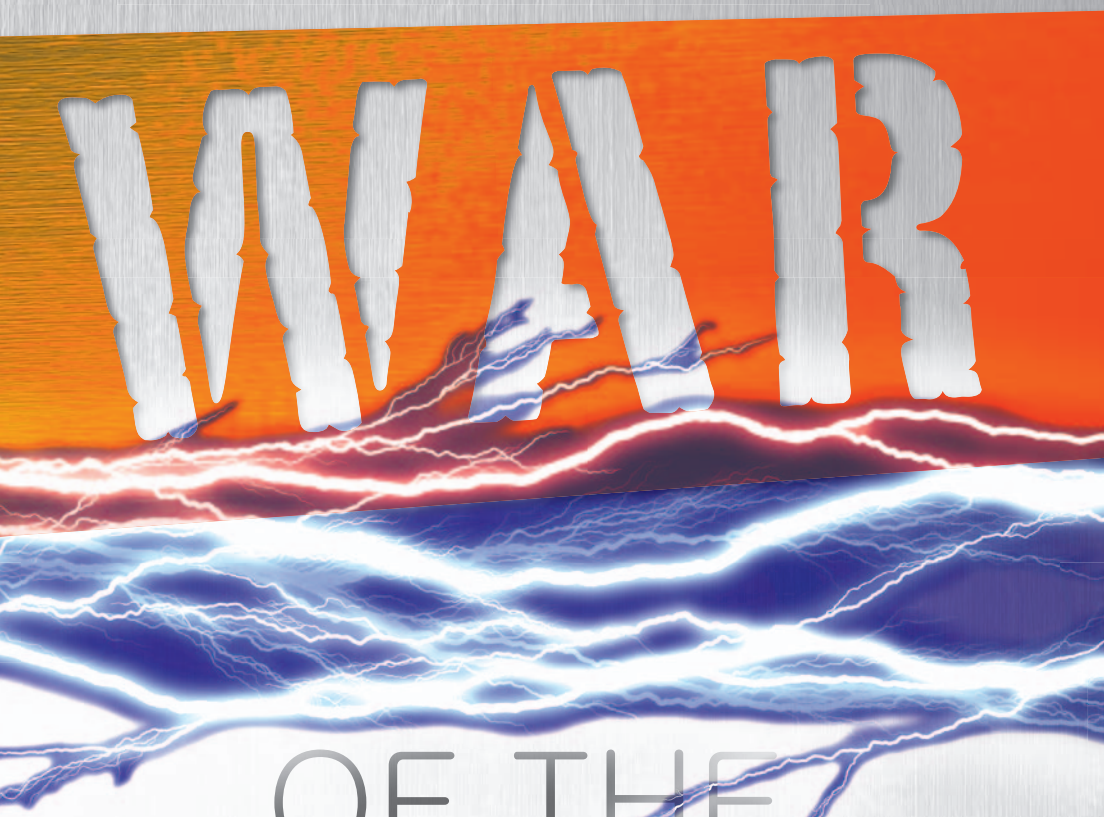


SCIENTIFIC RIVALRIES
AND SCANDALS



WAR

OF THE CURRENTS

THOMAS EDISON
VS NIKOLA TESLA

STEPHANIE SAMMARTINO
McPHERSON

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STEPHANIE SAMMARTINO MCPHERSON



Twenty-First Century Books
Minneapolis

To my husband, Dick

Thanks to Peg Goldstein for her insightful comments and editing, Steve Shegedin for helping with technical details, and Richard McPherson for his unfailing support and encouragement

