

How Household Vacuum Cleaners Work

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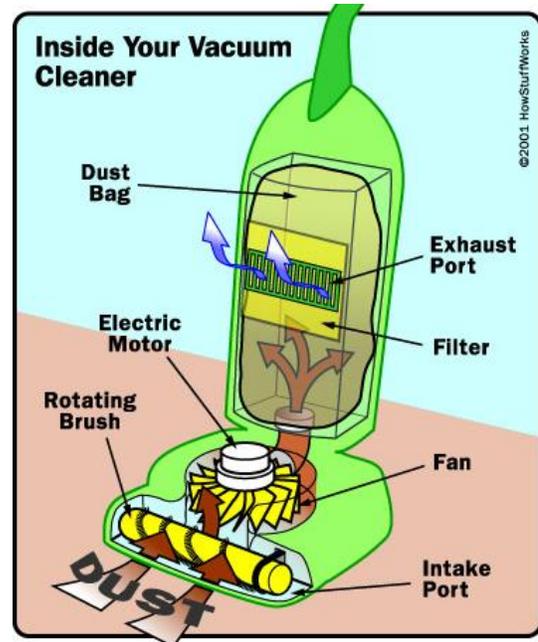
A vacuum cleaner's function is a method of cleaning floors and other surfaces using suction created by a pressure drop. From the countless number of vacuums produced each year, most will find their way to the homes of the average consumer. There are various types of vacuums that can be purchased, including bagged, bagless, and cyclonic. They all work with the same principal. An analogy to think of is as you sip soda through a straw, you are using suction mechanisms. When you suck the soda up, you cause a pressure drop between the bottom of the straw and the top of the straw. With greater fluid pressure at the bottom than the top, the soda is pushed up to your mouth. This is the same idea at work in a vacuum cleaner.

Vacuum Cleaners with Bags

The first vacuums were simple sucking machines with a brush and suction head at the front, a motor in the middle, and a bag at the back. When you switch them on, the motor will begin spinning, resulting in air and dirt being sucked in and blown into the bag.

Internal Components of Bagged Vacuums

The conventional vacuum cleaner is made up of six main components: an intake port, electric motor, fan, porous bag, filter, and an exhaust port (see image to the right).¹ It should be noted that the intake port can include numerous cleaning accessories.



How Bagged Vacuums Work

The bagged vacuum is the type that all modern day vacuums are modeled after. Once the vacuum is plugged in to an electrical outlet, it begins rotating the brush and fan using a rubber belt and shaft respectively. The rotating brush loosens dirt from the rug or floor and pushes it up inside the vacuum internally using air. The dirt is able to travel in the air because of friction and moves toward the exhaust port due to the rotating fan blades. As all this air travels forward, the density of the particles increases in the front and decreases at the back of the fan. This change in pressure (pressure drop) behind the fan is less than the atmospheric pressure outside of the vacuum. This creates suction, resulting in a partial vacuum inside the vacuum; hence where a vacuum gets its name

¹ Harris, Tom. (2001). [Online Image]. Retrieved March 11, 2015 from <http://home.howstuffworks.com/vacuum-cleaner.htm>

from. This pressure drop is also the reason why the outside air is pushed into the vacuum cleaner. An added effect of the air moving forward is that it cools the electric motor as it passes it. The dirt/air mixture eventually travels to the back of the vacuum, into the dirt bag. The combination of the filter and dirt bag separates the dirt from the clean air, trapping the dirt in the bag. The clean air finally exits through the exhaust port and back into the atmosphere. A constant stream of air will move through the intake port and out the exhaust port as long as the fan is running and the passageway is clear.

Bagless Vacuum Cleaners

Today, the most common vacuum found in homes is bagless. Replacing the bags in vacuums are detachable plastic bins that are designed to be easy to empty and maintain unlike porous bags. Since a plastic container won't help separate the dirt from the air like a bag would, better filters are needed.

Internal Components of Bagless Vacuums

Referring to the image² below, the major components of a bagless vacuum consist of:

- 1) Intake port
- 2) Dirt collecting bin
- 3) High-efficiency particulate arrestance (HEPA) filter
 - A HEPA is an air filter that satisfies specific standards of efficiency set by the United States Department of Energy. To qualify as HEPA, the air filter needs to remove 99.97% of particles that have a size of $0.3\mu\text{m}$.
- 4) Electric motor unit
- 5) Exhaust port

This is where the dirt collecting bin and HEPA filter housing is inserted



² Woodford, Chris. (2014) [Online Image]. Retrieved March 11, 2015 from <http://www.explainthatstuff.com/vacuumcleaner.html>

How Bagless Vacuums Work

The way a bagless vacuum works is fundamentally the same as a bagged vacuum in the sense that a pressure drop still occurs behind the fan, causing suction (fan still runs on the motor). The yellow arrow in the image above shows the path through the vacuum. The differences between how a bagless and a bagged vacuum work is that the bagless utilizes a dirt collecting bin and a HEPA filter. Once the air containing the dirt has travelled through the intake port and into the collecting bin, the HEPA filter separates the dirt, leaves it behind in the bin, and allows clean air to pass through. This clean air finally passes out through the exhaust port, back into the atmosphere. Since bagless vacuums utilize this HEPA filter, more of the power from the motor is used to pull air through the filter, which may cause it to clog more frequently than a bagged vacuum.

Cyclonic Bagless Vacuum Cleaners

The first compact, household cyclonic vacuum was invented by James Dyson of Dyson. Dyson created this vacuum because the longer you use a bag, the more it fills up and the more likely issues will occur. As a bag fills up, the amount of empty air it can hold decreases, so its ability to suck dirt gradually weakens. Cyclonic vacuums tend to function better than both bagged and bagless vacuums, however they cost significantly more.

Components of a Cyclonic Vacuum

The major components, seen in the image to the right³, include:

- 1) Rotating brush and air intake
- 2) Height adjustment
 - This allows you to adjust the brush height for various types of surfaces
- 3) Electric motor and fan
- 4) Dust collection bin
- 5) Cyclone
 - A cyclone is a cone-shaped piece of plastic with small holes at the top that causes the air to experience a centrifugal force.
- 6) Air hose



How Cyclonic Vacuums Work

Again, the way a cyclonic vacuum works is fundamentally the same as the vacuum, utilizing a pressure drop behind the fan to create suction. The vacuum sends the air stream containing the dirt via the electric motor and fan through the inside along a high-speed spiral path due to the cyclone. As the air stream shoots around, the dirt experiences a centrifugal force, causing it to be whipped outward, away from the air

³ Woodford, Chris. (2014) [Online Image]. Retrieved March 11, 2015 from <http://www.explainthatstuff.com/vacuumcleaner.html>

stream. This means the dirt is extracted from the air without using any sort of filter. All of the dirt simply collects at the bottom of the vacuum in the collection bin as the clean air passes out through the air hose.

Conclusion

In the end, there are various types of vacuums that a consumer can purchase for their household. Since the bagless vacuum has begun to replace the bagged vacuum completely, and cyclonic vacuums are becoming more popular, consumers have much to consider. Even though all of these types fundamentally function the same way, there are differences that will cause a consumer to lean towards one vacuum or another.