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Thomas Edison

How a Boy Who Learned Differently Changed the World

by Nancy Churnin

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Nancy Churnin

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Longing for Light

Thomas Alva Edison had a secret. He was afraid of the dark.

Today, if you are afraid of the dark, you can turn on a light—maybe even a small night-light—before you go to bed. But when Tom was born on a snowy morning on February 11, 1847, in Milan, Ohio, there were no electric lights. Imagine Tom as a child. It's nighttime. He's snug under his covers, his mother sitting close beside him. There's a lit candle near as she reads to him, showing him pictures in the book.

After finishing the chapter, she marks the place. He looks at her pleadingly. No! Surely it isn't time yet. She points to the candle so he can see how much it has shrunk.

She takes his hands and presses them together. It is time for prayers and hugs. His mother blows out the candle. Leaving it lit would run the risk of the candle falling and catching threads from his bed or bedclothes. Sparks could ignite a deadly fire.

She leaves the room. Tom is the youngest of seven, but he is already aware of death. His brothers Samuel Ogden and Carlile Snow passed away before he was born. His sister Eliza Smith died when he was a few months old. His big sister, Marion Wallace, married and moved out when he was two. He still has two siblings in the house, William Pitt and Harriet Ann, but they are in their twenties and, like Marion, will marry and leave soon.

The dark is filled with mysteries, and Tom's mind is full of questions that have to wait until morning. Small wonder that as he lays in bed, he wishes that there was a switch he could flip to turn the light back on.

Could this have been the start of his obsession with inventing a safe, clean light that could stay on as long as he wanted?

obsession: thinking about or doing something an abnormal amount

We know that years later, after he did invent the electric light, he'd keep it on late into the night.

And we know that Tom was always thinking. And thinking. And watching. He got his best ideas from nature, from feeling the power of the wind, the possibilities of the sun.

Many nights, no doubt, he gazed out the window to drink in the soft glow of the moon and the stars. It wasn't enough light to read or draw by. Often unable to sleep—he never liked to keep his eyes closed for more than five hours—he twisted from side to side, calculating how long he'd have to wait for the sun to come up again. Wouldn't it be something if he could create his own little sun and share its wonder with others? Wouldn't it be something if he could turn night to day and stay up as long as he wanted?

But what would a homemade sun look like? Like wax melting on the candle, his thoughts would finally melt into dreams and he would sleep until his father shook him awake to start his chores.

2

A Boy Who Thought Differently

Most people accept and learn how to work with the world they have. But Tom wanted more. When Tom was born, there were no electric lights, telephones, movies, televisions, or smart screens. If people wanted to hear music, they went to hear people sing or play instruments. Most people accepted that was how it would always be. But not Tom. Just because something didn't exist, that didn't mean it couldn't happen. It just meant that no one had figured out a way to make it work yet.

Tom's mind glowed with ideas as he helped his father fix broken fences and build plows and other tools out of wood. He felt like a magician as his hands cut, hammered, and nailed raw materials into useful objects. What else could he build with wood and metal, he wondered? What else was possible?

3

A Boy Who Learned Differently

When Tom was seven, his family moved to Port Huron, Michigan. There, his father worked hard to support their large family as a farmer and a carpenter. Tom helped his father with the farming, tending to the sweet corn, radishes, onions, parsnips, and beets in the family's eight-acre garden. After harvest, he and his father traveled the mile and a half to town to sell the vegetables door to door. Tom was proud of his garden and the money he earned to help his family. One year, he gave his mother $600 he had earned just from selling vegetables!

Soon after they moved, Tom caught scarlet fever. His face burned, his eyes burned; he was hot and sweaty, and worst of all, it was hard to think! *Ahhhh*, he moaned. *Shhh*, his mother said as she pressed cool towels on his forehead and coaxed him to sip cool water, then later, a bit of soup. Slowly, after many days, Tom cooled down and was able to breathe a little easier. Finally, he could read and think again.

---

scarlet fever: contagious disease that can include a red rash

"How are you feeling?" his mother asked when she entered his room. He didn't answer. She asked again. Silence.

She walked over and tapped him. He turned, happy to see her. Now, maybe Tom hadn't heard her because he was lost in his own thoughts, as he often was. Or maybe he hadn't heard her because he had started to lose his hearing. In later years, Tom couldn't say for certain when his hearing loss began. But by the time he was twelve, four years later, Tom couldn't hear at all in one ear and could hear only partly in the other.

Whether he didn't respond because of not hearing or not wanting to hear, his mother understood early that Tom learned differently. He couldn't be told what to do. He had to figure things out for himself at his own pace.

But the teacher in the little one-room schoolhouse Tom attended, near where he lived, didn't understand that. Tom's teacher grew increasingly frustrated at the eight-year-old child who didn't listen to the lessons, who sat around drawing pictures of storefront signs and steam engines!

Three months after he started school, Tom overheard his teacher saying there was no point in trying to teach Tom because he was *addled*—his mind was all mixed up. His teacher said Tom was impossible to help.

"I burst out crying and went home and told my mother about it," he recalled later. "I almost decided that I must really be a dunce."

His mother was furious. She went to the school, found the teacher, and told him that her son "had more brains" than he did. Then she told him that Tom was finished with this school and she would teach him herself.

Tom's mother knew he was never going to process facts and learn things without his mind wondering and pondering, *What if?* She understood he wasn't going to switch subjects until he was ready. Once his mind got fixed on an idea or a problem he wanted to solve, there wasn't much hope of getting him to let it go until he was ready.

Tom's mother believed these differences could be his strengths. She helped Tom with his reading and his numbers. She gave him the chance to learn the way he needed to—by thinking and wondering and doing experiments.

process: examine to understand
pondering: thinking about

4

A Growing Confidence

Tom's mother turned their home into a school. Learning happened in every room, and outside too. She started with books from their home library and added more every chance she could. Tom's eyes brightened every time she brought him something new. They read and talked about the plays of William Shakespeare and the novels of Charles Dickens. They discussed history, philosophy, geography, and more.

Tom loved reading. He may not have had many friends around him, but books became his friends. He was always happy to see them and always grateful for the great stories and fascinating facts they provided. Best of all, feeling his mother's pride in him, Tom's confidence bloomed.

"My mother was the making of me," he recalled years later. "She was so true, so sure of me; and I felt that I had someone to live for, someone I must not disappoint."

The science books were Tom's favorites. He was only nine when he devoured *A School Compendium of Natural and Experimental Philosophy*. He lingered over each page. There Tom was, in a small rural town, getting to

know Nicolaus Copernicus, the great astronomer who figured out that the earth rotated around the sun; Sir Isaac Newton, who discovered the laws of gravity; and Michael Faraday, who invented the electric motor. They were all inventing and discovering things, adding to the wisdom of the world, just as he wanted to do! They were asking questions about how people could rediscover, rearrange, and reproduce the miracles of nature—just as he dreamed of one day recreating the light of the sun.

