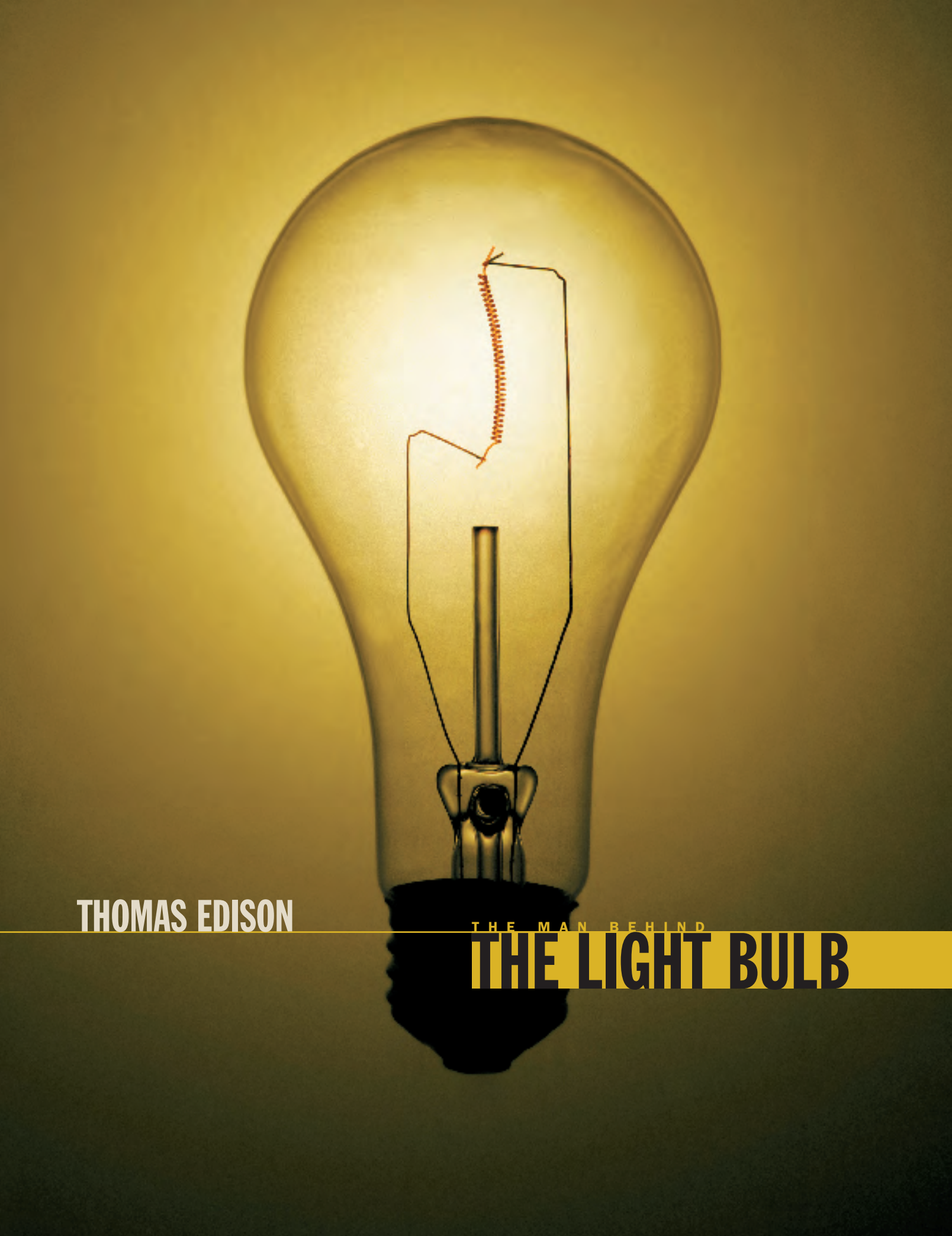
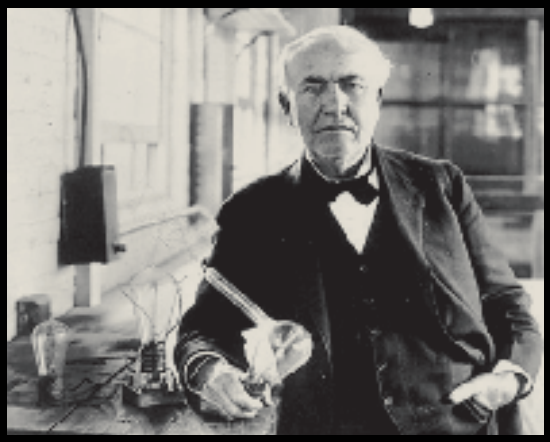

THOMAS EDISON
THE MAN BEHIND
THE LIGHT BULB

It is late on a winter's night in 1876.