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CONTENTS

INTRODUCTION

LIGHTING THE WHITE CITY. . . . 4

CHAPTER 1

THOMAS EDISON: DC CHAMPION. . . . 8

CHAPTER 2

NIKOLA TESLA: THE CHALLENGE OF AC. . . . 16

CHAPTER 3

ENTER GEORGE WESTINGHOUSE. . . . 26

CHAPTER 4

RIVALRY BECOMES WAR. . . . 32

CHAPTER 5

WATER AND LIGHT. . . . 44

EPILOGUE

AC AND DC IN A CHANGING WORLD. . . . 52

TIMELINE. 58

GLOSSARY. 59

SOURCE NOTES 60

SELECTED BIBLIOGRAPHY 61

FURTHER INFORMATION. 62

INDEX 63

INTRODUCTION

LIGHTING

THE WHITE CITY

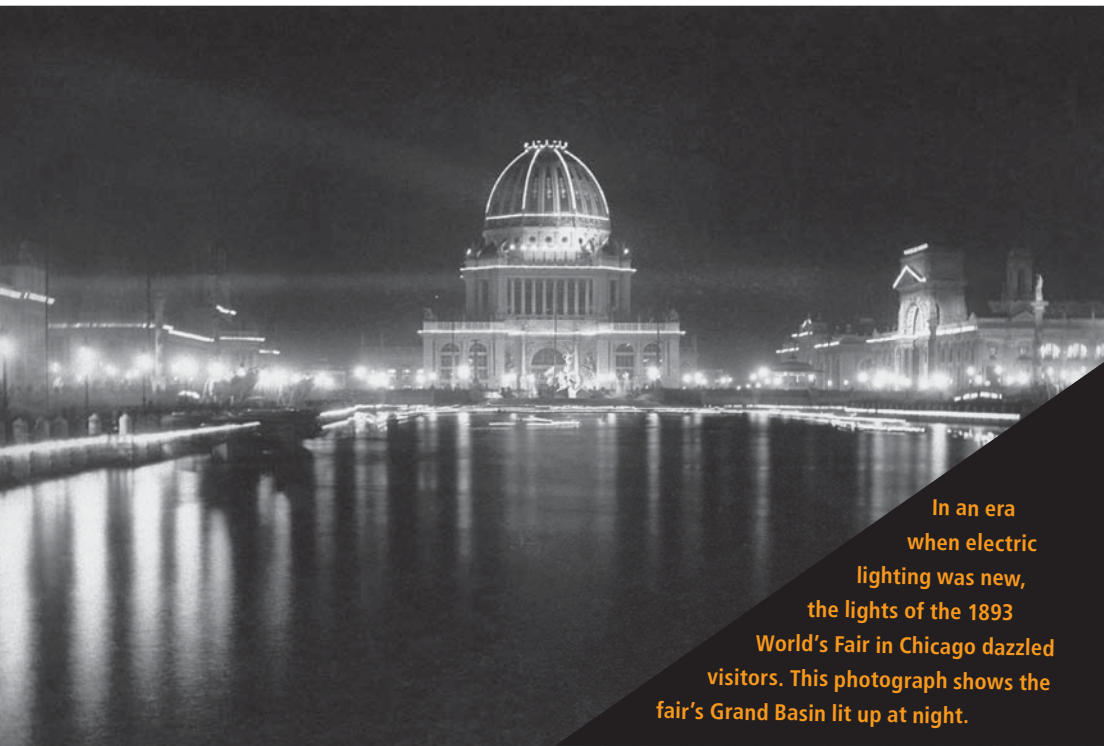
No one who witnessed the opening of the Chicago World's Fair in 1893 would ever forget the dazzle. Dubbed the White City for its abundance of white architecture, the fair marked the four-hundredth anniversary of Christopher Columbus's arrival in the Americas.

But the hundred thousand people who mobbed the fair's Court of Honor on May 1 were thinking more of the future than of the past. While a choir began a lively performance of George Frideric Handel's "Hallelujah Chorus," President Grover Cleveland flicked a switch that sent vast electricity-driven

machines into motion. Suddenly, water gushed forth from three enormous fountains, boats rang their bells, and a cannon boomed. Fairgoers exclaimed in wonder.

By night, the fair provided an even greater spectacle. Everywhere, electric lights gleamed brightly—thousands and thousands of them. Even the fair’s giant Ferris wheel glittered with three thousand bulbs. In a world where electricity was new—where many people still read by the light of gas or oil lamps and walked down pitch-black streets after dark—the sight was astounding.

