FAMOUS AMERICANS
FOR YOUNG READERS

THOMAS A. EDISON

INEZ N. McFEE

THE · STORY · OF
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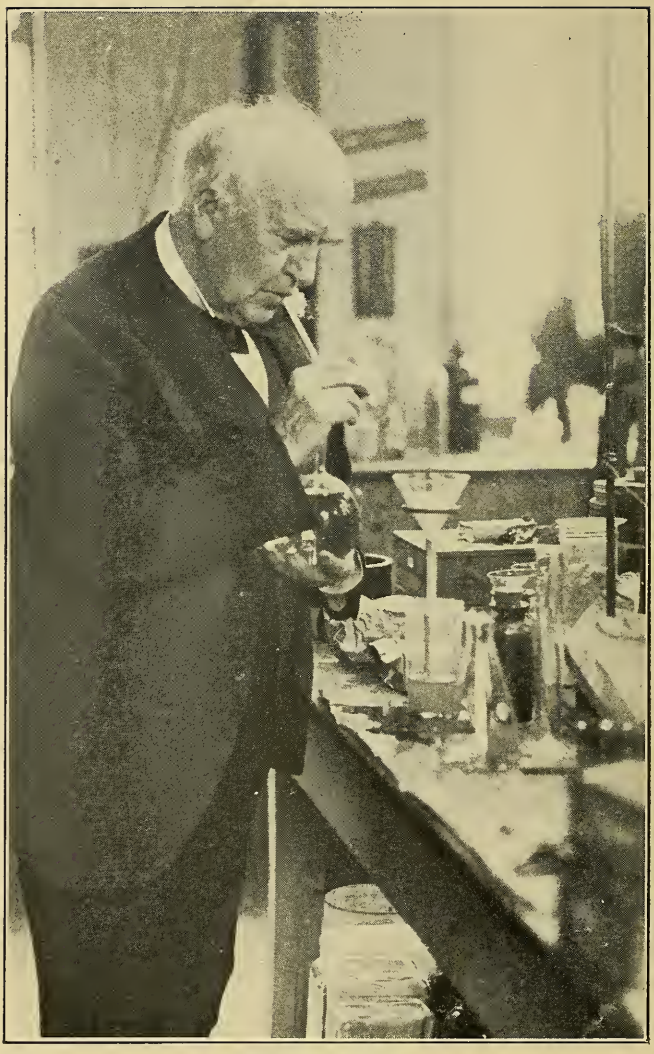

EDISON IN HIS LABORATORY

Hard at work, on his 74th birthday

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THE·STORY·OF THOMAS A. EDISON

BY

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BARSE & HOPKINS

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PREFACE

The life story of Edison abounds in surprises. Not alone for his achievements, but for his indomitable courage and ability to surmount obstacles does his career read like a fairy tale. In his boyhood he was "news butcher" on a train, and even then was experimenting in chemistry. But his improvised laboratory nearly burned up the baggage car, and he was thrown out bodily. Later he was a tramp telegrapher and earned the reputation of being one of the fastest operators who ever handled a key. A fortunate chance, for which he was ready, enabled him to establish a modest workshop at Menlo Park, N. J., which in the years to come was to grow into the present spacious plant at Orange. Here have been produced many marvels, now familiar to us all—the incandescent electric light, the phonograph, the motion picture, the improved storage battery, and literally hundreds of other things—and back of them all has been the genius of one man. He has been aptly called "The Wizard," and many of his discoveries seem magical, but he himself said they were simply the result of "taking pains."

That we are still only on the threshold of many wonderful things is evidenced by Edi-

son's own emphatic declaration: "We are just emerging from the chimpanzee state mentally. We don't know one-millionth of one percent about anything. Why, we don't even know what water is. We don't know what light is. We don't know what gravitation is. We don't know what enables us to keep on our feet, to stand up. We don't know what electricity is. We don't know what heat is. We don't know anything about magnetism. We have a lot of hypotheses, but that's all."

It lies perhaps for some of our readers to go on beyond the province of this book, to follow the great Wizard's zealous, untiring course, and to aid perchance in solving the mystery of some of these things, which are for the most part so common that most of us are incapable of recognizing them as problems at all.

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THE STORY OF THOMAS A. EDISON

I

BOYHOOD DAYS

The little town of Milan, Ohio, is to-day noted chiefly as the birthplace of Thomas Alva Edison. But on that cold winter afternoon, February 11, 1847, when occurred this event which was to have such influence in the lives of all mankind, it was a hummingly prosperous little grain-market, filled with bursting granaries which were loaded out to Eastern ports by way of the thrifty Milan canal. The Edison home stood within close view of the busy wharf, and something of its hustle and bustle must have communicated itself to the soul of the babe.

"A bonny boy he is," said the good neighbor who came to apprise the waiting father of the little one's safe arrival. "Fair and sweet, with gray eyes—the very image of his mother."

"Good!" exclaimed Samuel Edison huskily,

and his tall spare form seemed to add on an inch or two to its six feet. "If he is only like her in brains, and temper, too, he will indeed be a blessing!"

And well might the husband and father say this. Nancy Elliott, his Scotch-Canadian school-teacher wife had never been aught but a joy to him.

Little "Alvie" soon became all that his fond father desired. The child seldom cried. His temper, "from the moment he could distinguish between pleasure and pain, was an angelic one. He is said to have cracked jokes when a baby, and from the time when he began to take notice he was quite conscious of the humorous side of a situation." And, as soon as he began to talk, he started in on the endless series of *Whys* which were to occupy all his days! About the home, down the tow-path to the wharf, where he escaped as soon as his toddling legs would carry him, he was always meeting a *Why?* And, when those he questioned answered in sheer desperation, "I do not know!" he increased their annoyance by asking, "Well, *why don't you know?*"

Odd, yes and downright stupid were some of

those questions, or so it seemed to those who failed to fathom his drift, and they thought him not quite right mentally—"half-baked," as we would term it to-day. And, indeed, some of his own efforts at investigation gave truth to this; for instance, when he wanted to know how goose eggs turned into fluffy little goslings, and he was found calmly hovering the eggs himself, while the old goose hissed her angriest. Nearby was cached a supply of food for himself, in case the outcome proved of long duration!

He did not get on well at school. Few teachers were able to satisfy his constant queries, and they failed to understand him through lack of sympathy. Indeed, one almost broke the lad's heart by telling the school inspector right before him that there was no use trying to explain anything to little Al Edison, as the child was "too addled" to understand. Home he rushed at top speed and flung himself into his mother's arms, crying out his grief. Brave Nancy Edison! Her lips quivered and her own eyes filled with tears, for she was hurt to the quick and righteously indignant. Brains there were in plenty behind that broad fore-

head and those clear, questioning gray eyes, that she knew very well. Why, the child had mastered the alphabet and had learned to read almost by his own efforts! He was filled with a strong desire to know things, and he needed only to be guided in the right way. Forthwith, she determined herself to become his teacher. They would read and study together, and this she told him in a burst of enthusiasm which proved beyond a doubt what a champion she could be.

"My mother was the making of me," says Edison. "She was so true, so sure of me, that I ever afterward felt that I had some one to live for, some one whom I must not disappoint."