These scientists never claimed that steps forward in science happened overnight. Nothing was easy or quick. They described how they would try one thing after another and never give up until they reached their goal. Tom decided that's what he would do too.

Tom, who had never fit in with the crowd, had found his people. Soon he was studying the six simple machines—the lever, the pulley, the wedge, the screw, the wheel and axle, and the inclined plane. Why, he used them all! When he pried open the lid of a tin with a spoon handle, he used a lever. When he chopped wood with an axe, he used a wedge. Every time he climbed a ladder, he was using an inclined plane. When he twisted a jar open, he used a screw. And when he drew water from the well by pulling a rope around a wheel to lower and raise a bucket, he used a pulley that had a wheel!

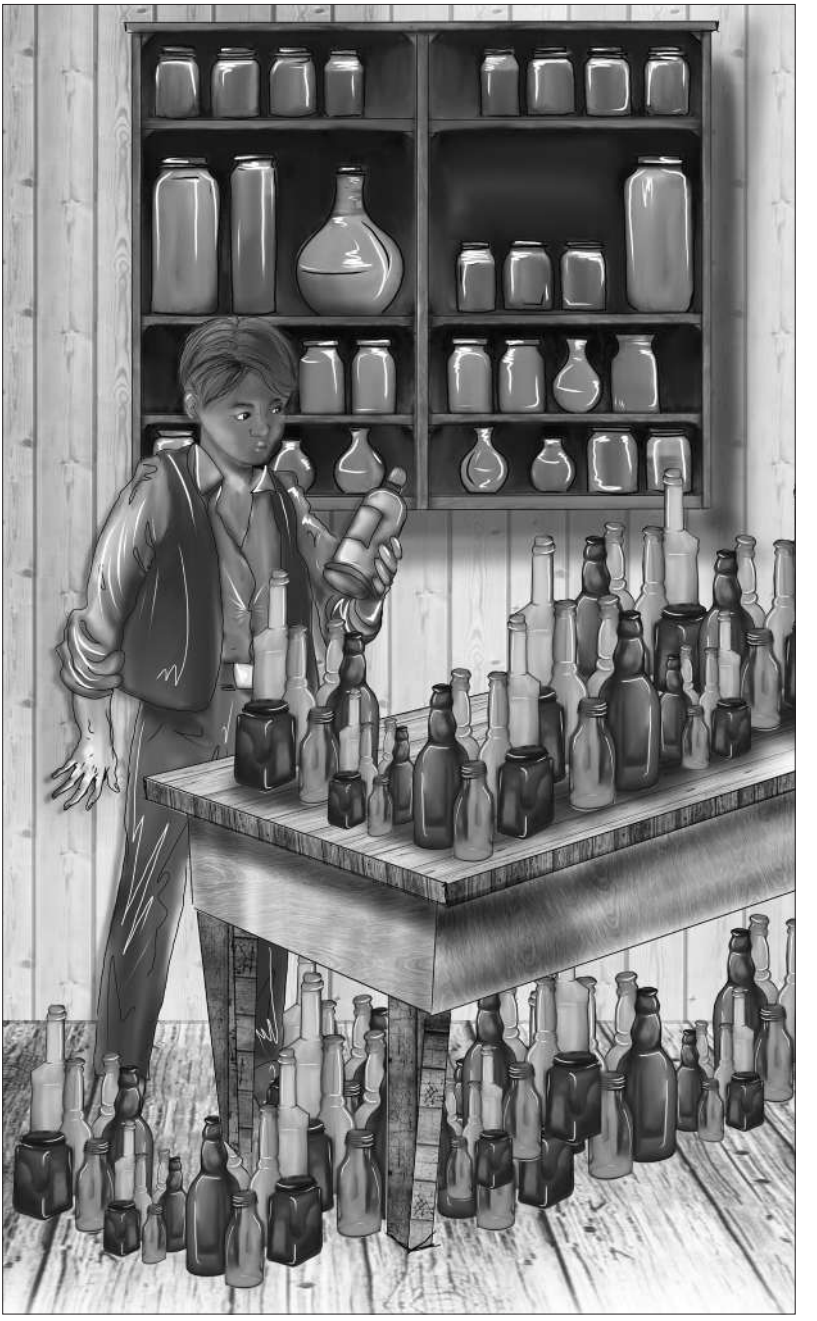
gravity: force by which a planet attracts people and objects toward its center

He learned that friction was caused by rubbing one thing against another, like sandpaper against wood. He was curious about a vacuum, which involved an object with no matter or air. When he read about electricity, a form of energy involving the movement of charged particles too small to see, he became increasingly fascinated by lightning and wondered how he could create a light like that safely inside a home.

At nine, he flipped through *The School Compendium* and found experiments he could do at home. He did them all. At ten, his mother bought him a copy of an old *Dictionary of Science,* and he got to work on those experiments too. But he needed chemicals, scraps of metal, and wire. He used all the money he saved and earned to buy what he needed and scrounged the rest. He put his treasures in hundreds of old medicine bottles, liquor bottles, and glass Mason jars—the makings of his own laboratory—which he kept in his room. He labeled the chemicals "Poison" so nobody would touch them. He mixed ingredients that made heat and light—and, occasionally, explosions.

His mother made him keep his laboratory in the cellar after that!

charged particles: tiny amounts of substance that have an electric charge



5

Riding High

Tom's hearing kept getting worse. But he didn't complain. The less he could hear sounds that connected people through conversation, the more the thoughts and ideas in his head took over.

When Tom was born, most people traveled by horse or wagon. Steam locomotives were a relatively new invention, and about nine thousand miles of railroad track had been completed by 1850, when he was three years old. Tom was fascinated by the railroad—how it worked, how it connected people, and how it got them so quickly from one place to another.

This was the future! Tom applied for a job as a newsboy on the railroad. When his application was accepted, Tom was thrilled! He was only twelve, but he knew this would lead to something amazing—and it did.

Being a newsboy gave Tom time to think and wonder.

Each day, at 7:00 a.m., he boarded the Grand Trunk Railroad at Point Huron and traveled to Detroit, about sixty miles away. He had all day to spend in Detroit before picking up the newspapers, taking the train back to Point Huron, selling the newspapers on the train, and arriving home at 7:30 p.m., just in time for dinner. The only thing he didn't like was that his father made him go to bed at 9:30 p.m. If only there was a way to read in the dark that didn't involve a flickering candle, an oil lamp, or a smelly gaslight!

During the day, Tom spent his time at the Detroit Free Library, reading and exploring the streets around it.

As always with Tom, one idea led to another. He figured out that he could increase his income by selling freshly grown vegetables and fruits from home, as well as other treats, which he would buy at one price and then sell at a higher price. After all, he had a great many potential customers on the train.

But what really grabbed his attention was seeing the wires that railroads had parallel to the train tracks. He learned that these wires would allow people on running trains to communicate with people at rail stations through a language of dots and dashes called Morse code. This was amazing! He had to know more.

