

*The Design  
Of a  
Vacuum Cleaner:  
Five Easy Components*



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TECHNICAL DESCRIPTION

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# INTRODUCTION

A handheld vacuum is a convenient household item that can be used to pick up a variety of particles such as dust, dirt or other small objects. The text will break down the components of a vacuum and describe how each part contributes to the overall purpose of a vacuum. Students with a background in a technical field will be able to understand the language used in the text. This report should teach an intrigued user how a vacuum works by its five major components:

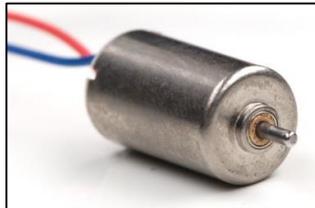
Trigger



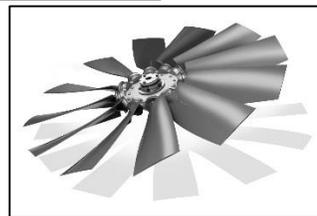
Battery



Motor



Fan

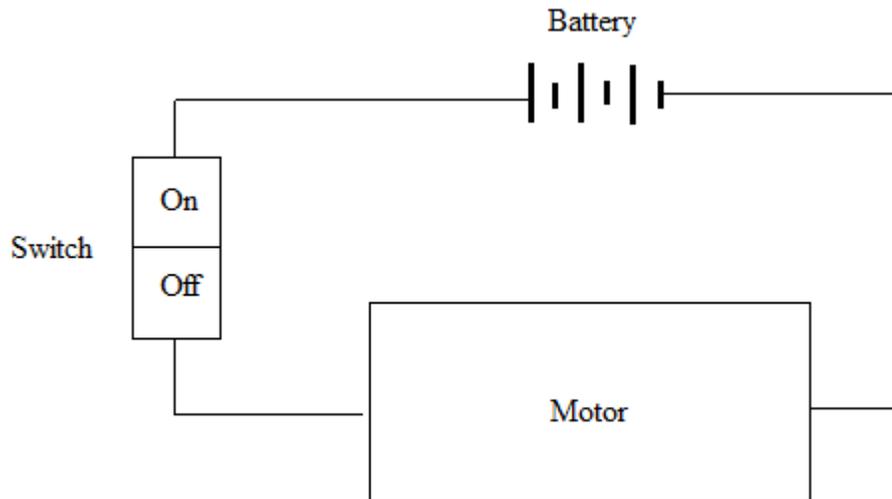


Filter



## TRIGGERING THE CIRCUIT

In order for the vacuum to be operational, there must be a trigger to turn it on. Usually located at a convenient location for the user, the switch closes a circuit at the source of power. The housing of the vacuum includes many wires linking the switch to the source of power and the motor. The entire circuit can be seen in Figure 1.



*Figure 1: Typical electrical circuit inside the vacuum*

When the “On” button is pressed, the small conductors inside the switch will connect and the circuit will be completed. A complete circuit will power the motor and ultimately cause suction into the vacuum. The “Off” button breaks the circuit. When pressed, the conductors inside the switch will no longer be in contact. Thus, the motor is no longer powered by the battery and stops the suction into the vacuum.



*Figure 2: On/Off switch used in vacuums*

## POWERING THE MOTOR

Another important component of the circuit is the rechargeable battery. The power in the battery limits the amount of suction capable by the vacuum. Most handheld vacuums use battery packs of about 12 volts. The battery pack is usually detachable from the vacuum and is able to be recharged for further use. A rechargeable battery has a limited life for each use of the vacuum. Most handheld vacuums can create powerful suction for about 20 minutes.

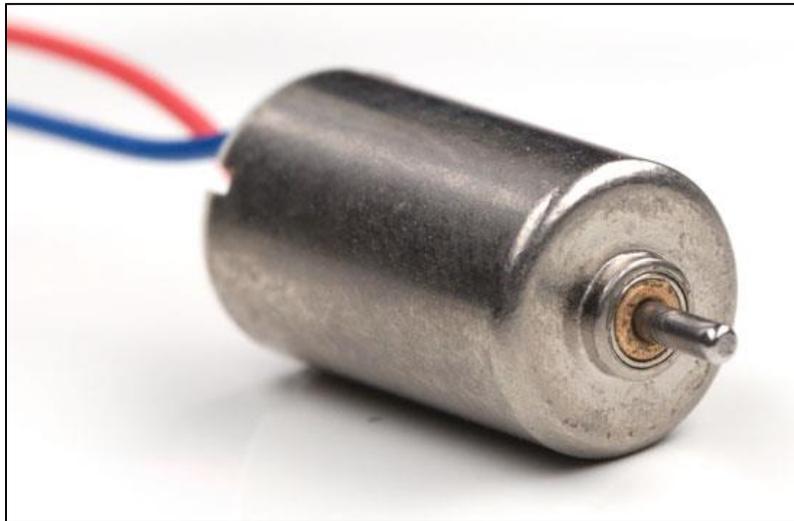


*Figure 3: Inside of a 12V battery pack*

The 12 volt battery, in Figure 3, uses thin slabs of metal to create a connection between consecutive battery pods. The pods is what is inside the battery pack. Connecting wires will link the battery pack to circuit shown in Figure 1. The purpose of the battery is to power a motor inside the vacuum housing. Ultimately, the battery is the source of power that the vacuum needs in order to create suction.

## ROTATING THE FAN

The last component in the electrical circuit is the motor. The motor requires the switch and the battery to work in order to be functional. An aluminum shaft is connected axially to the inside of the motor. In Figure 4, the red and blue wire would connect the motor to the circuit. When the circuit is completed, the motor will function and the axial shaft will rotate.