About this time the prosperity of the little community received its death blow. The Lake Shore Railroad had been established; it missed the town of Milan and "killed" the canal. The Edisons moved to Port Huron, Michigan, "a prosperous town whose chief characteristics were bustle and enterprise," and here they settled in a fine old homestead, in the midst of an apple and pear orchard, just at the edge of the town. The large roomy house had delightful

porches, where Al and his mother might always be found at certain hours, in pleasant weather, hard at work on schoolroom tasks which Mrs. Edison assigned and conducted with as much regard for rule and punctuality as she would have done had her pupils been fifty instead of one. And the young lad repaid her well. He needed never to be told a thing twice, and no lesson was too long or too hard for him. Reading and writing were soon mastered, but the third "R" was a debatable point—Al had no head for mathematics, and he would not try to learn—a thing, by the way, which he has never regretted. "I can always hire mathematicians," he once said to a friend, "but they can't hire me!" Geography, history and English were readily approached through the broad avenues of reading, the father contributing here by giving young Al a substantial reward for each new book mastered. Between the ages of nine and twelve, the boy had read Hume's "History of England," Sear's "History of the World," Gibbons's "Rome," "The Penny Encyclopedia," and several works on electricity and science.

But these lessons and associations, happy as they were, could not last. Tannie, the sister, was continually writing stories and verses and spoke quite confidently of the time when she should be "an author." Will, the elder brother, was exceedingly clever with his pencil and there was talk of sending him to Europe for an artist's training—a thing, by the way, which never materialized. As for Alvie himself, a chance book, Parker's "School Philosophy," had determined his future career. He would be a great chemist and an inventor. All his share of the profits for work early and late in his father's large market garden went for the purchase of experimental supplies. A corner of the cellar became his laboratory, and here were set up some two hundred or more of the bottles he had hunted and begged from all quarters. As each one was filled, it was in turn labeled "Poison" to insure its safe-keeping, for often his mother, resenting the continual encroachments made on her part of the cellar, was inclined to "clear out the trash!"

Presently the boy was familiar with all the chemicals obtainable in the small town, and had tried to his satisfaction many experiments

mentioned in his scientific reading. But this was not enough; he wanted to dip into other things. Just before his vision was the open door into analytical chemistry, and why he did not become a chemist to the exclusion of everything else was due perchance to the progressive order of the times. Every paper he picked up had something to say of the new wonder of the world—*electricity.* What was it? What might it not accomplish? Experiments with electrical batteries fired the boy with the enthusiasm of discovery. He must know more! He must have more money for experimental supplies! With his rich heritage of hustle and bustle, he determined to start some enterprise to float himself independently, then no one could complain of his wasting money, and he at once confided the idea to his mother, who, a trifle awed by the boy's sureness, asked almost timidly what work he thought best suited to his qualifications.

"Well," said young Al, with that characteristic largeness and freedom which was always his, "it does not matter much what I do, so long as the work is honest and brings in the cash!"

After due deliberation, he decided to sell newspapers. And he made known his plans with a businesslike directness which argued well for his future prosperity.

"I do not want to hawk papers on the street," he said. "Why wouldn't it be a good idea to apply for the job of selling on the Grand Trunk road between here and Detroit?"

A railway newsboy! His mother's vivid imagination at once pictured the train in a ditch, and her ambitious offspring lying killed and bleeding beneath the débris. But young Al laughed away her fears, and soon got her to help write out his application. Then, believing that "everything comes round to him who hustles while he waits," he set about finding where he could obtain his supplies the most advantageously.

Sure enough, his industry had its reward, and Al was the happiest boy in the whole country. Needless to say, he was a quick success. People liked his bright face and pleasant manners; his stock was neat and clean; he had what people wanted, and they bought liberally.

The train left Port Huron about seven in

the morning and was three hours reaching its destination; the return trip began at four-thirty P. M. This left young Al with considerable time on his hands in Detroit. It only took a few minutes to replenish his supplies; so he went over to the public library, where he at once determined to read the place through in the days while he waited. But, he tells us laughingly, in later years, "Other things interfered before I had done!"

It was an easy time for a "newsy" to work up a trade, but the story of Edison's first *coup* is none the less interesting for all that. It was his custom always to drop into the composing room of the *Detroit Free Press* and look over the proofs. In this way he could judge how many papers to buy. The Civil War was then in progress, and one day his quick eye caught the news of the terrible disaster at Shiloh. Racing around to the telegraph office he begged a friendly operator to wire ahead to the stations on his line, requesting the agents to chalk up on their bulletin boards that papers telling about a terrible battle would come in on the next train. In return he offered the operator newspaper service free for six months.

Then young Al went back to the news office.

"I want one thousand papers on trust," he said, looking the foreman squarely in the eye. "I know I can sell 'em," and he proceeded to detail his plan.

The man heard him through, and then clapped the lad heartily on the shoulder. "You are a genius, kid," he said. "But you'll have to see the boss."

Upstairs, young Edison asked for fifteen hundred papers! He got them, too, and as he said later, "Then I felt happier than I ever have since!"

At the first stop, where he usually sold two papers, he sold five hundred. The town had turned out *en masse!* Taking his cue from this, at the next station Edison asked ten cents per copy, and the price reached twenty-five cents before he got to the end of the run! Then a few papers remained. He put these in a cart and went up by the church where prayer meeting was in session. Calling out the news of the battle, he soon had the minister and all the congregation clamoring about him, bidding against one another for the precious sheets. He had made a small fortune for a boy, but

best of all he had shown that he had shrewd business sense.

While waiting around the composing room Al learned to set type. And then he had another bright idea: he would himself edit and publish the *Grand Trunk Herald,* and thus add further to his precious hoard. Securing the gift of a quantity of old type, and buying for a small sum a press which one of his numerous friends had taken on a bad debt, he set about realizing this scheme. The result was such an interesting little sheet that more than once an item from it was copied in the *London Times!* The paper sold readily, and not infrequently through the kindness of his telegrapher friends young Al beat the newspapers to an important scoop. In four years he had earned something like $2,000, which, aside from the sum he insisted on paying for his board, went the way of all his funds.

To-day, so far as is known, the only existing copy of the *Weekly Herald* hangs in the library of the Edison home. Mrs. Edison has proudly had it enclosed in a case-like glass frame, and the well-preserved sheet, 12x16 inches in size, may thus be read on both its

interesting sides. It is a pleasing memorial of the activities of a fourteen-year-old boy, and in spite of a few errors in spelling and English, would challenge most youths of the present to do as well.

The *Herald* and his duties as a newsboy still left Edison with a margin of time on his hands. True to his thrifty training, he at once turned this to account by establishing a laboratory in his end of the car. And here, as might have been expected, he one day came to grief. A bottle of phosphorus jarred from its shelf, and igniting at once set fire to the car. The hot-headed Irish conductor, incensed at the danger to his train, soundly boxed the lad's ears, and threw the precious chemicals and apparatus out the window. It was a dire calamity, but the worst feature was the permanent deafness which developed in the boy's right ear, as a result of the cuffing, an affliction which no amount of surgical skill was ever able to remedy, and from which Edison suffered all his life, even though he himself regarded it philosophically.

"Broadway is as quiet to me as a country village is to a normal person," he once said.

"While working as a telegrapher, my deafness was a distinct advantage. I could hear only the instrument on my own table, and I had not to contend with the noise that unstrung the nerves of the other operators. In like manner, my deafness helped me in working out the telephone transmitter and the phonograph." It also helped him to preserve poise all through the years by giving him those blessed moments of utter relaxation, frequently snatched on the job, where sleep would otherwise have been impossible.