The School Compendium had a fascinating section on Morse code, a language of dashes and dots that could send messages over great distances. Tom read how Samuel Morse had come up with a way of sending printed messages, called telegrams, using an electromagnet—an iron rod wrapped with many turns of wire that were connected to a battery. When current flowed through the coiled wire, it turned the rod into a magnet, causing it to strike against a metal plate with a loud click.

Best of all, those clicks were visual—something he

could see—and they made vibrations. It was a language Tom could feel. Tom studied until words flowed through his fingers. He couldn't wait to show his mother. He tapped:

•••• • •–•• •–•• – – –

She smiled but didn't understand.

"It's Morse code," he told her. "•••• is H, • is E, •–•• is L, •–•• is L, and – – – is O. I just said 'Hello'!"

Growing up, Tom didn't have many friends. But now, he was making friends with kids who wanted to learn Morse code too. He told them if they could read the dots and dashes, they could send each other telegrams. They waited eagerly as Tom worked on creating a small telegraph. When it was done, they helped him string wires from tree to tree.

Dots and Dashes

Just three years before Tom was born, Samuel Morse used the code he had designed, in which those clicks formed combinations of dots and dashes that signified letters of the alphabet, to tap out the first official telegram. Amazing! His first message, the words "What hath God wrought," traveled in less than a second from Washington, D.C., to Baltimore, Maryland, which was thirty-four miles away.

vibrations: fast shaking movements

The telegrams were a hit! More kids wanted to join. Tom added poles to attach more wires. It worked great until a cow barged into his family's orchard, knocked down those poles, and got tangled up in the wires. *Moo*! Tom didn't bother setting up the system again. In 1861, when Tom was fourteen, the Civil War broke out. No one could get the news of the day fast enough. And that led to Tom's new idea.

6

Writing High

Tom reached out to a telegraph operator in Detroit, asking him to wire the news about major events in the war to the stations on the way to Port Huron. The station agents would write the news up on chalkboards. As soon as the train arrived at each station, people would rush to buy newspapers from Tom so they could get all the details. After one particularly deadly battle, he sold a thousand papers.

One day, as he walked by a bookseller's shop in Detroit, he spied an old printing press. The bookseller had been given the press by a tenant who couldn't pay his rent. That's when Tom had another brainstorm. Clearly, the war had increased the demand for news. Could he earn more money by printing his own newspaper? Tom asked if he could buy the press. The bookseller agreed, even though he thought Tom was wasting his time. Where would this boy print the newspaper? Who would write the stories?

---

tenant: someone who pays to use another's space

But Tom was thrilled. First, he had a new machine to figure out. He bought ink and paper and got it working. Now, that wonderful machine would allow him to do another thing he loved—communicate without hearing or talking, just as he'd done with his telegram.

He wrote about local news, gossip, and train schedules—and printed his *Weekly Herald* in the train's baggage car! He added items about engines being repaired, notices of lost luggage, praise for porters and the work they did, and jokes. Tom's newspaper was the first to be printed on a moving train. There were a lot of misspelled words and unusual punctuation, but no one seemed to mind. And while the printing added to the din of the train clattering on the tracks, that didn't bother Tom. By this time, he could hardly hear.

Tom sold single papers for three cents apiece and yearly subscriptions to his weekly paper for eight cents a month. Soon, he had sold around five hundred subscriptions and was regularly selling another two hundred copies every week, for three cents each.

He also continued his science experiments on the train—that is, until a bottle of phosphorous spilled and burst into flame! The train conductor yelled at Tom and made him shut down his lab and printing press. But Tom was allowed to keep his job as a newsboy. And he eventually persuaded his father to let him set up a new laboratory at home, where he continued to write and publish his newspaper.

The train was exciting, but it could also be dangerous. One day, Tom saw the station agent's three-year-old son playing on the gravel at the side of a track, just as a boxcar came barreling his way. Tom raced across the track, grabbed the child, and pulled him to safety. The grateful station agent, James U. Mackenzie, said he would do anything to thank Tom.

He asked Tom if he would like to learn how to be a telegraph operator. *Yes*! That was a dream come true for Tom. He showed up for his first lesson with a set of telegraph instruments. The boy whose old teacher

phosphorous: chemical that glows in the dark
boxcar: train car used to transport goods

had thought him too "addled" to follow and understand lessons was declared by his instructor to be an expert in telegraphy within three months.

Tom was ready now for his next adventure. When he was sixteen years old, Tom left home to take a job as a telegraph operator in Canada. He later took positions in various parts of the United States. He finally settled into working as an operator for Western Union in Boston, Massachusetts. But his mind was never far from the work he really wanted to do.

Tom kept a notebook with him at all times that he filled with sketches and doodles. His pockets were always bulging with pliers, coils of wire, and metal scraps for the inventions he continued to work on. Tom was sure that at some point, one of his ideas would change his life—and the lives of millions.

7

His First Invention

In 1868, at the age of twenty-one, Tom came up with an idea that he thought would be his breakthrough. Legislators at that time voted by calling out "Aye" or "No" and having a clerk jot down their responses one by one. That took a long time! What if Tom could speed up the process by automating it? He thought and sketched and thought and sketched. Then he had it.

Tom created what he called an electrographic vote recorder. It would list the names of all the voters in two columns of metal type, one column with the heading "Yes" and the other headed "No." Each legislator could flip a switch for yes or no. The switches were attached to wires that would transmit a signal through an electric current to a cylinder. A revolution, or turn, of the cylinder would record the voter's name in the correct column and tally the votes on a dial. After voting, a clerk could place a sheet of chemically treated paper on top of the columns and press down with a metallic roller, and the results would be printed on the paper.

Legislators: lawmakers
automating: making something happen automatically
transmit: send

A friend took Tom's invention to Washington, D.C., to show it to a committee in Congress. Tom applied for a patent, which meant that he had created something new that no one else had a right to copy. But when his friend returned, he told Tom that no one wanted to buy his invention. It turned out the legislators preferred the slow method of voting aloud. That gave them time to make deals in advance of their final vote tally.

Despite the failure to sell his vote recorder, Tom decided to quit his job at Western Union. He placed an ad in the *Telegrapher*, a magazine for telegraph operators, that said: "Mr. T.A. Edison has resigned his situation in the Western Union office, Boston, Mass., and will devote his time to bringing out his inventions."

He had come up with a new machine that worked, even if no one wanted to use it. He would learn from this experience to make sure he knew what inventions people wanted or needed before he started working on them. He would move to a place where he would meet a lot of people and find out what kinds of machines would make their lives better.

8

Reinventing Himself

Tom arrived in New York City in the spring of 1869 with empty pockets and a heart full of hope. On the morning he arrived, he had no money for breakfast. A friend and former telegraph operator, who was also out of a job, loaned him one dollar. After thinking hard about what would be the most satisfying and filling choice, he bought a warm apple dumpling and a cup of coffee. *Mmm*, that apple dumpling was good! It became his favorite food for the rest of his life.