“Having seen nothing but kerosene lamps for illumination, this was like getting a sudden vision of Heaven,” recalled one newly arrived immigrant from Poland. Author Hamlin Garland captured the wonder when he urged his parents, “Sell the cookstove if necessary and come. You must see the fair.”



In an era when electric lighting was new, the lights of the 1893 World’s Fair in Chicago dazzled visitors. This photograph shows the fair’s Grand Basin lit up at night.

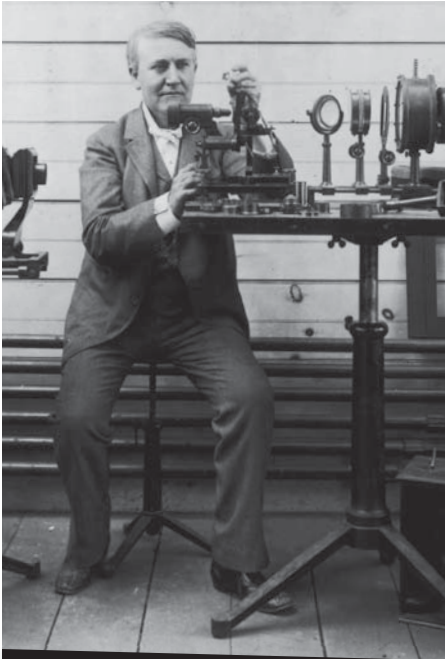
A BITTER RIVALRY

Behind the glamour, however, and the promise of future electrical marvels, seethed a bitter dispute on the best way to distribute electricity. In some ways, the fair was the climax of that fiercely waged conflict. Fairgoers had only to visit the White City's Electricity Building to see the lines of rivalry clearly established. Facing each other at opposite ends of the vast hall, two companies, General Electric and Westinghouse Electric, vied for attention.

General Electric was a successor to the Edison Electric Light Company, founded in 1878 by U.S. inventor Thomas Edison. In the Electricity Building, people could hardly miss General Electric's display. It featured an immense lightbulb crowning an 80-foot (25-meter) tower. Five thousand sparkling pieces of glass attached to the bulb reflected its light in rainbow hues. The General Electric exhibit opened to a stirring march by composer John Philip Sousa's band while the tower was transformed into a breathtaking light show. According to the *Chicago Daily Tribune*, "Electricity danced up and down and all about [the tower] in time with the rhythm of the music." The delighted crowd broke into a spontaneous tribute to the man who had invented the first successful lightbulb. "Edison! Edison! Edison!" the people roared.

Although the Westinghouse exhibit lacked such showmanship, Westinghouse carried more weight behind the scenes. The Westinghouse Company, founded by inventor George Westinghouse, supplied the electrical equipment that powered the lights and machinery at the fair. After a long dispute with Thomas Edison about the best way to distribute electricity, Westinghouse had won the contract to power the fair.

The Westinghouse Company favored a distribution system called alternating current (or AC). Alternating current reverses direction as it travels along wires from a power plant to its destination. It moves forward and backward along the wiring many times in a second. Thomas Edison was a critic of alternating current. He said it posed too many dangers of electrical shock. Edison backed a system called direct current (or DC). In this method of delivering electricity, current travels in a straight line along electrical power lines.



Thomas Alva Edison (*left*) and Nikola Tesla (*right*) competed fiercely over the distribution of electricity via alternating current (AC) or direct current (DC). Edison supported DC, while Tesla supported AC.

For many years, Thomas Edison did whatever he could to damage the reputation of alternating current. Meanwhile, George Westinghouse, working with inventor Nikola Tesla, argued that AC was not only safe but was also superior to direct current. By the time of the world's fair, the conflict had pretty much played itself out. But in the years leading up to 1893, competition between backers of the two systems was fierce—so fierce, in fact, that historians call it the War of the Currents.

CHAPTER 1

THOMAS EDISON:

DC CHAMPION

Before the invention of electric lighting, people spent much of their lives in semidarkness. When the sun went down, people lit their homes with candles and with lamps fueled by oil or kerosene.