Though he never dared reëstablish his laboratory on the train, young Al was not to be discouraged. His spare time was given to reading and to mapping out plans for home experiments. In time his little corner in the cellar came to occupy a very large share of the boy's thoughts, for his publishing business came to an inglorious end. Following the ill-advised counsel of a lad who loved all manner of pranks and mischief, the title of the *Herald* was changed to *Paul Pry,* and its contents became mostly "take-offs" of prominent citizens and the officials of the road. Whether merited or not, these articles were never very well

received, and the paper lost heavily in prestige. The end came when one irate gentleman cornered Al, and after telling him exactly what he thought of his obnoxious paper, promptly took the young editor by the coat collar and the slack of his pants and threw him into the canal! As he swam ashore, Al sensibly decided that the career of a sensational publisher was undesirable, and he determined to abandon the business in favor of electricity and telegraphy.

But the time for the necessary experiments to make his work practical grew more and more inadequate. He had to be off shortly after six in the morning, and he did not get home until after eight at night. Moreover, his father, a stern disciple of the old maxim, "Early to bed and early to rise," stoutly insisted on his going to bed promptly at nine-thirty. Nor was he to be cajoled or tricked; such efforts always ended in disaster. What was to be done?

A few evenings later the boy came home without his customary supply of reading matter.

"Where are the papers?" asked his father, eyeing him disappointedly.

"We were pretty well sold up," Alvie returned innocently, "and Dick took what was left. I've had 'em all lately."

"Was there anything of particular interest?"

Al mentioned a few topics. "I tell you what, father," he said enthusiastically, "I might have Dick send in the news as his dad reads it aloud. We could all enjoy the paper that way!"

"Hmm!" observed Mr. Edison dubiously. He had small faith in Al's telegraphic ability, having always regarded as more or less of a nuisance the wire between the two homes, which the boys had industriously fashioned at odd moments, using an old river cable, some stovepipe wire, and glass-bottle insulators. However, it was this agency or a mighty dull evening; so he followed the lad, without a word, even though the heedless old clock cut into the procession with its very loudest chime, announcing nine-thirty!

Dick, of course, was all primed and waiting, and the news soon began to come in. Industriously Al scribbled off the items with flying fingers and handed the slips to his father as fast as each "special" was finished. It was

exhilarating business, and for nearly two hours Mr. Edison did not once bethink himself about the time!

Al had won. This method of procedure held for ten days or more, then the boy took to bringing in papers again, and he and Dick were left to their own devices. No longer did the nine-thirty signal sound an extinguisher in their midst!

Other boys became interested, and soon half-a-dozen or more houses in the neighborhood were connected. One of these recruits was always rather a duffer at the game. He couldn't get the signals over the wire, and he would stick his head out the window and yell across to know what messages had been sent—a procedure which always roused young Edison. He took it as a reflection on his telegraph, and to be sure the line was not altogether above reproach. How could it be, with the crude materials with which the small inventor had to work?

One night a stray cow played the part of a miniature cyclone among the wires which stretched hither and yon across the orchard, and the damage was never made good. For

the principal investor shortly had the opportunity of telegraphing without the responsibility of constructing and keeping up his line. But this is another story.

II

THE YOUNG TELEGRAPH OPERATOR

How young Edison became a real telegrapher, instead of a boy experimenter, is an interesting story. Al's train had taken the siding for a fast freight, when the boy, stepping out for a breath of fresh air, was horrified to see little Jimmie Mackenzie, the station master's two-year-old son, come rushing laughingly into the path of the oncoming engine. It was a matter of seconds, and the quick-witted boy sprang for him headlong, while the startled onlookers gasped shudderingly as the shrieking engine tore by. All felt that the brave young newsboy had made the leap in vain. But, lo! when the scene cleared there was Al on the opposite side of the gravel, with the blood running down his face from a cut he had received, but with the child safe in his arms. Moreover, he was as cool as a cucumber, and smiled away the father's incoherent thanks as he thrust the baby toward him and

made for his own train, now beginning to move. He had but done his duty, and so far as Al was concerned the chapter was closed.

But not so with Mr. Mackenzie. All day the circumstance flashed before his eyes, and he turned over one after another considerations as to how he might in a measure repay the young newsy's quick-witted action. At last he hit upon the proper thing, and when Al's train appeared on the next run he sought the boy out.

"See here," he said earnestly, "how would you like to stop off here four nights out of the week and study telegraphy with me?"

"Why—ee—" Al gazed at him in speechless delight, but the eagerness with which he grasped the operator's outstretched hand served better than words.

Forthwith began a friendship that ended only with the death of the gray-haired agent years later. For three months, according to schedule, young Edison dropped off at Mt. Clemons, and never did a teacher have a more absorbed pupil. Not a detail escaped him, and presently he knew even more about his subject than did his instructor. There was a

vacancy as night operator at the Port Huron station, and on Mackenzie's recommendation young Edison applied for the position, and got it. The salary was $25 a month, and seldom has there been a happier boy than young Al when he made known his good fortune at home.

He gave up his job on the train at once, and set about his new duties with a gay good will. Unfortunately, however, the work was not very heavy. The boy had but to record the passing of trains, and these were so infrequent that the time hung heavily on his hands. Moreover, he soon became desperately sleepy. He would not sleep daytimes, as other night operators did; for then he would have had to give up his beloved shop work, a procedure not to be considered even for a moment. So an alarm clock was purchased, and set to arouse him when trains were due. But sometimes the trains were off schedule, and again and again Al slept straight through all alarms. The despatcher was uneasy, but he liked young Edison and was disposed to be lenient. So, as a safeguard, he ordered the boy to send in the signal "A" every half hour. Al did so, albeit he considered the proceeding rather fool-

ish and that it was up to him to get round it. A few nights later he arrived with a small box in his pocket, and as soon as he had the office to himself, proceeded to connect the rather queer looking instrument he had brought by wires with the clock and the telegraph. Then he sat back with a broad grin and awaited developments. Nor had he long to wait. The hour hand was almost on the half hour, and at exactly that instant one lever of his ingenious machine threw open the key and another flashed the Morse "A" along to the despatcher. The boy's inventive ability had served him well! But lest there be some hitch in the operations he drew up a chair and read until another half hour had gone by. Promptly the little "dummy" did its duty, and then young Edison, with a boyish salute in the despatcher's direction, as promptly composed himself for slumber. He had two or three perfectly good hours before a train was due.

All went well for some time. The despatcher, being signaled night after night, so promptly on the hour, began to regain confidence in Thomas A. Edison. There was good timber in the boy after all! But murder will

always out. One night the despatcher happened to be at a neighboring station. He thought he would call up young Edison and test out his abilities a little. He signaled time and again and getting no answer began to fear something had gone wrong at Port Huron. So he jumped on a hand-car and went down, arriving almost on the half-hour. Looking in at the window he saw young Edison sound asleep. At the same moment, the despatcher's quick eye was attracted to the clock and its wired connections, and he stood spellbound while the faithful little levers performed their valuable services. Then, notwithstanding the ingeniousness of the little machine and the talent which it undoubtedly revealed, he walked in and shook the boy into wakefulness, telling him in no uncertain terms that he dared not trust him further. There was too much danger involved. So, breathless and not a little chagrined, young Edison found himself out of a job.

But he could not stay away from the station. The telegraph instruments, the wires and their complications, drew him as a magnet draws steel. So many times did he ferret out trouble

and right matters that the lineman finally threatened to give him a hearty licking if he didn't quit trying to undermine his job!