Tom had no money to pay for a place to sleep, so he walked the streets all night long. In those days, New York City had glowing, smoky gas streetlights that were lit by lamplighters in the evening and put out in the morning.

Finally, another friend of Tom's named Franklin Pope offered him a cot in the cellar of Samuel Laws's Gold Indicator Company, where he worked. While Tom was there, he took every opportunity to study the machine that had made the Gold Indicator Company famous.

Samuel Laws's gold indicator was a telegraphic instrument that registered changes in gold prices and transmitted them to the offices of more than three hundred brokerages nearby. Brokers who traded in gold made money for their clients and themselves if they bought gold when prices were low and sold them when they were high. Of course, it was hard to predict when prices would go up or down—buying and selling was always a gamble. The brokers paid a lot of money to use the machine that told them what gold was worth from one moment to the next, figuring that would improve their odds.

On the third day of living in the company cellar, Tom was in the office when there was a mighty crash. The gold indicator machine had stopped working! His friend Franklin rushed to find out what happened. He couldn't get the machine going. Soon, messengers began arriving from the stockbrokers' offices. Hundreds followed, knocking on the door, desperate to know if the gold prices were up or down.

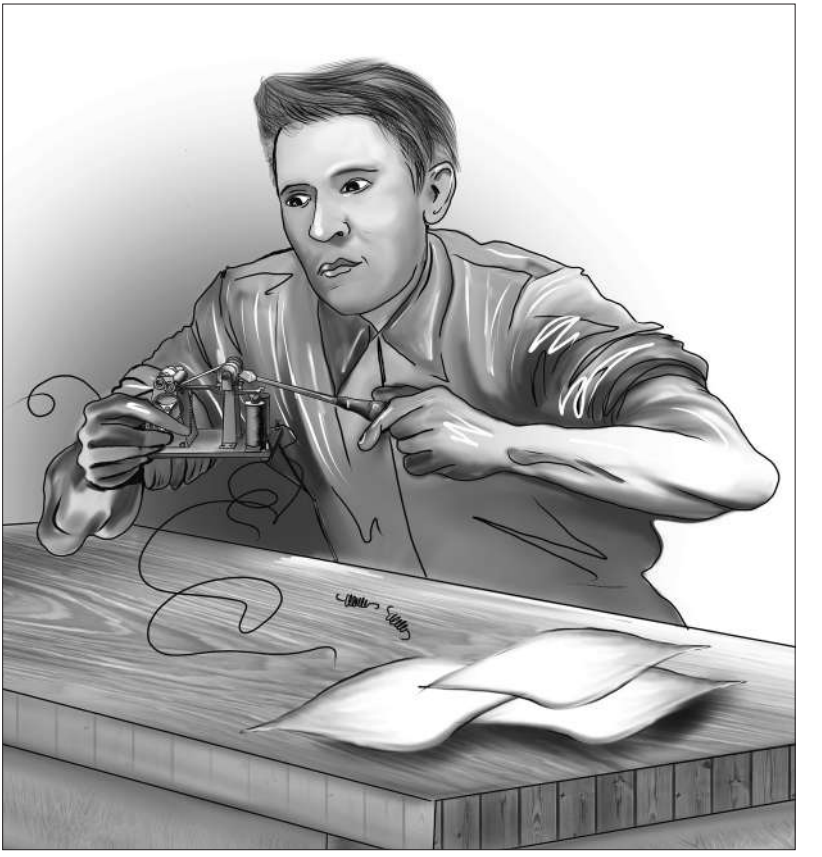
"It was pandemonium," Tom later recalled, "and the man in charge became so excited that he lost control of all the knowledge he ever had. I went to the indicator, and, having studied it thoroughly, knew where the trouble ought to be." He spotted the problem instantly—a spring had broken and was caught between two gear wheels of the machine.

pandemonium: loud, chaotic situation

Just then, Samuel Laws himself arrived. He demanded to know what had happened. Nobody who worked there knew the problem. But Tom did, and he offered to fix it.

"Fix it! Fix it!" Samuel said. "Be quick!"

Tom removed the broken spring, put in a new one, and reset the dials. He explained how to readjust the receivers in the stockbrokers' offices and sent people to do that. The machine was back up and working in two hours.



Tom was a hero. He was hired to keep all the machinery of the Gold Indicator Company running. He kept that job until the company was bought out by the Gold and Stock Telegraph Company a few months later. Then, rather than look for another job, he began working on what would become his first big success: the universal stock printer.

Using his knowledge of telegraphs, Tom improved on existing machines to speed the flow of financial information and make them less expensive and easier to use. An operator could use Tom's machine to type stock information on a keyboard from a central transmitter that was sent to multiple locations to print on long strips of paper. Soon, thousands of strips of tape were printing during stock market hours.

Marshall Lefferts, who headed the Gold and Stock Telegraph Company, asked to buy the universal stock printer from Tom.

Tom hoped to be paid anywhere from $3,000 to $5,000. But instead of giving Lefferts a number, he decided to ask Lefferts what he thought the invention was worth.

Lefferts offered $40,000.

Tom couldn't believe it! What would his next invention be?

stock: ownership share of a corporation

9

A Love of His Own

Tom spent most of his time thinking about creating things and making other people's inventions better. That changed, at least for a while, starting one night in 1871. The rain was falling hard when a young woman named Mary Stilwell and two of her girlfriends ducked into the hallway of Tom's factory to stay dry. A gentleman who worked there invited them inside and gave them a tour. Mary was curious about a machine that one of the workers was fussing over. The man was dirty and covered with machine oil, but he had "very handsome eyes," she would later recall. The man lit up when Mary asked questions. And when it was time to leave, that man—who happened to be Tom!—ran to get his umbrella to walk her home.

Once they arrived, Mary's mother could see Tom wanted to come inside. She invited him in, and he stayed until 9 p.m. He asked permission to call again. Mary's parents said yes. He became a nightly visitor for the next five months. Then, on a Saturday, he proposed.

"Have you ever thought you would like to be married?" he asked.

"Why no," she replied, "not yet anyhow."

"Well, I have and I would like to, and I would like you for my wife."

Mary stuttered and stammered. Tom responded with his usual calm confidence.

"If you meant to say no you would say no, so now I'll see your father tomorrow night, and if he says yes we'll be married Tuesday."

Tuesday was three days away!

Tom talked with Mary's parents on Sunday. They said they would give their answer in a week. Exactly one week later, the following Sunday, Tom asked again and Mary's parents gave their blessing to marry on Christmas Day.

10

A Home of His Own

Ever since Tom had discovered the wonder of telegraphs, he had dreamed of making them work better and faster. After many false starts, he created what he called a quadruplex telegraph, which could send four different messages on the same wire at once—two in each direction.

This time, he had come up with something that people really wanted. However, he wasn't paid as much as he thought he should have been for his invention. And inventing was expensive. He had to pay rent and workers, buy supplies, and make it all last for who knew how long until he created something that worked. How could he help the money he earned last longer?