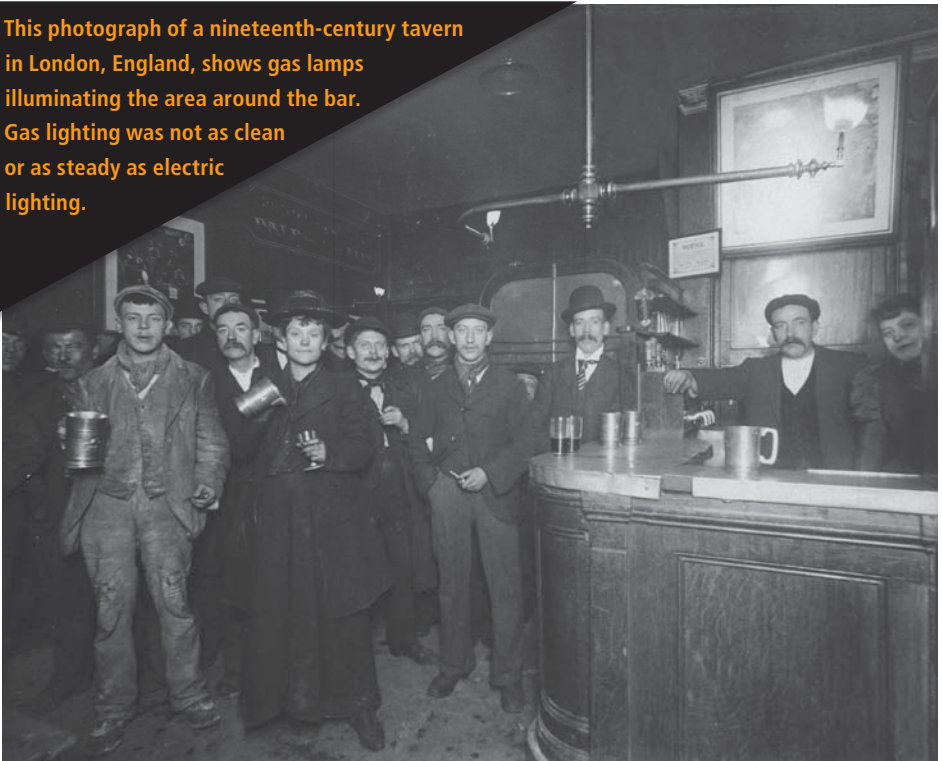
Light from lamps and candles was dim, unsteady, and not well suited for reading or other close work. Nevertheless, people mended tools, wrote letters, studied, and sewed clothing by the flickering light after dark.

Lamps and candles gave off soot and smoke as they burned. Lamps had to be carefully tended and cleaned often. And if someone knocked over a candle or lamp by accident, it could easily start a fire. Each year, thousands of people died in fires involving kerosene or oil lamps.

A step up from oil and kerosene lamps was gas lighting. In the early 1800s, companies began piping gas to homes and businesses in big cities in Europe and the United States. Gas lamps provided a steadier, brighter light than lanterns. But they still had flaws. The burning gas gave off soot, which dirtied wallpaper and upholstery. The gas also gave off fumes and consumed oxygen, making the air stuffy. People often complained of headaches in homes with piped-in gas.

By the mid-1800s, electricity had started to change the way people lived and worked. Businesses and governments used the telegraph, a system for sending electrical signals along wires. The signals carried coded messages across the country and even around the world. The telephone, invented by Alexander Graham Bell in 1876, converted the human voice into electrical signals. It enabled people to talk to one another over long distances.

This photograph of a nineteenth-century tavern in London, England, shows gas lamps illuminating the area around the bar. Gas lighting was not as clean or as steady as electric lighting.



"to make myself proof against adversity, and to achieve contentment and happiness to a point of extracting some satisfaction even from the darker side of life." He graciously called Thomas Edison "a wonderful man" who managed to get "great results by virtue of his industry and application."