Finally Edison got back into service as telegraph operator at Sarnia, over the Canadian line. As it was day service, there was no danger of his sleeping on the job. But there was another little fox which he was not proof against. His love for mechanical devices, short-cuts, *would* interfere, and one day he let a train pass which he should have held, as there was another train just ahead. Realizing his mistake instantly, he rushed frantically down the track in a perfectly useless effort to avert the tragedy. Fortunately, however, the engineers heard one another's whistles and were able to stop in time. Young Edison was so relieved at this that he did not much dread the summons to the chief's office. However, when he learned that he really stood in grave danger of the penitentiary, he resolved to get away while the going was good, and took a "tie-pass" at once, presently arriving in Indianapolis, where he found little difficulty in securing a job at $75 per month.

In those days, good telegraph operators

were scarce and the ranks of what few skilled men the country could boast had been sadly depleted by the war. It was a condition which bred "tramp" telegraphers, as it offered an opportunity to see the country and earn one's way en route. And Edison determined to make the most of it. In the next few months he handled important wires in Memphis, Cincinnati, New Orleans and Louisville. One who records this period says: "He lived in the free-and-easy atmosphere of the tramp operators—a boon companion with them, yet absolutely refusing to join in their dissipations. So highly esteemed was he for his honesty that when a spree was on hand the others asked him to keep their money for them."

At Louisville, the young operator especially distinguished himself by taking press reports. He received Andrew Johnson's presidential message in just one hour. He then paragraphed the copy so that the printers could take it in exactly three lines each, thus enabling them to set up the whole thing in record time. For this valuable service the Louisville press gave him a state dinner!

On one occasion young Edison arrived on

the new job looking so much like a veritable hayseed that the office force decided to "salt" him. Accordingly, a speedy man was duly posted, and young Edison seated to take what he sent. But "Tom" Edison, as he was now called, "Al" and "Alvie" having been left behind with his boyhood, was by no means as green and easy as he looked! Almost immediately he sensed what was in the wind, and draping the old linen duster, which he wore in lieu of a coat, over the back of his chair, he took up a pen, examined it carefully, and started in about fifty words behind. A broad grin spread across the room in his rear, but it didn't last long. The machine on the young fellow's table began to hum "like an old style Singer sewing machine," but "the jay" was in no wise flustered. Swiftly and smoothly his pen moved across the paper, leaving behind it a trail neat and legible as copper-plate; he crossed his "t's" and dotted his "i's" and punctuated carefully, for the copy was to go to the press room at once; while the plainly numbered sheets flowed from his desk and scattered like feathers in a gale. Presently the Memphis man began to feel his spurt of speed

and slowed down, and Edison quickly seized his chance. Opening the key instantly, he cut in: "Well, get a move on! Maybe you think you are running a primer class!"

A murmur of admiration ran around the room. Careless and untidy the newcomer might be, but he was no slouch at the board, that was certain! He must easily have been averaging fifty to fifty-five words per minute, and no doubt he could send as rapidly as he could receive. Thenceforward not a man there but was ready to stand by Tom Edison through thick and thin!

In Boston, young Edison took a different tack. For some time the office had been terribly pestered by cockroaches, especially in the anteroom where the night operators kept their lunches. Edison objected to sharing his scanty rations with such a villainous horde, and, one evening, he proceeded to lay an ingenious trap. By means of some tinfoil and fine wire he placed a double "ribbon" around the outer edge of the table top where the lunches were kept, and then connected up with two heavy batteries. News of the proceedings went round, and the whole force gathered to

await results. The cockroaches were exceedingly clever! They knew to an instant when fresh supplies might be depended on, and shortly after six-thirty, they always issued like a mob of mill operatives, and made a raid on the table. Scarcely had young Edison completed his work, when the advance guard made its appearance, and the robbers came on full tilt. Up the table legs they swarmed, each one eager to be first, yet keeping in line as good scouts should. The trail of ribbons halted the advance corporals, but pushed and harried by those in the rear, the crossing was attempted. Tentative steps on the first ribbon brought no dire results, and the second was attempted, when presto! over went the cockroach buddies, "as dead as a free message."

It must not be inferred that Edison had become so deeply engrossed in telegraphy as to forget his old passion for experimenting. On the contrary, to this he owed in part his status of "tramp telegrapher." He simply could not keep a job. His mind was too much occupied with the thousand and one schemes he had in hand. He was seldom on time; for wherever he worked, he managed somehow

to have a shop around the corner. It was nearly always past the hour for him to be on duty, before he recollected that he really had a bread-and-butter job which he could not afford to neglect. When hauled over the coals, he always expressed his regret and promised to reform. But he never did. And he was always broke! Books and apparatus, and occasional aid to some poor fellow-employee who was out of luck, took all his capital. Whenever he found himself minus a situation, he was usually in such straits, that unless he could secure a pass he had to walk to the new field, and when this was a matter of a hundred miles or so, it was anything but a laughing proposition.

His quest for supplies often led the young experimenter into questionable situations, and on one occasion came very near being serious. On one occasion, Edison dropped into an auction, and to his delight shortly became the owner of a great stack of *North American Reviews,* for the small outlay of two dollars. They made a sizable bundle, but the young man had no money to spend for delivery charges, and besides he was already overdue at the office. So he carried the load with him,

and no doubt had much ado to keep his mind on his work until he was free. This was about three o'clock in the morning. Then, with the heavy burden on his shoulder, he set out at a great rate for his lodging. As he emerged from a dark alley which he had taken as a short-cut, his weighted, stumbling appearance aroused the suspicion of a policeman, and he called out sharply, "Halt, there!" But Edison did not hear him, and hastened onward. Convinced now that it was a burglar making off with his loot, the policeman drew his pistol and fired, again repeating his command. Edison, on account of his deafness, did not hear the order, but the bullet whistled uncomfortably close to his cheek, and he turned, seeking an explanation. In an instant, the officer was upon him, and Edison had to open his bundle to clear himself.

"Well, my friend," grunted the policeman, then, divided between chagrin and relief, "if I was as deaf as you are, I'd go a little slow on these kind of expeditions. Why, if I had been a better shot, I might have killed you!"

"One day," records Milton Adams, who chummed with Edison during his Boston

sojourn, "he bought the whole of Faraday's works on electricity, brought them home at four o'clock in the morning, and read steadily until I arose, when he made for Hanover Street, about a mile distant (where we took our meals) to secure breakfast. Edison's brain was on fire with what he had read, and he suddenly remarked to me: 'Adams, I have got so much to do and life is so short that I am going to hustle,' and with that he started on a run for breakfast."

Throughout all his career as a telegrapher, Edison rarely accepted a day job. He wanted these hours for his experiments, and it often puzzled his friends to know when and where he slept. Not in office hours, he had to give that up, and when not on duty he was nearly always to be found hard upon the heels of some problem at his shop. When he was fifty-five, a reporter asked him if he kept regular working hours.

"Oh," said Edison, "I do not work hard now. I come to the laboratory about eight o'clock every day and go home to tea at six, and then I study or work on some problem until eleven, which is my hour for bed."

"Fourteen or fifteen hours a day can scarcely be called loafing," suggested his interviewer.

"Well," replied the Wizard, "for fifteen years I worked on an average of twenty hours a day."

III

OUTCROPPINGS OF GENIUS

Anxious days, however, were still ahead. Edison had given up his job as a telegrapher to promote the vote machine, his first invention, and he did not intend to bind himself to an operator's table again. There were plenty of other schemes in his head waiting to be worked out. What he needed was a laboratory of his own, and skilled workmen to assist in evolving his many projects! But he might as well have wished for the moon. He had no money, and without capital it was clearly impossible to be what he most desired to be—a great inventor.

