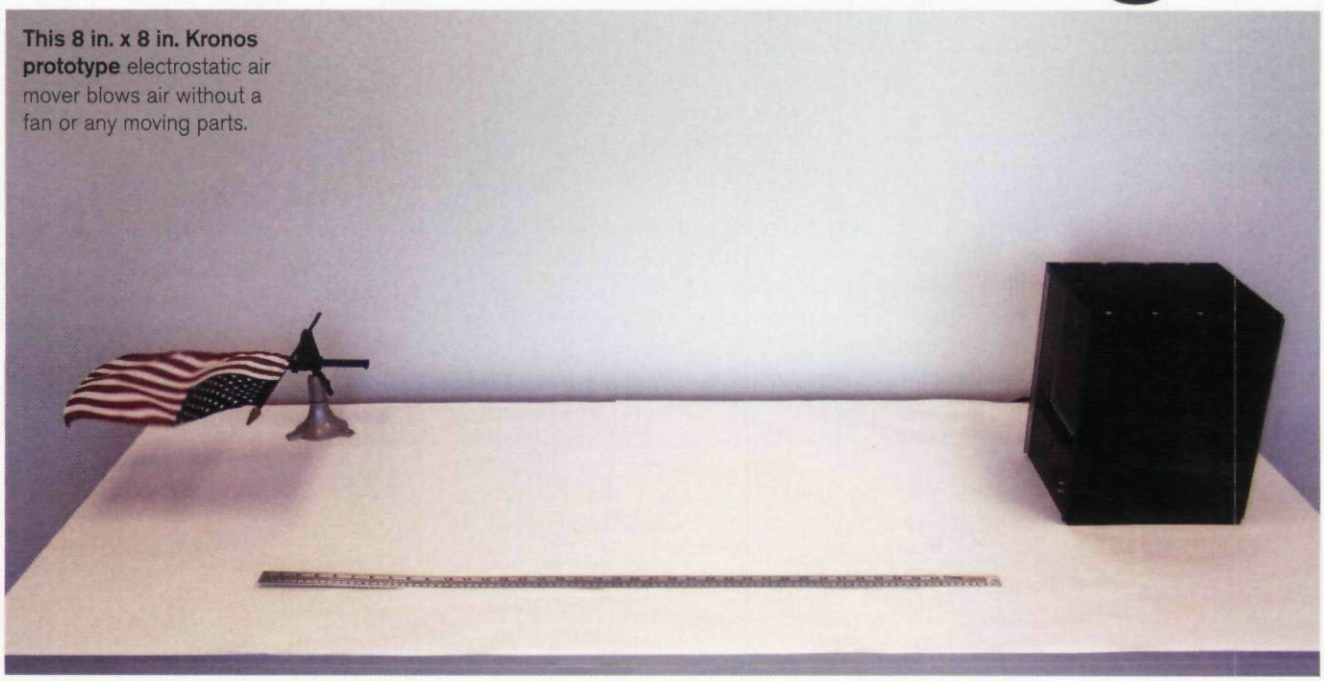
Moving Air, without Moving



This 8 in. x 8 in. Kronos prototype electrostatic air mover blows air without a fan or any moving parts.

Electrostatic air pumps to challenge traditional fans and blowers.

by richard babyak

The most innovative fan designs on the market today still share something in common with the large palm leaf fans waved around by the ancients — they all rely on moving a broad surface to beat the air into motion. Making a radical departure from that paradigm is a company called Kronos Advanced Technologies, Belmont, Mass., which has developed a technology that sets air into motion by shooting it with ions. In essence, the company has designed air movers with no moving parts.

The underlying physical principle — that ions moving through air will pull air molecules with them — is not new. In fact, it was first noted by the English scientist Francis Hauksbee in 1709. The novel achievement claimed by Kronos is that it has created a technique for significantly magnifying this effect, taking what was once little more than a scientific curiosity, and transforming it into a powerful functional tool.

The concept behind a Kronos electrostatic air mover is simple. The novel engineering lies in the implementation. The device consists of two oppositely charged electrodes, one of which generates ions by means of corona discharge.

A corona discharge occurs when a high voltage is run through a conductor whose shape, typically a point or narrow wire, ensures a high potential gradient. The discharge creates a plasma of ions around the emitting electrode. An ion is simply a charged particle, either positive or negative, depending on whether it has been given an electron or robbed of one. The charged particle then is attracted to another electrode with an opposite charge.

A number of devices already use corona discharge for practical purposes. For example, in a photocopier or laser printer, corona wires are used to impart a charge to both the drum and paper so that they will attract toner particles. Another example is a typical, industrial powder coating system, where a corona discharge spray gun imparts a charge to dry paint particles, which are then attracted to the workpiece possessing an opposite charge.