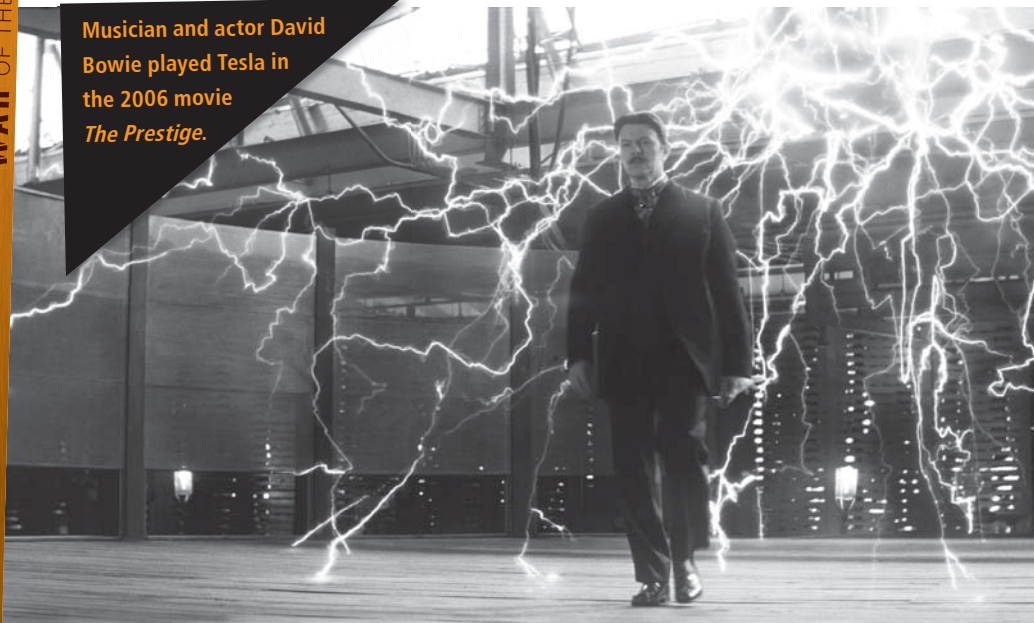
Tesla died on January 7, 1943. Certainly not a household name like Thomas Edison, he was nevertheless honored for his achievements. The *New York Sun* eulogized him as a genius and visionary: "[Tesla] was seeing a glimpse into that confused and mysterious frontier which divides the known and the unknown." The newspaper described Tesla as a man ahead of his time, concluding, "Probably we shall appreciate him better a few million years from now."

For many years after his death, Nikola Tesla was a forgotten figure. Few people knew about his contributions to modern technology. Most people associated electric lighting with Thomas Edison. People hailed Italian Guglielmo Marconi as the inventor of the radio, even though Tesla filed radio patents that predated those of Marconi.

COMEBACKS

In the twenty-first century, Nikola Tesla is making a comeback. He has showed up as the character of an eccentric genius in a 2006 movie called *The Prestige*,

Musician and actor David Bowie played Tesla in the 2006 movie *The Prestige*.



as well as in the video game *Dark Void*. The founders of Tesla Motors, makers of electric cars, named their company in his honor. The Nikola Tesla Inventors Club of Philadelphia includes online members from all over the world. Larry Page, who cofounded the search engine Google, also claims Tesla as an early influence and inspiration.

In the modern world, alternating current continues to travel long distances to provide electricity to homes and businesses. But new uses for electricity have evolved. The electronic age has brought in a host of gadgets that can operate without being plugged into an electric socket, such as cell phones, smartphones, and laptop computers. All these battery-run or cell-fuel-driven devices depend on direct current. Thus DC is making its own comeback. Author and historian Tom McNichol writes that “the Computer Age may well turn out to be DC’s revenge.” If this is the case, the future will belong to both alternating current and direct current—and probably in ways we cannot yet imagine.