In the emergency, he did what many another in search of a career has done—he somehow made his way to New York, arriving with scarcely enough cash in hand to rent a respectable lodging, much less purchase the books and apparatus which he must have. Good Luck, Fortune, Invincible Determination—what you

will—led him shortly afterward into Wall Street and to the head office of the Law Gold Indicator, where he hoped he might find an opening. And never was an arrival more opportune.

The indicators or stock-tickers of this company furnished "Gold news" to five or six hundred brokerage offices. And on this particular morning the machines had chosen to balk. Not only were all the repair men on the job, but in waiting were the head officers, and the uneasy messengers from each frantic broker, who was thus put summarily out of business. Edison walked into the hubbub, and managing, at length, to get close up to the "trouble finders," stood for a few moments an interested observer, his quick eye taking in all the complexities of the machinery, and *something else.* Then he made his way to Mr. Law.

"If you please, sir," he said quietly, "I believe I can put things to rights."

The great man stared, but his reply was emphatic: "Go ahead!"

Without hesitation or bravado, quite in fact as though he had been at work in that particular shop every morning for a year, Edison

leaned over the machinery and connected up a loose contact spring, and at once the indicators began doing business with their usual chirpy routine. The befuddled repairmen looked foolish indeed. Mr. Law touched the shabby stranger on the arm and said briefly: "Step into the office, young man!"

Edison came out a full-fledged technical overseer of the Law Gold Indicator Company, at a salary of $300 per month, and thus the first rung on the ladder was reached. Now, with such a princely salary, he could begin in earnest, and forthwith the young man's dream —a real laboratory—began to take shape. Bottles of chemicals lined the shelves, batteries of various kinds were bought and made, and "inventions" of many sorts got under way, mostly along the lines of telegraphy and electricity. And here Edison was happy indeed! Way into the "wee small hours" he worked, and sometimes all night through; for then, as now, he held Time in contempt, and would never carry a watch. "The time to quit was when the job was ended!" he maintained, and woe to the man who sought to interrupt or distract him! Deeply imbedded in his marrow

was the axiom of an old Scottish editor who had these words engraved above his desk: "Nothing is worse for those who have business than the visits of those who have none."

As might have been expected, however, one of the first things to which the young inventor turned his hand was an improvement of the stock-ticker. Presently the president of the company asked him what he wanted for his devices. Modest in his demands, Edison was about to say $5,000, when good sense came to his aid—in those days no one had ever heard the phrase "passing the buck"—and he substituted instead that he would rather the president made him an offer. Thereupon, he almost fell out of his chair; for the president named $40,000 as the sum the company was willing to pay! "My mouth flew open to voice my astonishment," said Edison, later. "But I was really too flabbergasted for speech, and the general, misreading my expression, quickly stated that it was the best they could do. I rallied then and played my part, quietly accepting the handsome sum."

Check in hand, Edison mechanically made for the nearest bank,—he had always been used

to cashing checks as soon as received. But when he thrust the slip into the window, payment was refused. "He would have to be *identified,*" the teller said. In his muddled condition, the real meaning of this failed to seep into the inventor's brain. He felt only that he had been "done," and he turned confusedly away and was leaving the bank, when he was met by an acquaintance, a man well-known in commercial circles, who quickly connected the young fellow's moody face with the slip in his hand, and paused to ask the trouble. How he laughed when Edison explained! But he put his arm around the young man's shoulder and walked him over to the cashier's window. Edison was soon "identified" to that individual's satisfaction, and the money was promptly forthcoming. "A great stack of it," as he afterward described the bundle of bills which was handed out to him. Placing the funds about his person, he got out, more in a quandary than ever. What should he do with such a vast sum? He knew how he wanted to invest it all right, but that would take time. Meanwhile, where could he keep the money? Banks were none too stable in those days, and

he was afraid to trust them. "He carried the money about with him for two days," says one of his biographers, "and probably no one before or since has ever been so inconvenienced by an overplus of wealth. In the end a friend persuaded him to open an account at a reliable institution."

Feeling himself now independent of a monthly pay-check, Edison gave up his position in the Law Gold Indicator Company, and removed his workshop to Newark, New Jersey, where he soon had a factory of his own in operation, and an experimenting shop, and the assistants he had so long desired. He began by manufacturing his improved stocktickers, for the substantial part of his business, and this work met with very considerable success. But Edison soon found that manufacturing and invention did not go well together. "I was a poor manufacturer," he says, "because I could not let well enough alone. My first impulse upon taking any apparatus into my hand, from an egg-beater to an electric motor, is to seek a way of improving it. Therefore, as soon as I have finished a machine I am anxious to take it apart again in order to make an

experiment. That is a costly mania for a manufacturer."

Shortly after the organization of his factory, the friends who interested themselves in the proceedings were surprised to find that the inventor had not installed a book-keeper. "Why," said they, "you can not hope to succeed without an accountant. You can not yourself be bothered with all the little details of profit and loss and keeping things straight." So a book-keeper was hired, and after seeing him installed in his proper niche the inventor promptly forgot all about this part of his business. For a year and a day he bought, invented, manufactured, and sold, and then suddenly the "man of figures" appeared before him with a sheet setting forth a "Statement of the Twelve Months' Business." Edison took a hurried survey, and then gave a boyish whoop of joy. For the figures showed a gain of $8,000 during the year!

"That is fine!" cried the inventor, shaking hands as enthusiastically as though all of this good fortune had been brought about directly by the book-keeper's own efforts. "We must celebrate!" And he gave orders on the spot

for a great banquet to be spread in the stock-room.

Such a gathering as the invitation assembled! All the members of the plant, from the overseer down to the least errand boy, sat down at the bountiful board, and no one was gayer than the host, as the eats and drinks fast disappeared and everyone talked and laughed and jested at once. It was a great success—a banquet long to be remembered! And Edison paid the bills for it with a glad heart, albeit a little cloud was rising in his own mental offing. He had been pondering matters a bit, and he couldn't quite see where the profits had been secured, or what had become of them. Accordingly the book-keeper was summoned to the private office. A busy two hours they made of it, and, as affairs progressed, Edison's face grew sober and long and the puffed-up accountant shrank into a nervous, red-faced, totally overwhelmed official. For divers errors had been made, and when the debits and credits had been sorted, instead of a profit of $8,000, there stood a plain loss of something over $7,000.

So much for the usefulness of a book-keeper!

Edison had all along felt that such an individual was entirely superfluous, and he eased himself of a few very tart remarks. Then his own good sense conquered. He knew the accountant could neither make nor mar the business. So he indulged in a hearty, if somewhat rueful laugh, over what the grand banquet had really celebrated, and heartened the book-keeper with the cheerful remark that "maybe they would do better next year!"

It was apparent to Edison that his factory and his laboratory must be separated. He could not put a quietus on his ever-recurring *"Why?"* and *"What if?"*, nor was it desirable that he should, for his ambition was still unchanged, he wanted to be a great inventor. So, in due time, a capable manager was found for the Newark factory, and the following year really did show a very excellent profit. But there was no banquet of rejoicing, for Edison himself was now deep in many things. Subsequently he moved out to Menlo Park, on the New York and Philadelphia Railroad, twenty-four miles from New York City, where he built a wonderful workshop and laboratory, and established a costly scientific library. But

this momentous event was not until after he had achieved certain of the triumphs in telegraphy, which are recorded in the next chapter, when all the world was following his work with keenest interest, and the title of "The Wizard of Electricity" had become stamped upon him.