While Tom puzzled over this, he and his team worked on their next creation: a special pen that pecked tiny holes in paper. People pressed ink through the holes and could make copies. Tom called it an electric pen.

Years later, the electric pen would inspire the creation of the photocopier. But Tom was soon consumed with another idea that would help him remain a full-time inventor and support his growing family.

In 1875, he purchased what was then an undeveloped pasture in Menlo Park, New Jersey, and made plans to move his shop there. A pasture? Really? The people he had worked with in New York City laughed at the idea of Tom among the cows. Nobody was going to go out there. They figured they'd never hear from him again.

While they laughed, Tom built a two-story wooden building, a hundred feet long and twenty-five feet wide, with a porch in front and a picket fence that kept out the cows. When construction finished in March 1876, Tom was twenty-nine, and he was delighted with the space. He had an office, a library, a machine shop, and an open laboratory space with long tables for his team to work at. He called it his Invention Factory.

He bought a three-story house nearby for Mary and their two young children, both of whom got their nicknames from Tom's beloved Morse code. Their daughter Marion, whom they nicknamed Dot, had been born in 1873. Thomas Jr., nicknamed Dash, was born in early 1876. William would be born two years later, in 1878.

Tom wished his mother could have lived to see her son happily settled with his family in their lovely home, and working in his Invention Factory. She had always encouraged him to go as far as his thoughts could take him.

Remembering how his parents struggled to keep the family fed and clothed, Tom was more determined than ever that his inventions would benefit everyone, not just the rich.

Tom made his Invention Factory a place where he and others loved to work—a place he couldn't wait to get to in the morning, a place he never wanted to leave.

He put a pipe organ in the building so he and his team could play music and sing, just as his mother used to do in their home long ago. He kept gaslights burning so they could work as long as they wanted. The gaslights weren't what he wanted—they were smoky and smelly, and people had to be careful to make sure they didn't start fires. Still, they made it possible for Tom and his team to work, eat dinner at midnight, and tell stories before going back to work. It was the life he'd dreamed of since he was a kid.

Tom called his team his "boys," and they called him "the Old Man"—even though he was younger than many of them.

When he was tired, he napped on a table. No one shook him awake. The boys were glad to see him get some rest—and to get some rest themselves!

When he was awake, he thought about his next project. He remembered how the first invention that he'd become obsessed with—the telegraph—connected people, allowing them to "talk" over great distances using Morse code.

Not everyone could or would master Morse code.

What if he could create a machine that would allow people to speak to each other using their voices over long distances?

pipe organ: musical instrument with pipes that make sounds

Yes, Tom dreamed of creating a telephone.

But he wasn't the only one with this dream.

Two other inventors—Scottish-born Alexander Graham Bell, living in Boston, Massachusetts, and Elisha Gray, living in Highland Park, Illinois—were working on the same goal. Bell got the first patent for a telephone on March 7, 1876.

Still, it was hard to hear callers on Alexander Graham Bell's telephone. Western Union, where Tom had started out as a telegraph operator and later became admired as the inventor of the quadruplex telegraph, asked Tom if he could improve on what Alexander had done.

Tom thought he could.

Tom studied how Alexander's telephone transmitted sound. When people spoke into Alexander's phone, the sound of their voice created an electric current—which meant the current didn't exist when nobody was speaking. Also, the current wasn't very strong, which was why it was hard to hear. If Tom added a battery that produced a constant current, the signal would be much stronger. He just needed to find a substance that would cause the current to vary in response to sound.

electric current: movement of tiny pieces of matter with electric charges
battery: device that changes chemical energy to electrical energy

Tom tried different materials.

Moist paper? No.

Felt? No.

Cork? No.

Chalk? No.

Graphite? No.

Tom tried and failed, tried and failed, tried and failed. But he wasn't discouraged.

As Tom would put it, every time people wondered why some of his inventions took as long as they did: "I have not failed," he would say, "I've just found ten thousand ways that won't work."

Finally, late one night, after a year of trying different substances, he went to put more oil in his kerosene lamp and was intrigued by the black carbon inside. He scraped some off, rubbed it on the disk of the telephone receiver, and *wow*! The sound became much clearer.

There was another change that Tom made. Alexander Graham Bell said *Ahoy*, a common greeting at sea, when he called or answered the phone. He hoped everyone would do the same. But Tom wanted people to say *Hello*.

Graphite: mineral that transmits electricity
kerosene lamp: lamp that produces light by burning an oil called kerosene

Even though Alexander used *Ahoy* on the phone for the rest of his life, it was Tom's *Hello* that stuck.

Tom didn't make a lot of money on his improvements to the telephone. After all, the invention was not his. But all the while, Tom's work was leading him toward becoming a household name. He was almost there.

11

The Wizard of Menlo Park

While working on the telephone, Tom had thought that there might be a way to record and reproduce the sounds transmitted. He attached a steel point to the vibrating part of the telephone, held it against some wax paper, and spoke into the mouthpiece of the telephone. The vibrations of his voice left a pattern on the paper!

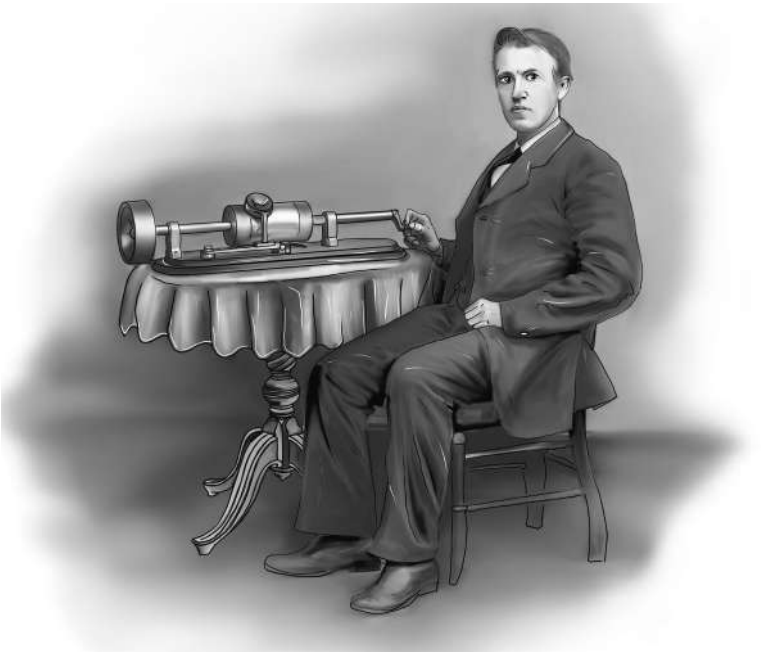
It reminded him of an old idea he'd had for an invention that could preserve sound and make it available to hear whenever someone wanted to hear it. Tom had set the idea aside at the time, but now he went back to it.

This time, some of the people who worked in his factory thought his idea was crazy.

It can't be done, people on his team said. Sure, now we know you can transmit sound over long distances with the telephone. But to preserve sound and replay it? That sounds . . .