TIMELINE

- 1877** Thomas Edison begins experiments with incandescent lighting.
- 1878** Thomas Edison founds the Edison Electric Light Company.
- 1882** Thomas Edison provides electricity to J. P. Morgan's office from the Pearl Street Station in New York.
- 1884** Nikola Tesla moves to New York and begins working for Thomas Edison.
- 1886** The Westinghouse Company debuts its AC lighting system in Great Barrington, Massachusetts. Westinghouse opens its first commercial power plant in Buffalo, New York.
- 1887** Nikola Tesla opens the Tesla Electric Light Company in New York.
- 1888** Nikola Tesla gives a lecture on AC power to the American Institute of Electrical Engineers. Tesla moves to Pittsburgh to work for George Westinghouse. Thomas Edison warns that alternating current is dangerous. Electrical engineer Harold Brown performs experiments on dogs to prove that alternating current is dangerous.
- 1890** William Kemmler is killed in the electric chair, which runs on alternating current. The Niagara Falls Power Company holds a groundbreaking ceremony for a power station at Niagara Falls.
- 1891** A generator sends 3,000 volts of alternating current up a mountainside to operate mining equipment in Colorado.
- 1892** The Westinghouse Company wins the contract to supply electricity to the 1893 World's Fair in Chicago. The company perfects its stopper light to provide lighting for the fair.
- 1893** The lights and machinery at the Columbian Exposition are all powered by AC generators. General Electric, Westinghouse, and Nikola Tesla provide demonstrations of the wonders of electricity at the fair.
- 1895** The Niagara Falls power plant goes into operation. It sends power from the falls to the city of Buffalo, New York, 26 miles (42 km) away—a record distance. The event marks the unofficial end of the War of the Currents, with AC as the winner.

GLOSSARY

alternating current: electric current that changes direction many times per second as it travels over wire

arc lamp: a lamp that sends a strong electric current leaping between two carbon sticks. The current gives off an intensely bright light.

commutator: a device that converts alternating current into direct current

conductor: a substance that transmits electricity

current: a flow of electricity

direct current: electric current that does not change direction as it travels over wire

dynamo: a machine that converts mechanical energy into electricity; also called a generator

filament: a threadlike wire in a lightbulb that glows as it transmits electric current

generator: a machine that converts mechanical energy into electricity; formerly called a dynamo

incandescence: light and heat produced by the flow of electricity

magnetic field: an area of force produced by an electric current

transformer: a machine that increases or decreases the voltage of alternating current

turbine: a device that is rotated by a moving force, such as water, wind, or steam. A moving turbine can provide power for an electrical generator.

voltage: a force that causes electric current to flow



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WEBSITES

Bakken Museum

<http://www.thebakken.org>

Located in Minneapolis, Minnesota, the Bakken Museum helps visitors explore the history and nature of electricity and magnetism. The museum's website includes information on exhibits, collections, and special programs for kids.

Biography of Thomas Edison

<http://www.thomasedison.com/biography.html>

This website presents a short biography of inventor Thomas Edison.

Edison's Miracle of Light

<http://www.pbs.org/wgbh/amex/edison/index.html>

This site is a companion to the PBS television program of the same name. It includes a timeline, an explanation of AC versus DC power, information on Thomas Edison and his work, and links to primary documents and recordings.

George Westinghouse

http://www.westinghousenuclear.com/Our_Company/history/george_westinghouse.shtm

This Web page from the Westinghouse Electric Company offers a biography of company founder George Westinghouse, who was instrumental in the triumph of AC power in the War of the Currents.

Lighting a Revolution

<http://americanhistory.si.edu/lighting/19thcentury/invent19.htm>

This website, a companion to an exhibit at the Smithsonian American History Museum, discusses various aspects of Thomas Edison's incandescent lamp.

Tesla: Master of Lighting

<http://www.pbs.org/tesla/>

This companion website to the PBS video of the same name provides extensive information on Nikola Tesla's life and inventions.

Tesla Memorial Society of New York

<http://www.teslasociety.com/biography.htm>

This website is devoted to the writings, inventions, and life of Nikola Tesla.