IV

EXPERIMENTS IN ELECTRICAL TELEGRAPHY

Back in the days when he was employed in a railroad office in Indianapolis, Edison worked out his first telegraphic invention, and says he, "Necessity was certainly the mother of it!" Edison and a young fellow named Parmley got into the habit of taking press reports in their spare hours at night, in the place of the regular man, who was thus happily enabled to enjoy a little "vacation."

"I would sit down," says Edison, "for ten minutes, and 'take' as much as I could from the instrument, carrying the rest in my head. Then while I wrote out, my pard. would serve his turn, and so on. This worked very well until they put on a new man at the Cincinnati end. He was one of the quickest senders in the business, and we soon found ourselves totally at sea. We simply could not keep up with him. Clearly something had to be done, and I presently solved the difficulty. I got

two old Morse registers and arranged them in such a way that by running a strip of paper through them the dots and dashes were recorded on it by the first instrument as fast as they were delivered from the Cincinnati end, and were transmitted to us through the other instrument at any desired rate of speed. They would come in one instrument at the rate of forty words a minute, and would be ground out of our instrument at the rate of twenty-five. Then weren't we proud! Our copy used to be so clean and beautiful that we hung it up on exhibition; and our manager used to come and gaze at it silently with a puzzled expression. He could not understand it, neither could any of the other operators, for we used to hide my impromptu automatic recorder when our toil was over. But the crash came when there was a big night's work—a presidential vote, I think it was—and copy kept pouring in at the top rate of speed until we fell an hour and a half or two hours behind. The newspapers sent in frantic complaints, an investigation was made, and our little scheme was discovered. We couldn't use it any more."

Another little labor-saver cropped out in the office at Memphis. Here messages that came in from New Orleans for New York had to be sent on to Louisville, taken again, and so forwarded by half a dozen relays to their destination. Of course in so many repetitions boundless errors were prone to creep in, and the service left a good deal to be desired. Naturally, too, the clumsiness of the system attracted Edison's eye. In a short time he had perfected an automatic repeater, which could be attached to the line, and so send the messages on of its own accord. The device worked very well, and might have been advantageously taken up by the company. But it happened that a relative of one of his employers had a similar instrument on the way to completion; so, instead of advancing his own interests, Edison's ingenuity cost him his job!

Here again, however, failure served only to teach the young inventor a lesson. If he meant to succeed he must somehow install himself in the favor of the Western Union, for any telegraphical device which he invented must be taken up by them to insure its profitability. So, as he set to work in earnest in his

Newark shop, on a scheme which he had long had in mind, he kept a weather eye open to the main chance. And Fortune favored him: shortly news drifted in that there was a serious breakdown in the line between New York and Albany. Tom Edison at once dropped everything, and presented himself before the president of the company.

"Look here," he said, "if I fix up this difficulty within two or three hours, will you take up an invention I have in hand and give it honest consideration?"

"Yes, sir," returned the president heartily, "we will consider anything you care to send us now or any time, if you get us out of this fix *within two days!*"

Away went young Edison at a speed equaled only by his zeal. Down at the main office he called up Pittsburg and asked for their best operator. When he had him, he told him to get hold of the best man at Albany, and to have him wire down along the line and see how near he could come to New York. Inside of an hour came the message: "Can wire down to within two miles of Poughkeepsie." It was only a short run to this point, and a

train was just due. Inside of his own time limit, Edison had the line in operation, and the way paved for his next triumph—an invention called the duplex telegraph, which had resulted from the query, "Why can't two messages go over the same wire in opposite directions at the same time?"

Gladly indeed did the Western Union take this up, for it would not only double the capacity of the single wire, but it would save the company thousands of dollars. Edison, however, was not satisfied with the performance of his invention: for another query had immediately intervened. Why couldn't *four* messages be sent just as well? He felt sure that they could. And presently he had evolved the quadruplex device, by which two messages could travel simultaneously in each direction. Now two sending and two receiving operators were employed at each end of a single wire, and the value of each line was multiplied by four. The principle involved was simple enough: the electrical currents used were of differing strength and each receiving machine would record only from the current specially adapted to it. This invention saved unreckon-

able millions to the Western Union in wire and repairs, for now by the use of the quadruplex a thousand miles of wire was changed presto into four thousand. Edison was paid $30,000 for his triumph. But he spent it all trying to invent a plan to carry six messages simultaneously on one wire! This attempt was never a commercial success, so that, while the quadruplex telegraph was the greatest invention so far conceived in connection with electrical telegraphy, it did not add one cent to the inventor's finances. However, it was the invention and not the money which concerned Thomas A. Edison; for, even after he had lost the $30,000 in experimenting upon further triumphs for one wire, he was not ready to give up.

And again his perseverance won! He produced the harmonic multiplex telegraph. By this invention tuning-forks, or "reeds," moved by electro-magnets, serve as keys to transmit impulses over the wire. At the opposite end are more tuning-forks, which vibrating with the same frequency, "pick up" the current which belongs to them, and give no heed whatever to stronger or weaker currents. A num-

ber of tuning-forks can be operated at the same time, and as many as sixteen messages have gone over the wire together, eight each way, by means of the harmonic multiplex system.

All this time Edison had been steadily improving the main telegraph system, patenting various little devices one after another, which the Western Union eagerly took up and exploited, and he now turned himself to the question of speed. The best of operators could turn out but thirty or forty words per minute, while the characteristics of both line and receiving apparatus allowed of a much greater rapidity. "We ought to have automatic senders and receivers, capable of transcribing three or four hundred words per minute," Edison concluded, and set himself to the problem.

He worked out a scheme of perforating paper tape with Morse characters, the tapes being afterward run through a transmitter at a great speed. The message was to be received by means of an inking device which recorded the same in Morse code upon a receiving tape. But the ink: that was the real problem. No fluid had then been manufactured which would serve the purpose. So Edison turned chemist!

And how hard and untiring he worked at this new stunt is best told in the words of Charles Bachelor, his friend and chief-assistant in those all-absorbing days:

"I came in one night," he says, "and there sat Edison with a pile of chemistries and chemical books five feet high. He had ordered them from New York, London and Paris. He studied them night and day. He ate at his desk and slept in his chair. In six weeks he had gone through the books, written a volume of abstracts, made two thousand experiments on the formulas, and had produced a solution (the only one in the world) which would do the very thing he wanted done—record over two hundred words a minute on a wire 250 miles long. He ultimately succeeded in recording 3,100 words a minute."

And still the half has not been told! For many of these scientific works over which Edison pored so industriously were in French and German—languages in which he was self-taught and still far from perfect. He literally had to grub his way through them. But he mastered these as he did his other problems.

Edison's next invention, the autographic

telegraph, might never have sprung into being had the telephone then been the thing of perfection and general use that it is to-day. The object of the autographic telegraph was to reproduce in one place the counterpart of a message written by the sender in another place. It rose from the necessity for communication between the different departments in business concerns, and it served further to supply written orders which might be filed away for future reference. To-day there are various forms of writing telegraphs, that devised by Elisha Gray and known as the telautograph being the most complete. The instruments find their chief use in banking houses, department stores, clubs, and government institutions for the transmission of orders from the various department heads. Edison's scheme provided that the message be written with a pencil on a specially prepared paper. And here again he delved into chemistry to produce what he required.