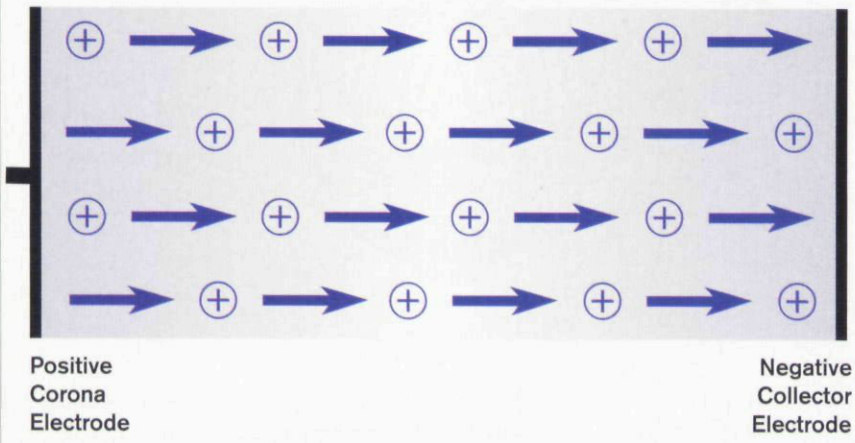


Fig. 1. In an electrostatic air mover, the corona discharge ionizes the air around the emitting electrode. As the ions stream across an open space to an oppositely charged collector electrode, they pull other air particles with them by means of electrostatic attraction, thus creating air movement.

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While the theory behind this phenomenon has been long known, the effect was historically deemed too weak to be of much utility from the standpoint of moving air. Kronos, however, says it has discovered how to crank up the volume of air flow by dramatically increasing the quantity and density of ions generated by the emitter electrode.

A Kronos device produces a high density of ions by using arrays of corona wire, charged with up to 15 kV or higher. The trick is to accomplish that without generating arcing between the wires. According to Daniel Dwight, president and CEO of Kronos, the secret lies in the combination of power management, materials used and configuration of the electrodes, which forms the basis for the company's patents.

Capabilities

Since air flow in a Kronos device is created by ionic flow instead of back pressure, the technology can precisely define airflow by controlling the intensity and geometry of the electric field between the electrodes.

Kronos has already built prototype air movers that can deliver up to 850 cfm at speeds up to 1,700 fpm, but Dwight says that theoretical modeling suggests the technology is capable of hitting up to 20,000 cfm.

He notes that the scalability is one of the things that makes the technology relevant to so many different applications, ranging from the on-chip cooling of a microprocessor up to air handlers for commercial buildings.

And the simplicity of a Kronos air mover offers the design engineer an enormous amount of design flexibility. Because the device consists of an emitter at one end, a collector grid at the other, and empty space between, it can be almost any shape or size. It can be rectangular, octagonal, round, or even curved. Dwight says it is also possible to design one that blows air out in all directions, creating the motionless equivalent of an oscillating fan. A Kronos device can be designed as either a standalone product, or as an embedded device.

Advantages

A Kronos electrostatic air mover can offer numerous advantages. The lack of any moving parts increases reliability while decreasing maintenance. No motor means no vibration and little noise. Dwight says a Kronos air mover produces less than 3 dB of noise, an imperceptible level.

Because there are no frictional losses, a Kronos air mover saves up to a tenth to a third the energy of a fan moving a comparable amount of air, depending on the application. For situations where the air mover is inside the space it cools, like a refrigerator or electronics cabinet, a Kronos device eliminates the additional thermal load that a fan motor would generate.

Uniformity of air flow is perhaps the most unique benefits derived from replacing a conventional fan with a Kronos air mover. This is because a fan can create turbulent air flow, and its motor obstructs air flow at the center. The graphs in ***Fig. 2*** and ***Fig. 3*** illustrate the difference.

