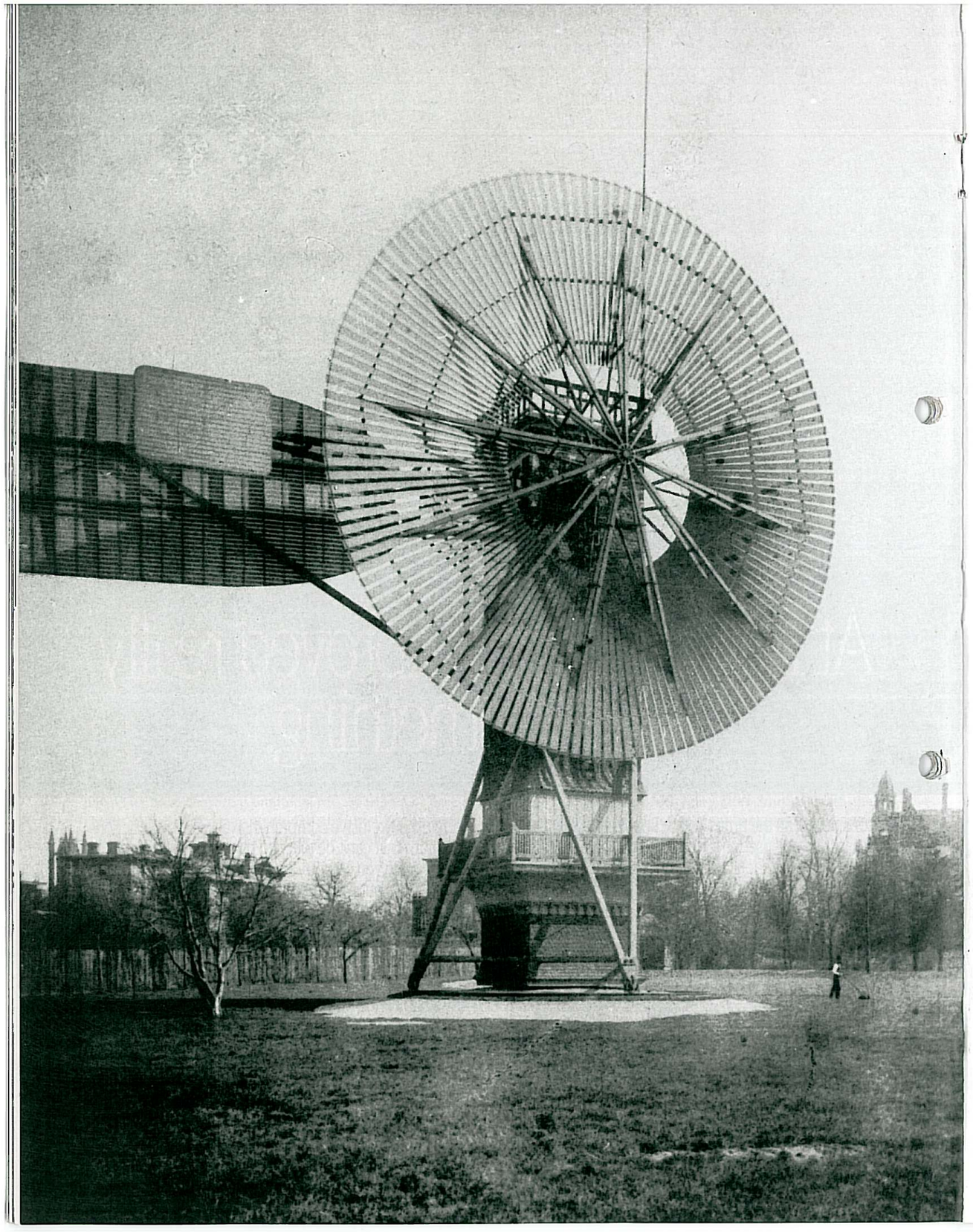
A FEW WORDS ABOUT THIS PICTURE

A wind-fueled electric power plant in the back yard, 1888

by Robert W. Righter



Brush's windmill towers over the neighborhood in 1889. For two decades it supplied electricity to his Cleveland mansion. The building is sixty feet high; the blades reach another twenty feet into the sky.

ALL: WESTERN RESERVE HISTORICAL SOCIETY, CLEVELAND, OHIO

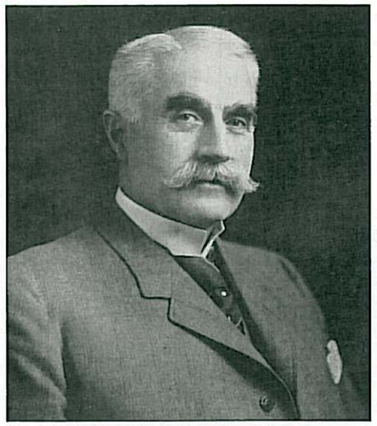
When this mammoth wind machine was unveiled in Cleveland in 1888, it surely inspired awe or admiration from passersby along the city's fashionable Euclid Avenue. At the time there was nothing like it in the world. It did not pump water or grind grain; it generated electricity, in the backyard of the inventor and scientist Charles Brush.