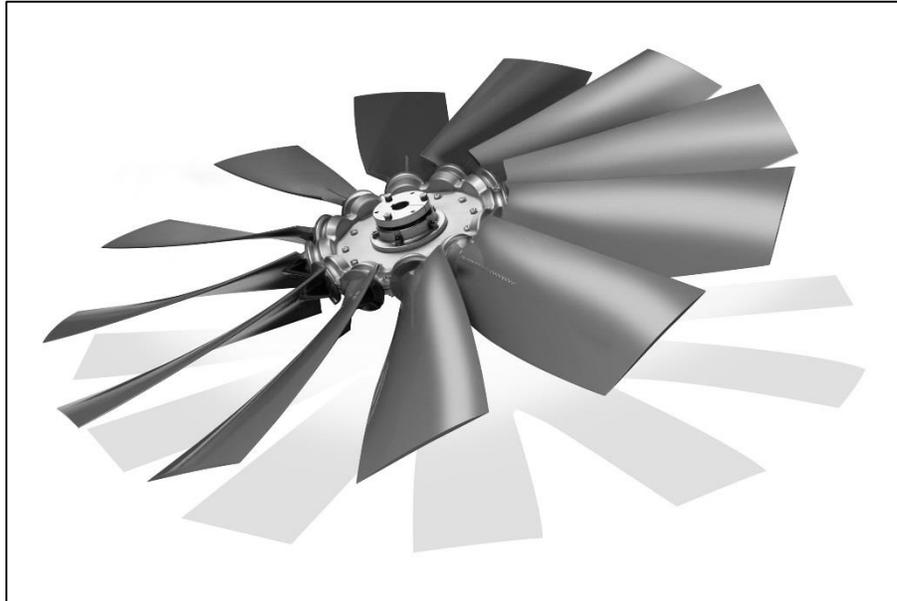


*Figure 4: Electric motor that turns the axial shaft*

The motor is essential to the suction of the vacuum. A fan that creates the suction is connected to the axial shaft. Therefore, the faster the shaft rotates, the more suction the vacuum will create. The motor must be properly lubricated to reduce friction between the shaft and the housing of the motor. The motor is the link between the electrical circuit and the fan that creates the vacuum's suction.

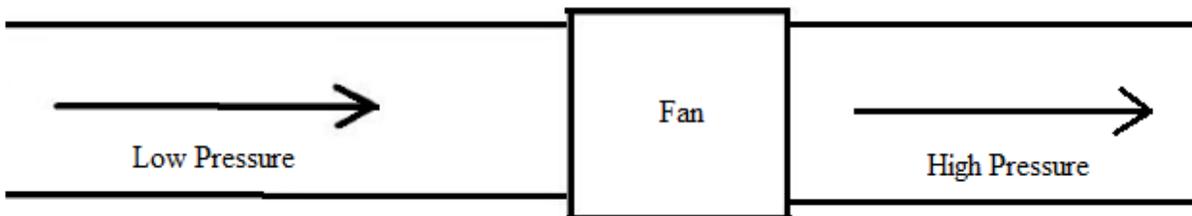
## STIMULATING AIR FLOW

An axial fan is used in vacuums to create suction. As seen in Figure 5, an axial fan has precise angles to optimize the amount of air it can displace.



*Figure 5: Axial fan creates pressure difference*

The fan has an opening in the center of the blades. This opening is used to be press fitted onto the axial shaft of the motor. The press fit creates a strong and tight connection so that the assembly is rigid. The axial fan displaces air similar to ceiling fans or stand up fans. The fan creates a pressure difference. In Figure 6, the air in front of the fan is at a low pressure and the air behind the fan is at a higher pressure.



*Figure 6: Pressure Difference causes air to flow from left to right*

The difference in pressure causes air to flow from low pressure to high pressure. The air will flow in through the nozzle of the vacuum, pass through the fan and out through an air outtake vent. Before the air passes through the fan, a filter must catch particles of dirt in order to prevent damaging the fan.

## CATCHING THE PARTICLES

The bag filter inside the vacuum housing is where dirt particles and other objects get stored until they are discarded by the user. The filter is important in catching objects before they reach the fan or motor. Dirt and dust can ruin the effectiveness of the vacuum by causing friction in the motor or damaging the fan blades. Also, it is easier for the user to discard the vacuumed objects when they are placed in a single filter bag.



*Figure 7: Filter bag catches vacuumed objects*

In Figure 7, the filter bag has a mesh lining to let air flow through easily but stops dust and dirt. The filter is easily detached from the vacuum and can be emptied. When the vacuum picks up too many items, the filter fills up the vacuum housing. This will make it difficult for air to flow through the vacuum housing and diminishes the effectiveness of the vacuum.

## CONCLUSION

A vacuum is a simple device to understand when broken down into its five components:

1. A switch closes a circuit to the battery pack and motor to cause a flow of electricity
2. A rechargeable battery pack powers a small motor inside the housing
3. The motor turns an aluminum shaft, which is connected to an axial fan
4. An axial fan creates a pressure difference, which pulls air through the vacuum
5. Air flows through a filter where vacuumed objects get trapped and stored in the bag

The process is repeated every time the switch is pressed on. Each component in the vacuum is a simple replaceable part. A vacuum is a useful household item that can clean up a variety of particles such as dust, dirt and other small objects.

## REFERENCES

Cover Photo:

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Figure 2:

“On/Off Switch”, Retrieved on March 19, 2015 from: <http://epilepsyu.com>

Figure 3:

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Figure 5:

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\*Figures 1 and 6 were created using the Microsoft software program, Paint