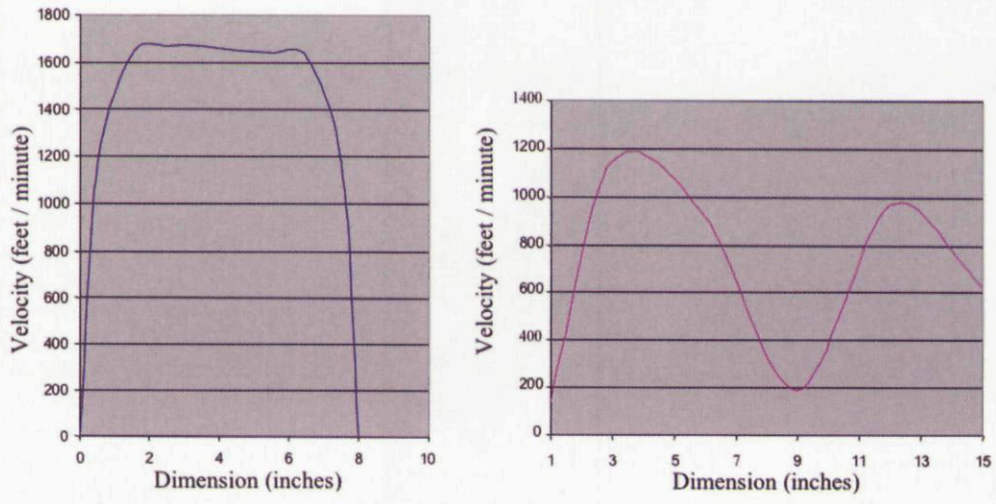

Fig. 2. Air profile cross section from a Kronos air mover (left) compared to one from a traditional fan (right). The valley on the right graph illustrates how a fan motor blocks air flow at the center.

Air quality

Kronos electrostatic air moving capabilities alone might be enough to snare the attention of many product designers, but for those concerned with indoor air quality, the Kronos technology offers the added benefit of inherent air filtration and purification properties.

Dwight says that a Kronos device removes 99.97 percent of particles that are 0.1 microns and 99.99 percent of 0.3 micron particles or bigger, a feat that exceeds a HEPA filter, only without any air obstruction or need for filter replacement. (Device was tested according to ASHRAE 52.2.)

In addition, the ion stream destroys microorganisms such as bacteria, viruses and mold spores, and breaks down volatile organic compounds. Dwight says that the technology destroys between 45 percent to 95 percent of the carcinogens found in cigarette smoke, which makes it attractive to the restaurant and hospitality industry. He says the technology can also kill pathogens, ranging from 95percent of anthrax spores to 100percent of Bacillus subtilis 168 (bacteria).

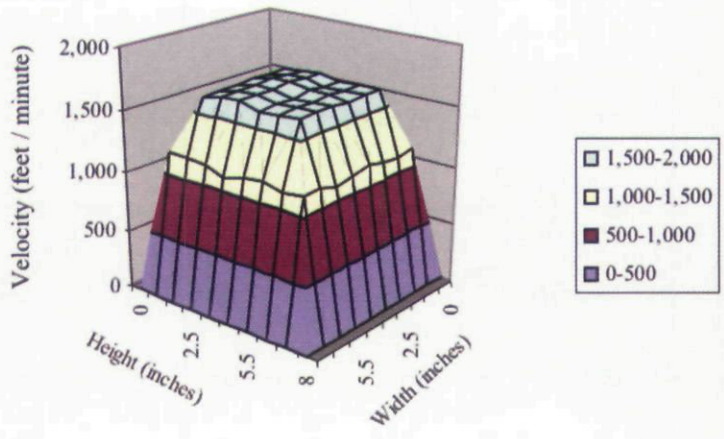

Fig. 3. Three-dimensional graph shows uniformity of air flow from a Kronos 8-in. x 8-in. air mover at different air speeds ranging up to 1,600 fpm.

Safety

In spite of the high voltage generated within a Kronos device, Dwight says the technology is inherently safe because it does not employ a build-up charging cycle, like many other high voltage devices.

"The voltage step-up is instantaneous and continuous. It is not storing a charge. If you were to stick a screwdriver in it, the corona field would sense the intrusion and immediately shut down without harm," Dwight says.

He also notes that the Kronos design manages to limit the generation of ozone, which is typically a by-product of a corona discharge process. He says the Kronos products are designed to produce less than 50 ppb of ozone, regardless of room size, easily meeting the specifications of both FDA and UL standards.

Kronos products have also been designed to meet FCC standards for EMI emissions.

Applications

The business model for Kronos is to design and develop specific applications, then license the technology to strategic partners. Dwight says there are numerous projects in progress, but most must be kept confidential due to non-disclosure agreements.

However, there are a few that can be discussed. One is a project for the U.S. Navy to develop square 8 in. x 8 in. air movers to fit perfectly into the square air ducts used to move air along the length of a ship. (See the photo.)

Another application in the works is the development of fan-less air purifiers for HoMedics, consumer products that will be sold in retail stores. That project has already moved beyond the prototype stage and is now in the testing and pre-production phase.

Kronos envisions that improving the indoor air quality of commercial building may represent one of its biggest opportunities.

"Eighty-five percent of buildings in the U.S. today lack air filtration," Dwight says. "With all the concern over security and diseases like SARS, the building owners would love to put in HEPA filters, but the resulting restriction on air flow would force them to replace all their air handling equipment to compensate. With a Kronos product, we not only don't restrict air flow, we improve air flow, taking some of the load off the air handlers. So we could provide them with HEPA-level filtration while simultaneously reducing their energy costs. So that's a huge, unserved market for us to pursue." ■

For more information, enter **314.**