INDEX

- alternating current (AC), 6, 7, 17, 18–19, 20, 21, 22, 23, 30, 45–46; double-phase, 23; and electrocution, 33–34; polyphase, 23, 25; single-phase, 23
- American Institute of Electrical Engineers (AIEE), 25
- arc lighting, 10, 11, 18, 34
- batteries, 53, 57
- Bell, Alexander Graham, 9, 10
- commutators, 14, 17
- Dark Void* (video game), 57
- diagrams, 19, 24
- direct current (DC), 6, 7, 17, 21, 22, 26, 53, 57
- dynamos, 10, 11, 13–14, 16–17, 20, 23, 24, 50
- Edison, Thomas Alva, 6; background, 10–11; collaboration with Tesla, 20–21; death of, 54; and death penalty, 33; development of DC, 6, 10–15; inventions of, 10–13, 54; Menlo Park lab, 12, 21, 26, 36; opposition to AC, 6, 22, 31, 33–34, 40
- Edison Electric Light Company, 6, 15, 20, 23, 29, 34, 36
- Edison Medal, 54, 55
- electric cars, 53, 57
- electricity, 4–5; and computer age, 57; distribution of, 6–7; experiments with dogs, 37–38; inventions, 52–53; and magnetic fields, 19; safety of, 21–22, 31, 32, 34–35, 38–39, 40
- electrocution, 32–34, 37–38, 39, 41, 43
- General Electric, 6, 46, 50, 53
- generators, 39, 51. *See also* dynamos
- hydroelectricity, 44, 50–51
- incandescence, 11–12, 29, 46, 52
- jumbos, 13–14. *See also* dynamos
- Kemmler, William, 39–41; execution by electrocution, 40–41, 43
- lamp lighting, 8–9; with gas, 9
- lightbulbs, 10, 11, 46–47
- Niagara Falls, 16, 17, 50
- Niagara Falls Power Company, 44
- patents, 23, 29, 46–47, 54
- phonograph, 10, 14
- power plants, 13, 14–15, 28, 29, 44, 46, 51
- Prestige, The* (film), 56
- Stanley, William (electrical engineer), 27, 28–29
- stopper lights, 46, 47
- Tesla, Nikola, 7; background, 16–19; collaboration with Edison, 20–21; collaboration with Westinghouse, 30–31, 35, 36, 43, 48; death of, 56; inventions, 42, 55; Nikola Tesla Inventors Club of Philadelphia, 57; opposition to DC, 7, 17–18; and radio, 55, 56; speeches and demonstrations, 25, 45, 48–49, 51; and Tesla Motors, 57
- Tesla coils, 42
- Tesla Electric Light Company, 23
- transformers, 24, 27
- voltage, 18, 24, 28, 37, 38
- War of the Currents, 7, 21–23, 32–43, 53
- Westinghouse, George, 6; background, 26–27, 29; collaboration with Tesla, 30–31, 35, 36, 48; inventions, 27, 54
- Westinghouse Electric, 6, 29, 36
- World's Fair (Chicago 1893), 4–5, 6, 46, 47, 48–49

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Stephanie Sammartino McPherson wrote her first children's story in college, and she hasn't stopped writing since. A former teacher and freelance newspaper writer, the award-winning author has written thirty books and numerous magazine stories. She especially enjoys writing about science and the human interest stories behind major discoveries. Her most recent book is *Iceberg Right Ahead: The Tragedy of the Titanic*.

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IN THE EARLY 1880s, only a few wealthy people had electric lighting in their homes. Everyone else had to use more dangerous lighting, such as gas lamps. Eager companies wanted to be the first to supply electricity to more Americans. The early providers would set the standards—and reap great profits.

Inventor **THOMAS EDISON** already had a leading role in the industry: he had invented the first reliable electrical lightbulb. By 1882 his Edison Electric Light Company was distributing electricity using a system called direct current, or DC. But an inventor named **NIKOLA TESLA** challenged Edison. Tesla believed that an alternating current—or AC—system would be better. With an AC system, one power station could deliver electricity across many miles, compared to only about one mile for DC.

Each inventor had his backers. Business tycoon George Westinghouse put his money behind Tesla and built AC power stations. Meanwhile, Edison and his DC backers said that AC could easily electrocute people. Edison believed this risk would sway public opinion toward DC power. The battle over which system would become standard became known as the War of the Currents. This book tells the story of that war and the ways in which both kinds of electric power changed the world.

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