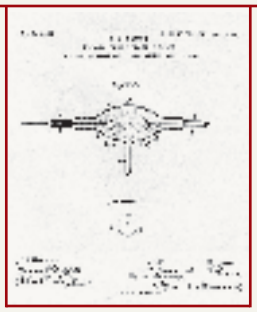
There is snow on the ground, and wood smoke curls from two brick chimneys. Inside, up the dark, uncarpeted stairs, a big bare-boarded room lit by gas jets and kerosene lamps stretches the building's full 100 feet. Its ceiling is laced with wire and piping, its walls lined floor to roof with jars of liquids and bottles of powder of every color. A rack in the center of the room is stacked with galvanic batteries, and every other nook and surface is covered with bits of copper, brass, lead, and tinfoil; crucibles, phials, and small darkened panes of glass; microscopes, spectrometers, telegraph keys, and galvanometers; rubber tubing and wax and small disks of some obscure material. At scattered workbenches and heaped-up tables there are a dozen young men engrossed in what they are doing: A bearded pair observe a spark jumping from an electromagnet to a metal lever; another boils a smelly chemical; another has his ear to some kind of telephone receiver; another, chewing tobacco, bends his head to frown at the needle on an instrument. In the far corner, stretched out on the floor amid a score of open books, is a pale young man with a mop of brown hair and stains on his hands, entirely lost to this world because he is concentrating on making a new one.

This is Thomas Alva Edison at 31. If we stay long enough, we will see him uncoil his shabby 5 feet, 8 inches and, stooping slightly, move slowly



among the workbenches, cupping an ear to listen to observations on the night's work, reaching over to tweak an instrument, breaking out in laughter as one of the fellows makes a joke at his expense. His black frock coat and waistcoat are dusty, and a white silk handkerchief around his neck is tied in a careless knot over the stiff bosom of a white shirt rather the worse for wear, but what stands out is the extreme brightness of his eyes.

Thomas Edison was America's most productive inventor in the 19th century and remains so into the 21st. His 1,093 patents are by no means the proper measure of the man. To Edison, the patents were the easy part, before "the long, laborious trouble of working them out and producing apparatus which is commercial" —and then fighting off the pirates. Edison's greatness lies not in any single invention, not even in the whole array, but in what he did with his own and other men's cleverness.



The invention for which he is most remembered, the incandescent bulb, is emblematic. The technology was a marked advance over the work of other inventors, but the piercing vision—and it was Edison's alone—was how he would bring light and power to millions of homes and offices.

In the early 1870s, he recruited three men who would be crucial: Charles Batchelor, an English textile machinist; John Kruesi, a Swiss clockmaker; and Edward Johnson, a voluble railroad and telegraph engineer. His journal of February 1872 had more than 100 sketches; with the help of Batchelor and Krusei, he won 34 patents in that single year.

Scientist George Barker of the University of Pennsylvania had enthused about a system of lights the inventor Moses Farmer had installed at an Ansonia, Conn., foundry. They were arc lights, so called because the light was an arch of elongated sparks reaching between two carbon electrodes. Bright as searchlights, they had been familiar since the '60s in British and American lighthouses and a few places of public assembly but were too blinding (and hazardous) for domestic use.

EPIPHANIES

Edison's intuition was to think small. Instead of sending current to create a leap of light between the electrodes of big arc lamps, useless for domestic lighting, why not send it along the wire and into a filament in a small incandescent lamp? Back at Menlo Park he worked euphorically through two nights. "I discovered the necessary secret, so simple that a bootblack might understand it," he wrote. Edison went public only a week after his visit to Ansonia. His spicy quotes got full play in the newspapers: He had not only found the way to create an incandescent bulb but would be able to light the "entire lower part of New York" with one engine and 15 or 20 dynamos: "I have it now! With a process I have just discovered, I can produce a thousand—aye, ten thousand (lamps) from one machine. Indeed, the number may be said to be infinite … with the same power you can run an elevator, a sewing machine, or any other mechanical contrivance, and by means of the heat you may cook your food."

It was hot air. The "secret" was something he had visualized but not realized, a thermal regulator to cut off current to the filament before it melted or burned out. The real secret, Edison found, arguing it out with Charles Batchelor, was to raise the voltage to push a small amount of current through a thin wire to a high-resistance filament. It was an application of the law propounded in 1827 by the German physicist George Ohm, but it was still imperfectly understood. Edison himself said later, "At the time I experimented I did not understand Ohm's law. Moreover, I do not want to understand Ohm's law. It would stop me experimenting." This is Edison in his folksy genius mode. Understanding the relationship linking voltage, current, and resistance was crucial to the development of the incandescent lamp, and he understood it intuitively even if he did not express it in a mathematical formula.