Edison's "grasshopper telegraph" was his most unique work in the telegraphic field. It arose from the query: "Why can't messages be sent from the fast-flying train?" And while

it provided successfully for communication between telegraphic stations and moving trains, it was never much of a commercial success, for the reason that few people found such messages necessary. This system, which transmitted messages across an air space of as high as 560 feet between the wires and the cars, probably gave Edison his first inkling of wireless telegraphy. He had unbounded faith in this triumph and applied for a patent as early as 1885.

"Wireless is going to be the telegraph of the sea," he said, then. "The time will come when anyone on the maritime exchange may send out a wireless message and catch any vessel afloat in any part of the world and change her routing. I don't think so much about the outlook for the wireless system on land. That field is practically occupied. But the ocean field is open. I think it will be only a question of a few years before wireless is developed to a point where it will be a practical and important factor in the industrial world."

But other things were claiming Edison's attention and he was not free to push the matter with his customary zeal. The Government

with its slow and tardy precision, took six years to act upon his claim and finally allowed him patent rights in 1891, but now others had entered the lists. Marconi in particular had taken up the subject, and Edison was quite content to give way to the young Italian, for whom he held the deepest admiration and confidence, feeling that in him rested the ability to perfect the scheme and bring it into practical working order round the world.

Edison's last telegraph message, with himself as the operator, was sent in 1896, during the Electrical Exhibition in New York. For twenty-six years he had scarcely given a thought to telegraphy, and the friends who now jokingly asked him to take a turn at press reporting were of the opinion that he would not know a dot from a dash. Indeed, Edison himself was a little dubious as to the outcome, but he accepted the challenge, and the little company went down to the telegraph room of the New York *Journal*. Once inside the place, however, a smile swept the Wizard's face, as he stood listening to the machines nearest him, clicking out their messages from all parts of

the world, and he observed genially: "Oh, I guess I'm all right yet."

Then, to the amazement of all, the old champion calmly sat himself down in the appointed place and began speedily to reel off in his inimitable "copper plate style," the message that poured in rapidly from the main office, while he selected and lighted a cigar with his disengaged hand, and went on without a break to the end; then he commenced to repeat the message just to see how he could send. This, too, was accomplished with speed and accuracy, and the inventor rose in delight.

"I believe I could receive or send if I live to be a thousand," he said smilingly. "It is not a thing one forgets. It read as easily as book print, but it kept me scratching to set it down."

V

EDISON AND THE TELEPHONE

No modern invention has had a more rapid and interesting evolution than the telephone. To-day it is a household and business necessity. Yet, less than forty-five years ago the public had never heard of such a thing. On its first appearance, the Western Union was asked to buy the telephone, but they laughingly said that they had no use for an electrical toy! To-day there are ten times more telephone than telegraph wires and their earnings are eight times more. As many messages are telephoned as are sent by the combined service of telegraph, post, and messenger.

The wonder now is that the telephone was not discovered by the many who sought to improve the telegraph, for nearly all of these men sensed the possibility of transmitting speech by wire. Only one of them, however, followed up the trail and put out a working model. This

was Alexander Graham Bell. "Had I known more about electricity, and less about sound," he is reported to have said, "I would never have invented the telephone." And this is the real reason the telegraph inventors did not secure this triumph: they were working to make an instrument to carry the voice, but they went at it by telegraphic methods.

So slowly did things move at first that it was almost a year after its invention before the telephone showed any business activity. Then the wave of popularity rose; in three months 778 telephones were in use, and the Bell Telephone Company was organized.

Now, indeed, the Western Union began to realize the value of an opportunity lost. To their dismay, business men demanded the telephone. What could they do about it? The answer was plain: get out a competitive instrument. They at once formed the American "Speaking-Telephone" Company, and took their difficulty to Thomas A. Edison, the man who had for so long spelled success and popularity for them.

"See here," they said. "We want you to get us out a telephone."

"Very well," returned Edison.

No sooner did he begin than his practised eye speedily detected the thing that was barring the progress of the telephone—the transmitter. Indeed, there was "no such animile!" The Bell people were talking into a magneto receiver. "And," says Edison, "you never heard such a noise and buzzing as there was in that old machine! I went to work and monkeyed around, and finally struck the notion of the carbon button and the induction coil."

Simple enough it sounds in the telling! We can only guess at the number of hours of thought and experiment that went into it. One strong ally Edison had in the beginning, the knowledge of the variable resistance of carbon under pressure. He had made use of this in various inventions. And it stood him again in good stead. The carbon transmitter improved Bell's invention a hundred-fold, and the Western Union was delighted.

"We will give you $100,000 for your rights," said the president.

"Very well," returned Edison, by now so used to flattering terms that he was skilfully able to conceal his surprise. It had been such

THOMAS A. EDISON
From a photograph taken in early manhood

a comparatively easy job that he had fixed $25,000 in his own mind as about right. "But," he continued, "there is one condition: that is that you do not pay me a lump sum. I want $6,000 every year for seventeen years—the life of the patent."

Then was Mr. Orton's turn to be surprised. But he agreed with equal promptness.

"By that stroke," Mr. Edison naïvely recorded later, "I saved seventeen years of worry! If I had taken the cash all at once, it would have gone the way of all my money. My ambition in those days was about four times ahead of my capital!"

And small wonder, with as high as fifty inventions on hand at one time, and as many employees, often high-priced men, working at piece work.

But to return to the carbon transmitter. Imagine the chagrin of the Western Union when it was found that Edison could not fit his invention to a telephone instrument of his own. There were certain points where he could not help but infringe upon Bell's claims. The thing simply could not be done. Likewise Bell tried to adopt Edison's scheme in a dif-

ferent way, but he could not do it. Each had an invention of little use standing alone, but invaluable when combined. The Western Union tried to build Bell 'phones with Edison transmitters, but this couldn't be done either. Nor did anything but heavy lawsuits result from their attempt to buy up and establish claims prior to Bell's. In the end a compromise was effected, whereby the Bell Telephone Company became the sole owners of the telephone system.

The carbon transmitter did not by any means end Edison's usefulness in the field of telephony. Once interested, he went on improving receivers and transmitters and taking out one patent after another for his various designs. He also evolved many systems for the transmission of speech which included all kinds of carbon instruments—the chemical telephone, the inertia telephone, the water telephone, voltaic pile telephone, mercury telephone, and condenser telephone. The electro-motograph receiver, involving what the Wizard termed his "electro-motograph principle," is deemed Edison's second triumphant contribution to telephony. The Western Union paid him $100,-

000 for its application to telegraphy, Edison arranging the same novel terms of payment as he had for his carbon transmitter. Curiously enough, too, this invention also came at the instigation of the company.

The Page patent, which related to the movement of the lever at the other end of a telegraph wire by magnet, had been bought up by a rival concern, and Mr. Orton went to Edison in considerable perturbation. Unless some way could be found to get around this, the Western Union's position was critical indeed. For, as matters then stood, possession of this "relay and sounder principle," as it was called, was vital to telegraphy.

"It seemed a pretty hard job," said Edison. "No one had ever conceived of withdrawing an armature lever except by magnet. But I went at it that night. And I had one thing for a base: some years before I had chanced upon an interesting and very peculiar phenomenon. I found that if a piece of metal connected to a battery was rubbed over a moistened piece of chalk resting on a metal connected to the other pole, when the current passed the friction was greatly diminished.