When Brush's "wind dynamo" first turned to the fresh breezes coming off Lake Erie, it was exploiting an ancient energy source. Wind had been used to drive vessels for thousands of years and windmills had been introduced in the blustery Seistan region of Persia by the tenth century at the latest. The familiar mill had been developed in England in the twelfth century and along with the water wheel had become a primary power source for six hundred years. But the idea of creating electricity from wind had originated only in the 1860s. Sometime during that decade the British physicist and electrical researcher Sir William Thomson (later Lord Kelvin) proposed the concept, while across the Atlantic the American Moses Farmer patented a device that would convert wind power to electricity. These men were somewhat ahead of their time and got nowhere with their ideas, for they had no means of storing electrical energy.

Around the same time, a young Charles Brush was toying with similar concepts. From his boyhood Brush had been fascinated by energy sources. Graduating first in his class from Cleveland High School, the fledgling scientist had delivered a valedictory called "The Conservation of Force," tracing the course of solar energy through vegetation to coal, steam, electric current, and finally light. His classmates may have found the speech less than enthralling, but the topic continued to intrigue Brush.

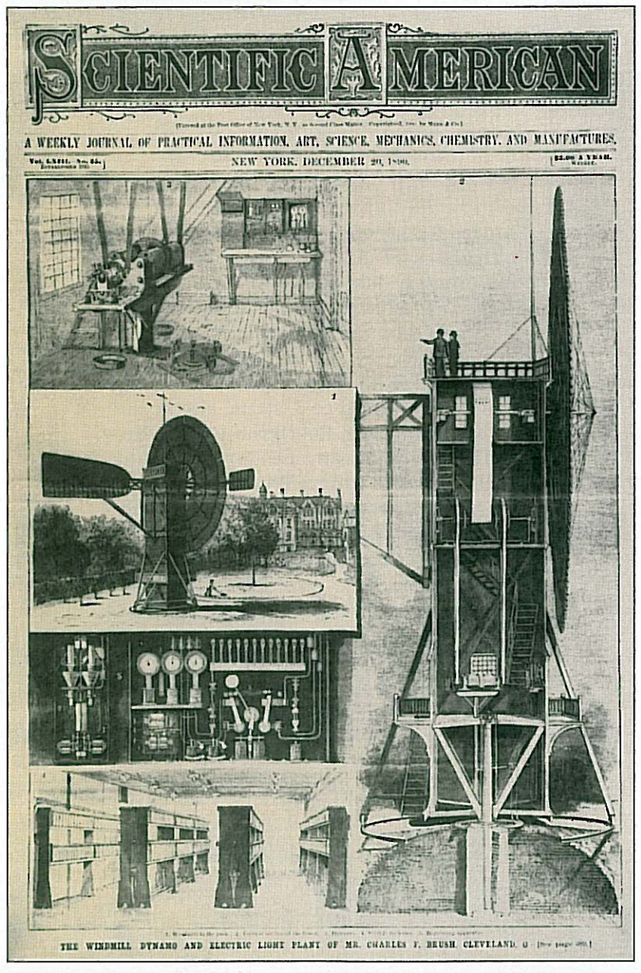
He breezed through the University of Michigan, receiving a degree in mining engineering. Turning to invention, he developed an improved electric dynamo. By 1879 he had combined this with his Brush arc light. A demonstration of his lighting system in downtown Cleveland caused such a sensation that Brush had trouble keeping up with the subsequent orders. By the close of 1880 some six thousand arc lights were illuminating previously dark cities across the country.

As a result Brush became a very wealthy man. With his newly acquired assets he built a mansion on Euclid Avenue with a state-of-the-art laboratory in the basement. The inventor became a local celebrity, participating in municipal affairs, dabbling in real estate, and maintaining an office in the Cleveland Arcade shopping center. Yet he was a scientist first, and he was happiest in the wee hours of the morning when he was deep in



The electrical pioneer Charles Brush in 1910, at the age of sixty-one.

A magazine cover shows, clockwise from bottom left: the bank of storage batteries; the apparatus that regulated voltage; the mill from outside; the wind-driven dynamo; and the tower in cross-section.


SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

NEW YORK, DECEMBER 20, 1890.

THE WINDMILL DYNAMO AND ELECTRIC LIGHT PLANT OF MR. CHARLES F. BRUSH, CLEVELAND, O.

thought or experiment.