They looked at each other. Tom knew what they were thinking. But he could picture what he wanted to create. He couldn't wait to try it!

If voice vibrations could make a fine steel point leave a pattern on wax paper, Tom thought, there must be a way to read that pattern in a way that would repeat the sound that had made it. He handed a drawing to his friend and team member John Kruesi. The drawing had a roller with grooves around it and a handle for turning it. There were metal tubes with diaphragms on either side of the roller. A needle stuck out from each diaphragm.



diaphragms: thin discs that vibrate

John and the rest of the team shook their heads. They'd never heard of anything like this. And yet, if it did work . . .

Just build the machine, Tom said.

John worked and worked through the night and the next day. Finally, he brought Tom the contraption. Tom told him to go home and get some sleep, but John refused. If the machine worked, he wanted to be the first to hear it.

"All right," Tom said. "But first I need some tinfoil." He had decided that tinfoil would work better than wax paper.

Tom wrapped the tinfoil around the cylinder. He turned the crank. The cylinder spun. He spoke into a tube:

"Mary had a little lamb, its fleece was white as snow . . ."

He turned the roller back to the starting point, put the second diaphragm needle in place, and turned the crank again.

And they heard, faintly: "Mary had a little lamb, its fleece was white as snow . . ."

Tom and his team laughed and whooped. Everyone took turns talking into the machine and hearing their voice.

Finally, after the boys left, Tom tinkered a little more.

When dawn broke, he picked up his machine, took a carriage to the train station, and strode to the office of *Scientific American* magazine.

The editor, Alfred Ely Beach, was surprised to see him.

"What's this?" Alfred asked. He peered at Tom's strange machine, trying to figure out what it was supposed to do.

Tom smiled. He recited, "Mary had a little lamb." Then he turned the crank as Alfred's staff huddled around, curious.

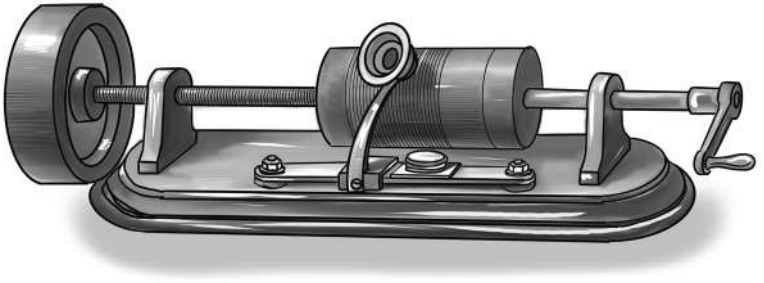
"Mary had a little lamb," the machine crackled.

People gasped and yelled. Alfred cranked it again. They heard Tom's words come from the machine again. They couldn't believe it! Soon, everyone in the building wanted to see and hear the phonograph. Reporters poured in to write about it. After stories ran in the magazine and the newspapers, President Rutherford B. Hayes asked Tom to bring the machine to the White House.

Tom imagined some of the ways the phonograph could be used. He wrote an article about how it could be used to read out loud to the blind, to play music, to create talking dolls, to take dictation at the office, and to preserve lessons for students. But soon his restless mind had turned to other inventions, leaving others to use his technology to develop these uses.

phonograph: machine that records sound
dictation: speaking that will be written down

The greatest impact the phonograph had on Tom was to transform him into a famous inventor, a miracle worker in the eyes of the public. Now thousands of people were making trips to tour his Invention Factory in Menlo Park, the place that Tom had built on an abandoned cow pasture in New Jersey—the place where so many were sure that no one would ever want to go.



12

Looking for Light

Everyone wanted to know what miracle the Wizard of Menlo Park had up his sleeve next.

But for once, Tom wasn't sure what that would be. Then a friend showed him an "arc lamp" that used electricity to give off light.

An arc lamp that used electricity? Tom remembered his childhood dream of inventing a light that was safer and cleaner than candles, oil lamps, or glass lamps. A safe light—a bright, clear light that wouldn't cause fire or blacken walls or give off a smell of gas. A light that allowed people to turn night into day. A light that everyone could afford. He needed to know more about this invention.

It turned out the arc lamp wasn't new. The first arc lamp had been invented in the first decade of the 1800s. In the 1870s, they were just starting to replace the gas lanterns on poles that lit city streets.

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arc lamp: lamp that produces light using electricity and gas

Tom studied the work of the other inventors. He was impressed to see how two carbon rods inside a glass bulb and a two-thousand-cell battery could create an arc of light across a four-inch gap.

But there were problems with the arc lamp. The intensity of the light was too strong for everyday indoor use. The light flickered and hissed, and the color changed with temperature and time. The battery ran out quickly and was expensive to recharge and maintain. It was a luxury that ordinary people wouldn't think of buying for their homes.

Tom believed that he could make something better, cleaner, and more affordable—a light that would be accessible for all.

Then, he did something quite out of character for him. He began bragging to reporters about his electric light—which he hadn't invented yet. Tom knew that in order to do the work that was needed for this particular invention, he would need a lot of money to pay his team and purchase supplies. Plus, early on, he realized it wasn't going to be enough to create a light bulb. He was going to have to figure out a way to provide electrical power for whole neighborhoods, cities, and the country—to power those light bulbs at a cost that everyone could afford.

If investors believed that he had succeeded in creating this light, they would provide the money needed, thinking that when people bought his invention, they would get some of that money, making them rich, too. So he told them he was going to light up an entire street in New York City!

The investors came through. But Tom insisted that he wasn't ready to show them what he was working on. That was because apart from his ideas, he actually had nothing to show. Tom and his team put their heads together.

Tom began by picturing a glass bulb that contained a material he called a filament, which would carry an electric current that would give off a soft, clear light.

Tom knew that the filament would glow for longer if there was no oxygen inside the bulb. So he would have to find a way to suck the air out of the bulb. Tom and his team found someone who had invented a vacuum pump that could extract air from glass bulbs.

But what could he use for the filament that would be better than the two carbon rods in the arc light? Tom thought and thought and thought. One night, while he was sitting in the laboratory, he glanced at the nearby kerosene lamp. He remembered how the black carbon

filament: thread-like object

inside had helped him make the telephone work better. His mind wandered as he began rolling the dark soot between his fingers until it became as slender as . . . a filament! Wait! Could this carbonized substance be the solution again?

He shared his idea with his team. They carefully bent the carbon into a horseshoe shape and slipped it into the bulb. It worked! It didn't work as well or as long as Tom wanted or needed it to work. But he knew he was on the right track. What if they tried burning—carbonizing—different materials for the filament?

They tried several metals.

Not good enough.

They tried fishing line. Coconut fiber. Spiderwebs. Celluloid. Cedar. Human hair. Cotton soaked in boiling tar.

More than a year went by as Tom and his team worked on the light. While they tried thousands of options, Tom's investors grew restless. Reporters grew skeptical, and when the money ran out, the investors wouldn't give Tom any more.

