laden  
 30 air, comprising a suction chamber; a dirt receptacle having communication with said suction chamber through a restricted opening; a suction nozzle provided with a sharp edged termination which forms a restricted opening therefor, and  
 35 projecting partially through said suction chamber and mounted to point directly into said receptacle through said restricted receptacle opening and from a point directly opposite thereto, thereby providing a conduit for unobstructed straightway  
 40 communication between said nozzle and said receptacle through the intervention of said suction chamber; and a suction device comprising exhausting means having its intake in communica-  
 45 tion with said suction chamber but in no way obstructing the communication between said nozzle and said receptacle, said suction device serving to draw air through said nozzle, abruptly around the sharp edged termination thereof and into said suction chamber, and thence to exhaust  
 50 the air.

4. Means for separating dirt from dirt-laden air, comprising a suction chamber; a dirt recep-  
 55 tacle having communication with said suction chamber through a restricted opening; a suction nozzle having a restricted opening provided with a sharp edged rim and mounted to point directly into said receptacle opening from a point within said suction chamber and directly opposite there-  
 60 to, thereby providing a conduit for unobstructed straight-way communication between said nozzle and said receptacle through the intervention of said suction chamber; and a suction device comprising  
 65 exhausting means having its intake in communication with said suction chamber but in no way obstructing the communication between said nozzle and said receptacle, said suction device serving to draw air through said nozzle, abruptly around the sharp edged termination thereof and into said suction chamber, and thence to exhaust  
 70 the air.

5. Means for separating dirt from dirt-laden air, comprising a suction chamber; a dirt recep-  
 75 tacle having communication with said suction chamber through a definitely prescribed opening; a suction nozzle mounted to point directly into

said receptacle through said opening but in spaced relation with respect to the rim of the opening, thereby providing a three-way open communication between the interior of said nozzle, the interior of said receptacle, and said suction chamber, each with respect to each other; and a suction device having its intake ports in direct communication with said suction chamber, but in no way obstructing said three-way open communication, thereby necessitating the air to turn abruptly around the termination of said nozzle as it is sucked from the interior of said nozzle to enter said suction chamber and thence to be exhausted into the atmosphere through the action of said suction device.

6. Means for separating dirt from dirt-laden air, comprising a suction chamber; a straightway conduit passing through said suction chamber and having one end thereof open to permit the entrance of dirt-laden air, while the other end is sealed against air leakage to form a chamber for receiving the dirt contained in said dirt-laden air, and a gap or opening in said conduit at a point within said suction chamber to form communication therebetween; and a suction device having  
 25 its intake port in communication with said suction chamber, thereby necessitating the air to turn abruptly around the edge of said gap or opening in said conduit as it is sucked from the interior of said conduit to enter said suction  
 30 chamber and thence to be exhausted into the atmosphere through the action of said suction device; while the dirt passes straight on, due to inertia, to settle in the closed end of said conduit.

7. In a suction cleaner, the combination of a  
 35 suction fan having an unobstructed through opening at the axis thereof which forms a suction chamber, the blades thereof diverging radially from said through opening to form inlet and exhaust ports, the inlet ports communicating  
 40 with said suction chamber and the exhaust ports communicating with the exterior atmosphere; a suction nozzle leading into one end of said suction chamber; a dirt receptacle having a restricted opening which provides direct communication be-  
 45 tween the interior thereof and the other end of said suction chamber; means for rotatably mounting said fan, and means for driving said fan.

8. In a suction cleaner, the combination of a  
 50 suction device comprising a fan casing having exhaust ports; a suction fan rotatably mounted within said casing in operable relation to exhaust through said exhaust ports and having an unob-  
 55 structed through opening at the axis thereof which forms the suction side of the fan; a suction nozzle leading into one end of said fan opening; and a dirt receptacle having a restricted opening which provides direct communication be-  
 60 tween the interior thereof and the other end of said fan opening.

9. In a suction cleaner, the combination of a main casing having an exhaust opening; a suction fan rotatably mounted in said casing in operable relation to exhaust through said exhaust  
 65 opening, and also having a through opening at the axis thereof to serve as the suction end of the fan; a suction nozzle leading into said suction end of said fan; a partition adjacent to said fan and on the opposite side thereof with respect  
 70 to said suction nozzle, and having an opening coaxial in relation to said through opening in said fan; a dirt receptacle arranged to inclose said opening in said partition, thereby providing open communication between said dirt receptacle  
 75

and said suction end of said fan; and means for rotating said fan.

5 10. In a suction cleaner, the combination of a fan having two disks, an opening at the axis of each disk, and a series of fan blades connecting  
5 the two disks in parallel and coaxial relation and extending radially towards the periphery of said disks and away from said openings, thereby providing inlet and exhaust ports respectively at the  
10 center and periphery of the fan and also an unobstructed through opening at the axis of the fan; means for rotatably mounting said fan but retaining said unobstructed through opening;  
15 means for conducting dirt-laden air into one end of said unobstructed through opening, and a receptacle in open communication with the other end of said unobstructed through opening.

20 11. A suction fan comprising a frame structure of radially diverging blades with an unobstructed, through, and straightway opening at the axis thereof; and a hub at the axis thereof which is hollow and thereby in effect extends  
25 said unobstructed, through, and straightway opening; and means for rotatably mounting the fan comprising an annular bearing in correlation with said hub, whereby said unobstructed, through, and straightway opening extends  
30 through said bearing as well as the hub.

12. In a suction cleaner, the combination of a main casing having exhaust openings; a suction fan rotatably mounted within said casing in operable relation to exhaust through said exhaust openings, and having a through opening at the axis thereof to serve as the suction side of the

fan; a suction nozzle carried by said casing and leading into one end of said through opening; a dirt receptacle within said casing and having a restricted opening which communicates with the other end of said through opening; means for  
5 rotatably mounting said dirt receptacle; means for connecting said dirt receptacle with said fan whereby they must rotate in unison; and means for rotating said fan and said dirt receptacle.

13. In a suction cleaner, the combination of a main casing having exhaust openings near the forward end thereof; a suction nozzle protruding from the forward end thereof with its opening leading rearwardly into the forward end of said casing; a motor mounted in the rear end of said casing; a fan rotatably mounted in the forward end of said casing and having a through opening at the axis thereof with radially disposed blades which surround said nozzle opening and also form exhaust ports which register with said exhaust  
15 openings; a dirt receptacle interposed between said motor and said fan and mounted to rotate through the action of said motor; means for connecting said fan with said receptacle whereby they must rotate in unison; and a partition  
20 between said fan blades and said receptacle having an opening coaxial in relation to said nozzle opening and said fan, said opening providing open communication between said receptacle and said nozzle opening, and also between said receptacle  
25 and said exhaust ports through the channels formed by said radially disposed fan blades.

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