SUCCESS

After two sleepless weeks, Edison relieved the carbon rollers. His new idea was to bake the carbon into a length of plain cotton thread. On the eighth attempt, on October 21, the dexterous Batchelor held his breath carrying a tiny thread bent into the shape of a horseshoe to Boehm's house for insertion in a bulb. "Just as we reached the glass blower's house, the wretched carbon broke," Edison recalled. "We turned back to the main laboratory and set to work again. It was late in the afternoon before we produced another carbon, which was broken by a jeweler's screwdriver falling against it. But we turned back again and before nightfall the carbon was completed and inserted in the lamp. The bulb was exhausted of air and sealed, the current turned on, and the sight we had so long desired to see met our eyes."

Thread No. 9, lit at 1:30 a.m., lasted until 3 p.m.—13 1/2 hours, whereupon Edison added a stronger battery to boost the light to 30 candles, or three times gaslight. They watched the tiny filament struggle with the intense heat. The light continued for 60 minutes. It was a crack in the glass that turned the room back into darkness—amid the cheers of exhausted men. They had proved that a carbon fil-

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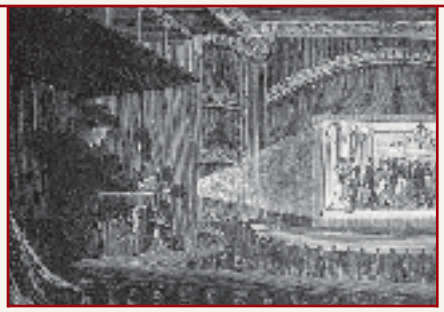

ament in a vacuum would work.

After examining the charred filament under a microscope, Edison launched another search for an organic fibrous material, some form of cellulose that might yield even more resistance than cotton. By November 16, they settled on a piece of common cardboard. Edison records: "None of us could go to bed, and there was no sleep for any of us for 40 hours. We sat and watched it with anxiety growing into elation. The lamp lasted about 45 hours, and I realized that the practical incandescent lamp had been born."

Already, Edison was preparing to establish electric beachheads in New York, Paris, and London. The lab staff worked frantically making bulbs by hand, one by one, so that on New Year's Eve, when Edison opened Menlo Park to a public exhibition, he had around 300 bulbs.

What Edison attempted next can be characterized only as awesome, as if having climbed Everest he sprouted wings and flew from the top. "There is a wide difference," he said, "between completing an invention and putting the manufactured article on the market," but marketing an electric light bulb was the least of it. He had to invent the electrical industry. He had to conceive a system down to its very last detail—and then manufacture everything in it. He had to build a central power station; design and manufacture his own dynamos to convert steam power into electrical energy; ensure an even flow of current; connect a 14-mile network of underground wiring; insulate the wiring against moisture and the accidental discharge of electrical charges; install safety devices against fire; design commercially efficient motors to use electricity in daylight hours for elevators, printing presses, lathes, fans, and the like; design and install meters to measure individual consumption of power; and invent and manufacture a plethora of switches, sockets, fuses, distributing boxes, and lamp holders.

Luckily, Edison was worth around half a million dollars by then; Western Union had made big payments for his telegraph and telephone patents. In December 1881, he began to dig up cobblestones for conduits radiating symmetrically outward from Pearl Street. He was often down in the trenches in the raw early hours checking the connections made by the wiring runners. It took six months to do the work.

LIGHTS ON

Sunday was normally the one day of the week reserved for his neglected wife, Mary, and their two children, but Sunday, Sept. 3, 1882, was different. All day and into the night Edison was on Pearl Street rehearsing every part of the operation for the system's debut due on Monday afternoon. So much might go wrong when he gave the orders for the steam to flow. "The gas companies were our bitter enemies, ready to pounce upon us at the slightest failure," he recalled later. When the chief electrician pulled the switch at 3 p.m., only one of the six dynamo sets worked and the steam engine was wobbly. But Edison, over at the offices of Drexel, Morgan & Co., ready for the big moment when he would ceremonially connect the 106 lamps there, was not disappointed. They all came on! They came on, too, at the offices of the *New York Times*, "in fairy tale style," said the paper, 52 filaments appearing to glow stronger as the night drew in.

Edison's success was at once a vindication and an incitement. His patent was swiftly challenged, his ideas stolen. But Edison would not sue; he would out-invent and undersell them all. When Pearl Street went on line in 1882, no fewer than 200 companies across America had already signed up with the Edison Company for Isolated Lighting, using 45,000 lamps a day: companies like Marshall Field's dry goods store in Chicago, George Eastman's Photographic company in Rochester, N.Y., the Stetson Hat Co. in Philadelphia, and Dillard's Oregon Railway and Navigation Co. The electrical evangelists Edison had sent overseas had done their work well. A London newspaper summed up the acclaim: "There is but one Edison."

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