Tom and his team kept going. After all, as his mother

Celluloid: type of plastic that can be set on fire
skeptical: doubtful

had learned long ago, once Tom's mind got fixed on an idea or a problem he wanted to solve, there wasn't much hope of getting him to let it go until he was ready.

Then, one day, Tom asked for a spool of cotton thread.

Thread? It seemed too simple, especially after all the other things they'd tried. But they heated the thread until it carbonized. They carefully inserted it into the bulb.

And, after a few attempts, on October 21, 1879, the filament glowed for about fourteen hours! Tom and his team had done it! They had made a safe, clean light that worked inside a building. Now their big challenge was to keep quiet as Tom planned how to wow the public.

Tom told a reporter from the *New York Herald* that something amazing was going to happen. The reporter believed Tom. Four days before Christmas, a headline in

the *New York Herald* blared, "Edison's Light: The Great Inventor's Triumph . . . It Makes a Light, Without Gas or Flame." The editors at the *New York Herald* sure hoped Tom would come through.

Experimenting with Filaments

Carbonized cotton thread was the first successful filament Tom used in the electric light bulb, but it wasn't the last. His team would try cardboard after cotton and bamboo after that. But the filament that would ultimately dominate was tungsten, a brittle metal with a high melting point that was made pliable after years of work by scientist William David Coolidge. Coolidge introduced the tungsten filament to the market in 1910 and received a patent for his filament in 1913. By 1916, 85 percent of incandescent bulbs in the United States had tungsten filaments.

incandescent: emitting light; glowing

13

Let There Be Light

On New Year's Eve in 1879, thousands of people from New York and Philadelphia rode the Pennsylvania Railroad to Menlo Park. They arrived in tuxedos and ball gowns. The Wizard of Menlo Park was ready for them. Wearing his favorite clothes—an old gray shirt, a coat full of acid holes, and dusty trousers—he was mistaken by many for one of his workers. Tom busily checked the lamps that were strung on wires between leafless trees from the railway station to the laboratory. For a moment, it reminded him of the telegraph system he and his friends had set up in the trees when he was a boy.

Tom knew that the world was watching. Tom stepped forward and pulled a switch. Immediately the electric lamps glowed, casting light across the snow. As the crowd gazed at the night sky, they gasped! The Menlo Park magician had done it again.

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tuxedos: fancy suits

In 1880, Tom set up the first factory to make electric lights. Within a year, his factory was producing one thousand electric lamps a day. In 1881, he displayed the electric light at the International Exposition of Electricity in Paris, where his invention won two gold medals and a diploma of honor—the highest honor awarded at the exposition. In 1882, a chandelier comprising around 250 electric lights was displayed at the Crystal Palace Electrical Exposition in London.

But there was more to do. The next step was to install systems of electric power in New York City. Tom had launched the Edison Electric Illuminating Company, now known as Consolidated Edison Inc., in December 1880. The company's mission was to build power-generating stations throughout New York. He now bought two adjacent buildings at 255–257 Pearl Street in Manhattan, where he planned to build his first power station. He set up a factory in New York that he called the Edison Machine Works. There, he and his team worked on making the electric light accessible to all. They worked on the fuses, sockets, switches, and conductors needed to create electric power grids.

adjacent: next to each other
fuses: safety devices that can stop the flow of electricity
conductors: objects that allow electricity to flow

Tom persuaded city officials to let his team lay electric wires in underground pipes in the city in order to prevent short circuits and shocks. Many people were frightened by his ideas. What if these wires blew up the city?

Tom's team got to work, laying fifteen miles of cables in pipes that ran under the city streets. Tom stayed in the thick of it, helping install pipes with his hands, sometimes deep in the muck of the ditches, with mud coating his clothes the way soot coated the filaments in his light bulbs.

On September 4, 1882, without knowing for sure if it would work, Tom was ready to reveal what he and his team had been working on. They were all exhausted and in debt. There was a lot at stake.

Tom went over the science for what he had done in his head. It should work. But would it? One thing he had learned on this journey as an inventor is that many things can go wrong before you succeed.

On that day, at three o'clock in the afternoon, a switch was pulled at the Pearl Street station, and lights shone over one square mile of New York City. The boy who had struggled in school, who was almost deaf, had changed the world.

short circuits: instances of electricity flowing in a way it should not

14

Tom's Legacy

Tom had many ideas that were ahead of his time—including the electric car, which lost out to Henry Ford's gas car in the early 1900s but is surging back to popularity today.

But among all of Tom's inventions—and there were many wonders among the 1,093 patents he would accumulate over his lifetime—he will always be remembered as the father of the electric light. As with many of his inventions, he didn't create the electric light from scratch. In fact, he ended up buying other inventors' patents for their lights or merging with companies they'd formed. But there's no question that he had a genius for improving on what already existed and transforming it into things everyone could afford and use easily.

Electric lights are not just a joy and comfort for children who are afraid of the dark, as young Tom was—they changed the world. Electric lights save lives in hospitals and emergency situations. They made working

accumulate: gather

and playing possible after the sun went down, led to the creation of colorful holiday lights, and introduced breakthroughs in home appliances and factories.

When Thomas Edison died on October 18, 1931, at age eighty-four, everyone mourned. His body was allowed to rest in his favorite place, the library of his laboratory, surrounded by his books and test tubes, before he was buried. His funeral took place on October 21, the fifty-second anniversary of when he unveiled his incandescent light. On that night, President Herbert Hoover asked that all Americans dim their lights for one minute to honor the great inventor. For one minute, everyone was in the dark—as young Tom had been years ago, when he had first dreamed of finding a way to bring the gift of light.

Timeline

1854:	Tom's family moves to Port Huron, Michigan.
1859:	Tom starts selling newspapers on the train that runs between Port Huron and Detroit, Michigan.
1863:	Tom starts working as a traveling telegraph operator.
1869:	Tom moves to New York City, where he develops the universal stock printer.
1873–74:	Tom develops the quadruplex telegraph, which allows operators to send four messages over a wire at the same time.
1875–76:	Tom buys land in Menlo Park, New Jersey, where he builds an invention laboratory.
1877:	Tom improves Alexander Graham Bell's phone by adding carbon to the transmitter. He creates the phonograph and becomes known as the Wizard of Menlo Park.
1879:	Tom develops the electric light bulb.
1881–82:	Tom guides the building of a central power station at 255–257 Pearl Street, New York, that brings electric light to a square mile of New York City.
1887:	Tom builds a new, larger laboratory in West Orange, New Jersey.

1888:	Tom invents the kinetograph, the first motion picture camera.
1893:	Tom opens the Black Maria, the first motion picture studio.
1899:	Tom founds the Edison Portland Cement Company, which helps make cement a more affordable building material by improving the production process.
1900:	Tom develops a storage battery that he hopes will power an electric car. It ends up being used in boats, submarines, railway cars, traffic signals, miners' lamps, and buoys.
1928:	Tom is awarded a Congressional Gold Medal by the U.S. Congress.
1931:	Tom dies on October 18 in West Orange, New Jersey. President Herbert Hoover asks all Americans to dim their lights for one minute in his honor.

