How the Dyson Bladeless Fan Works

In October 2009, James Dyson's consumer electronics company, famous for its line of vacuum cleaners, introduced a new device to the market called the Dyson Air Multiplier. The Air Multiplier is a fan with an unusual characteristic: It doesn't have any visible blades. It appears to be a circular tube mounted on a pedestal. The shallow tube is only a few inches deep.

Looking at the device, you wouldn't expect to feel a breeze coming from the mounted circle. There are no moving parts in sight. But if the fan is switched on, you'll feel air blowing through the tube. How does it work? How can an open circle push air into a breeze without fan blades?

As you might imagine, there are a few scientific principles at play here. There's also an electronic element. While the tube doesn't have any blades inside it, the pedestal of the fan contains a brushless electric motor that takes in air and feeds it into the circular tube. Air flows along the inside of the device until it reaches a slit inside the tube. This provides the basic airflow that creates the breeze you'd feel if you stood in front of the fan.

According to Dyson, the breeze generated by the Air Multiplier is more consistent and steady than one from a standard fan with blades. Since there are no rotating blades, the breeze from the fan doesn't buffet you with short gusts of air.

What's the secret behind the technology?

The Mechanics of the Air Multiplier

Calling the Dyson Air Multiplier a fan with no blades is perhaps a touch misleading. There are blades in the fan -- you just can't see them because they're hidden in the pedestal. A motor rotates nine asymmetrically aligned blades to pull air into the device. According to Dyson, these blades can pull in up to 5.28 gallons (about 20 liters) of air per second.

The air flows through a channel in the pedestal up to the tube, which is hollow. The interior of the tube acts like a ramp. Air flows along the ramp, which curves around and ends in slits in the back of the fan. Then, the air flows along the surface of the inside of the tube and out toward the front of the fan. But how does the fan multiply the amount of air coming into the pedestal of the device?

It boils down to physics. While it's true that the atmosphere is gaseous, gases obey the physical laws of fluid dynamics. As air flows through the slits in the tube and out through the front of the fan, air behind the fan is drawn through the tube as well. This is called **inducement**. The flowing air pushed by the motor induces the air behind the fan to follow.

Air surrounding the edges of the fan will also begin to flow in the direction of the breeze. This process is called **entrainment**. Through inducement and entrainment, Dyson claims the Air Multiplier increases the output of airflow by 15 times the amount it takes in through the pedestal's motor.

Yet there's one problem that Dyson didn't quite overcome with its newfangled fan. On the next page you'll see why Dyson changed the design of its Multiplier when it came time to make a second version.

Multiplying Air, Reducing Noise

In spite of its luxurious looks and cutting-edge concept, the Dyson fan did have one notable flaw. It wasn't really very quiet. Dyson took note, and decided to revamp the second generation of its Multiplier.

Doing so required a steep investment by the company. Dyson dumped more than $60 million into research and assigned 65 engineers to the project. Together, they created 640 prototypes and filed hundreds of patents, tweaking each design a little more, to investigate the movement of air inside their funky fan.

As you can imagine, part of the noise problem originated from turbulence. The Multiplier sucked air into its base, where it bounced around willy-nilly, creating chaos ... and noise. To pinpoint this noise, researchers placed the fan in a semi-anechoic (soundproof) chamber with 10 microphones listening for every whir and buzz.

Then they built translucent prototypes and passed ultraviolet paint and smoke through the device. High-speed cameras provided frame-by-frame playback, offering visual clues as to areas where air was bunching up and basically causing a ruckus.

Dyson's engineers addressed the turbulence problems by integrating Helmholtz cavities into the fan's base. If you've ever held a seashell to your ear or blown across the top of a glass bottle, you've experienced the effect of these cavities, in which sound bounces and skids across a hard surface.

It's fun to play games with these kinds of cavities. In the right hands, these spaces are also exceedingly useful. On the next page you'll find out why.

Helmholtz Cavities and the Art of Noise

Helmholtz cavities make noise, of course. Figure out exactly how these cavities work, and then you can control that noise. By adding Helmholtz cavities of sorts into the base of the Multiplier, engineers increased air pressure, and ultimately these cavities began to work as silencers.

Car manufacturers are very familiar with the principles of Helmholtz cavities. They manipulate them to their advantage when quieting exhaust systems. In the case of the Multiplier, engineers basically tuned the cavities to specifically mute sounds in the range of 1,000 Hertz, which humans tend to find especially aggravating.

Their efforts (and those heaping mountains of research cash) paid off. According to Dyson, the second-generation fan is 75 percent quieter than its ancestor. And because air moves more smoothly and efficiently through the entire Multiplier, Dyson was able to scale back on the motor. They say the new motor requires 40 percent less power.

For its quietness, the Noise Abatement Society awarded the Multiplier with a Quiet Mark award. The award goes to products that clamp down on unnecessary noise pollution.

Dyson is quite literally banking on its new, quieter fan. As with the first-generation version, the new ones are pricey. The smallest desk model starts at $300.

There's no question that the Dyson Air Multiplier is a striking invention. Its sleek design and innovative technology set the blogosphere abuzz when it launched. Perhaps in the future, none of our fans will have visible blades.

Author's Note: How the Dyson Bladeless Fan Works

I actually played with one of the first Multiplier fans when they first hit the tech scene. The design was inarguably eye-catching and sleek and modern. It really looked quieter. But it wasn't as quiet as many people hoped, making the updated and much quieter version inevitable. Now the fan has less turbulence, and thus less noise. Now, if only Dyson would price its fans at a point that they wouldn't cause so much noise in my checking account, maybe we'd be getting somewhere. - NC

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