Early in the 1880s *Scientific American* challenged its readers to solve the energy storage problem, writing that "it seems incomprehensible that such a ready and potent agent [as the wind] should escape practical use so completely." Readers responded with such suggestions as compressed air, electric batteries, and the lifting and lowering of weights by complex gear systems. One enthusiast suggested giant springs that could be forced down by wind wheels and then "drive the machinery by their recoil." The magazine allowed that such a plan might work but that "it will be wise for [its operator] to be cautious in its management," because it would be a "fearfully dangerous instrument."

Charles Brush put his faith in storage batteries. To harness his windmill's energy output, he placed 12 large batteries, containing 34 cells each, in his basement. More than 400 cells may sound excessive, but Brush planned to install 350 incandescent lights in his mansion and two arc lights and several electric motors in his laboratory.

The wind machine he designed to power it all would require a sixty-foot tower weighing forty tons and a rotor of 144 blades eighty feet high at the top. Within the tower a complicated system of gears and belts produced a fifty-to-one ratio between the rotor and the dynamo, allowing the slow-turning rotor to spin a generator's armature. Special switching devices and safeguards prevented the machine from spinning out of control, and an automatic regulator prevented its output from exceeding ninety volts at any speed. An admiring *Scientific American* reporter stated that "every contingency is provided for, and the apparatus, from the huge wheel down to the current regulator, is entirely automatic."

The general design followed that of a traditional English windmill. A sturdy fourteen-inch wrought-iron gudgeon—or metal pivot—was sunk eight feet into solid masonry. On it sat the iron frame of the eighty-thousand-pound tower. To support the tower during heavy winds, arms hung down and outward in a V configuration at each corner, pointing toward a circular track. At the end of each point was affixed a caster that, under normal circumstances, came close to but did not touch the track; when the wind quickened, the caster would make contact with the rail to relieve the gudgeon of further pressure and possible damage. The ingenious system yielded a supply of electrical power for Brush's home second in the nation only to that generated for J. P. Morgan's New York mansion.

Brush never patented his wind dynamo. According to his friend Charles Baldwin Sawyer, he hoped it would be "useful throughout the world," but presumably Brush was referring to the *concept* of wind energy rather than to his elaborate machine; he knew the cost of such a behemoth would prohibit its widespread use. *Scientific American* correctly warned its readers that they "must not suppose that electric lighting by means of power supplied in this way is cheap because the wind costs nothing. On the contrary, the cost of the plant is so great as to more than offset the cheapness of the motive power."

It was sound advice, for even today wind-generated electrical power is a difficult technology. Still, judging from the scant evidence available, Brush's machine performed without serious problems at least until 1900, when the inventor decided to draw much of his electricity from the newly installed Cleveland central power system. In 1908 he finally stopped using the generator.

Altogether, Brush had relied primarily on his extraordinary machine for some twelve years. Considering the challenges posed by an inconstant primary source of energy, it was an incredible accomplishment. Why was he so successful? First, he understood electricity as well as any American. Second, his design was sound. Third, he was constantly on site, and irregularities in performance could be nipped in the bud.

After Brush retired his machine in 1908, it fell into disrepair. The belt rotted, the blades of the wheel deteriorated, and the tower buckled and sagged. By the time he died in 1929, only the tower and some skeletal apparatus remained.

Shortly before his death Brush got a call from James Bishop, curator of Henry Ford's museum in Dearborn, Michigan. Bishop wanted to acquire the old windmill, remove it, and reconstruct it in Dearborn. Brush evidently had no objection; indeed, he might well have been flattered that someone cared about the long-neglected machine. However, after Brush's death his fellow Clevelanders protested the arrangement. To them the removal of the windmill would represent the loss of a historic landmark, and its consignment to a museum largely devoted to Thomas Edison's inventions would relegate Brush to secondary status. A Brush Memorial Committee was formed to retain and restore the wind dynamo in Cleveland, and after some terse correspondence Bishop agreed to abandon his project.

The committee, left with the considerable task of raising money for reconstruction and maintenance of the machine on the Case School of Applied Science campus, was full of good intentions but failed. The Depression and the relative obscurity of wind energy combined to defeat their best fund-raising efforts. Ultimately, in November 1931 the group consented to have the tower lowered to the ground, boxed, and stored in a nearby warehouse. The mill remained in that ignoble state until the 1950s, when an efficient young executive of the Clevite Company, looking for warehouse space, ordered the apparatus removed to a dump. That was the end of the world's first electric wind machine.

As the nation today faces fuel shortages and inexorably moves toward a post-petroleum world, Brush's old invention may serve not only as a historical curiosity but also as an example. Someday our oil may be gone, but the nonpolluting, renewable wind will remain as long as man lives on earth. ★

Only J.P. Morgan's mansion in New York had more electricity than Brush got from his windmill.

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By 1925 a portion of the tower was all that remained standing.