More Amazing Facts

Tom had many ideas that were ahead of his time. In 1900, he began working on a nickel-iron storage battery that he hoped would power an electric car. When his friend Henry Ford began selling his low-cost Model A cars that ran on gasoline in 1903, people lost interest in the electric car. So Tom used his battery to power other things, including boats and submarines, railway cars and traffic signals, miners' lamps, buoys, and homes out in areas that didn't have access to his electric grid.

One of his greatest inventions, which most people don't know he created, was the motion picture camera, in 1888. That's right—movies were invented not in Hollywood, California, but in Tom's lab in New Jersey. His movie camera was called the kinetograph, and it aimed to do for the eye what the phonograph did for the ear.

Tom built the first movie studio, which he called the Black Maria, to shoot films. And because movie lights didn't exist, he opened the roof and used the sunlight to shoot his pictures. The whole building was built on a track so that it could move with the sun. People couldn't view Tom's movies on a screen. They watched them through a peephole in a device called a kinetoscope. Tom even created the first device that played motion pictures with a soundtrack—the kinetophone, which combined a kinetoscope with a phonograph.

In August 1884—two years after Tom lit up New York City with electric lights, when he was at the height of his success—his beloved

wife Mary died of an illness. She was only twenty-eight years old. Their children, Marion, Thomas, and William, were eleven, eight, and five.

In 1885, Tom met and fell in love with Mina Miller, whose father was an inventor and a businessman. Tom taught Mina Morse code and proposed to her by tapping on the palm of her hand. They married in 1886 and had three children together: Madeleine, Charles, and Theodore.

Mina loved to entertain. The couple welcomed everyone from Orville Wright, who coinvented the world's first successful motor-operated plane with his brother Wilbur, to Helen Keller, who had learned to read, write, speak, and excel at academics even though she had been blind and deaf since before age two, and automobile maker Henry Ford, who began his career working for Tom at the Edison Illuminating Company in Detroit.

Tom encouraged Henry to pursue his passion to innovate the automobile. Tom continued to be a mentor and later a friend after Henry left his company and succeeded in his dream of producing low-cost gasoline-powered automobiles. Starting in 1914, Tom and Henry took annual camping trips along with their friends Harvey Firestone, founder of the Firestone Tire and Rubber Company, one of the first global makers of automobile tires; John Burroughs, a leader in the nature and conservation movement; and other friends, family, photographers, and servants. They called themselves the Vagabonds. They continued their trips until 1924, after which their fame made it too difficult to travel without attracting attention.

Discussion Questions

1. What would have happened if Thomas Edison gave up on the first or second or hundredth time his light bulb didn't work?

2. What qualities helped Tom succeed as an inventor?

3. Edison was almost deaf. In what ways was that a challenge? In what ways did it help him?

4. Edison learned differently. In what ways was that a challenge? In what ways did it help him?

5. If you had lived in Edison's time, would you be friends with him? What would be the most fun thing you would like to do with him? Set up a telegraph between your homes? Write and sell newspapers on the train? Invent things? Something else?

6. Edison liked to imagine things that would make people's lives better. What new inventions do you think would make our lives better?

7. Edison didn't work alone. How did it help him to be part of a team?

8. What kind of goals do you think you could accomplish if you put together a good team?

9. Sometimes, instead of inventing something new, Edison worked hard on making other people's inventions better. What kind of things already exist that you think could be made better?

10. Can you imagine a world where only rich people could afford electric lights and batteries? Edison wanted to invent things that were affordable for everyone. Why do you think that was important to him?

11. Edison said, "Opportunity is missed by most people because it is dressed in overalls and looks like work!" He also said, "Genius is 1 percent inspiration and 99 percent perspiration," "There is no substitute for hard work," and "I never did a day's work in my life. It was all fun." What do you think he meant by these statements? How can you apply that to your life?

12. Edison said, "What you are will show in what you do." What did he mean by this? He also said, "If we did all the things we are capable of, we would literally astound ourselves." What did he mean by that? How can these ideas help you in your life?

Meet the Author

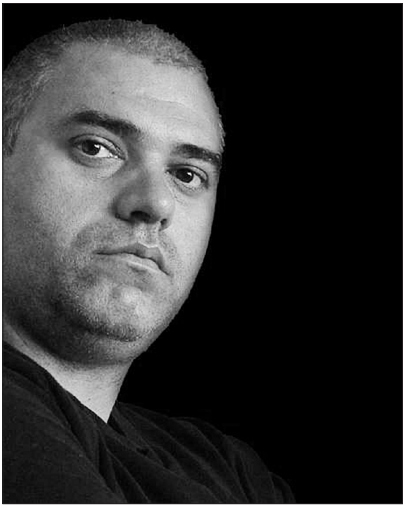
Nancy Churnin is an award-winning children's book author who writes about people who have made the world a better place and who inspire children to be heroes and heroines too. She admires Thomas Edison for his creativity, persistence, and determination to bring things to the world that made life better for all. Those are the principles she tries to follow as a writer, too.

Nancy won a 2021 National Jewish Book Award, a 2022 Sydney Taylor Honor Book award, and a 2022 National Communications Contest award from the National Federation of Press Women for *Dear Mr. Dickens*, a true story that inspired the creation of an educational

program at the Charles Dickens Museum in London. She has also won two Sydney Taylor Notable Book awards, for her works *Irving Berlin: The Immigrant Boy Who Made America Sing* (2018) and *A Queen to the Rescue: The Story of Henrietta Szold, Founder of Hadassah* (2021).

Born and raised in New York City, Nancy lives in North Texas, where she enjoyed being a theater critic for the *Dallas Morning News* before becoming a full-time author. Her books come with free teacher guides, resources, and projects she hopes you'll try on her website, nancychurnin.com.

Meet the Illustrator



Ivan Pesic was born in Blace, Serbia, in 1975. In 2000, Ivan moved to Belgrade, Serbia, where he studied graphic design in college. Unhappy with the political and economic situation in Serbia, Ivan emigrated to Virginia, USA, in 2005. Ivan and his wife, Alisa, have two children, Tara and Luka. His work can be seen in many galleries in Virginia, Washington DC, North Carolina, and Georgia. Ivan has also donated his paintings to public schools and charity organizations. The primary medium Ivan uses is acrylic and oil paints; however, he also likes

to experiment with different mediums and techniques. Aside from painting, Ivan has done pencil drawings, wall murals, mixed media art, photography, graphic design, and more. In his work, he reconstructs dreams, fairy tales, nursery rhymes, lullabies—the pieces of our lives and memories that are a part of us. Every piece of his artwork tells a story, stories with a hero, a villain, with action, movement, and other elements that give his work life and energy. Ivan's work can be viewed on his website: **www.ipartstudio.com**

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