When the current was reversed the friction was greatly increased over what it was when no current was passing. So I substituted a piece of chalk turned by a small electric motor for a magnet, and then connected a sounder to a metallic finger resting on the chalk, when presto! the Page combination was as dust and ashes in Jay Gould's covetous grasp!" [1]

Mr. Edison's remarkable instrument, the electro-chemical or loud-speaking telephone, which can be made to sound three or four times as loud as a man can shout, rose from the conflict between the Bell and Edison patents in England. "Send us a receiver without a magnet," cabled Edison's agent. "We are restrained from the use of Bell's device." A large order! Anyone but an Edison would have been "stumped," for the magnet was a prime factor in converting the sound waves into electrical waves and *vice versa*. But not so the Wizard. He turned triumphantly to his electro-motograph principle again, and shortly had in hand his ingenious "chalk receiver," which consisted simply of a cylinder of chalk

[1] Mr. Gould was then the chief owner and director of the Atlantic and Pacific Telegraph Co., an organization which harried the Western Union at every turn.

moistened with certain chemicals, a thin spring, and a diaphragm of mica in a resonator. And the result was wonderful! "A much too ingenious invention," wrote Bernard Shaw, who was then in the employ of the Edison Company, in the establishment of telephone exchanges abroad; "it is a telephone of such stentorian efficiency that it bellows your most private communications all over the house, instead of whispering them with some sort of discretion." But it saved Edison's foreign trade, and eventually brought him a draft of thirty thousand pounds for his English rights. And here again the inventor had the laugh on himself! He accepted the offer thinking it was for thirty thousand dollars, and when he found that it was for thirty thousand *pounds* instead, his surprise amounted almost to consternation.

Marvelous performances were wrought with the various developments of the loud-speaking telephone, in the days when any kind of a telephone was a curiosity, and people would assemble in great crowds to witness a demonstration. At the first public exhibition in New York the hall was packed with a delighted

audience who listened to "such enchanting novelties" as *Mary had a little lamb, Jack and Jill, John Brown's Body,* the alphabet, whistling, laughter loud and long, and such other inspirations as came to Mr. Charles Bachelor, who was at the other end of the wire in a distant part of the building. "A truly remarkable invention," everybody said, but nevertheless there was some dubious head-shaking when it was announced that by the use of the electro-chemical telephone a man talking in New York had been heard 1,000 feet from the receiver in an open field at Menlo Park.

Few people sensed the workings of the telephone. They had understood the telegraph readily enough. It was easy to see that by simply breaking and joining a current, dots and dashes might be made; but it was a different matter to conjecture how the exact tone and quality of the voice could be heard and understood miles distant. Not many people believed like the school teacher who was called on for an explanation—that *the wire was hollow and they talked through it*—but they didn't understand it, and they looked upon it simply as an electrical freak,—a thing totally without

a future. That was forty odd years ago. To-day 12,700,000 telephones are connected to the Bell system. There are 25,700,000 miles of wire, with a total investment of $1,450,000,000, and a force of employees numbering 235,000.

Aside from his valued services in training countless telephone experts to establish exchanges both at home and abroad,—a story which there is no space here to relate,—Edison did another thing in its way as valuable as the induction coil and the carbon button. When telephones were first set up, it was customary to ring the bell and ask ponderously "Are you there?" or "Are you ready to talk?" Edison did away with this, one day, so the story goes, when he yelled "Hello!" into the transmitter, in his delightfully brief and matter-of-fact fashion. *Hello!* No other word could be so altogether pat, and it has gone around the world, as essential to telephony almost as electricity itself.

VI

THE STORY OF THE PHONOGRAPH

It is to the phonograph, more perhaps than to any other of his inventions, that Thomas A. Edison owed his title of "Wizard." And small wonder—there is something positively uncanny in the ability to take a few pieces of metal and preserve sound so that it may be kept for centuries to come. Yet the inventor himself regards the phonograph as one of the simplest of his inventions. "Why," said he, "it all but discovered itself."

It was back in those busy Menlo Park days, of 1877, when he was busy with the telephone transmitter. While working with a disk of carbon, having a sharpened pin point on the back of it, Edison noticed that when he spoke against the disk, the sound vibrations made the point prick his finger. Instantly the inventor called to mind the *phonautograph,* a discovery made by Leon Scott, some twenty years before. This consisted of a piece of bladder

stretched over a frame, with a hog's bristle fastened stoutly in the center. When words were spoken close against the frame, the membrane vibrated with the motion of the sound waves, causing the bristle to scratch a little wavy track or *sound picture* of the human voice on a revolving cylinder which had been well-coated with lamp black.

"Hmm!" mused Edison, as the pin point gave him another jog. He saw that he had gone a step farther than Scott. But he was too engrossed with the work in hand to consider anything else just then.

Another day he was absorbed in a device for the automatic repetition of telegraph messages. Busy with feeding a strip of paper into the sending machine, which recorded the dots and dashes of the original message in a series of indentations, "The Wizard" saw that he was making pictures of the sounds communicated by the telegraph message on paper.

Pictures of sound! There it was again! And quickly the great inventor was on his feet. "Boys," he cried excitedly, "I can make a talking-machine!"

Eagerly reaching for pen and draughting

paper, he began at once upon the specifications, while the boys, used as they were to their chief's doing great things, stared at one another with disbelief plain upon their faces. In ten minutes the model was complete, even to the piece-work price $8, in Edison's trim figures in one corner, and he summoned John Kruesi, the best workman then on his force.

"How soon can you get this out?" he asked.

Kruesi's keen eye took in the details with lightning quickness. "I do not know exactly, sir," he said, "but I will do my best."

Edison knew Kruesi's best. It was a force as keen-edged and as tireless and indefatigable as his own. Well he knew that neither time, food nor water would interfere with the progress of the model, and he turned again to his own work, dismissing the matter entirely. For he had no great faith in this first draught. He thought he might possibly "hear a word or so that would give hope of a future for the idea."

Thirty hours passed, and then Kruesi presented himself with the completed device. And a crude, clumsy enough affair it was—as little like the perfect machines of to-day as one could well imagine. The cylinder turned by hand

and the indentations were to be made on tinfoil. For the first phonograph was planned to make its own sound pictures and then to reproduce the sound on the spot.

Edison looked at the machine a bit dubiously, and the boys gathered laughingly around. "I'll bet a box of cigars it don't work," observed Carman, the foreman of the machine shop, *sotto voce.*

But Edison, like most deaf people, often hears when he is least expected to. "Done," he returned, in the quick, sportsmanlike comradery which made him so beloved by his men, and then, leaning forward and slowly turning the handle, he spoke into the mouthpiece:

"Mary had a little lamb,
Its fleece was white as snow,
And everywhere that Mary went
The lamb was sure to go."

Then the cylinder was returned to the starting place, and to the astonishment of all there came sharp and distinct, in a curious metallic voice, the little time-worn verse, just as Edison had recited it.

Imagine the triumph of the moment! Few inventions have ever been conceived and exe-

cuted so swiftly. Kruesi's eight-dollar machine, the world's first phonograph, could not be bought to-day at any price. It is in the patent office at South Kensington, London.

Never before did an invention arouse a quicker and more world-wide interest. Newspapers and magazines, both at home and abroad, were quick to take it up, and Edison himself, in an article in the *North American Review,* set forth his ideas for the use of the phonograph. He saw in it perfection for the telephone and the telegraph; it could be used in the court room for keeping an accurate record of all proceedings—an item of no little moment on occasion; it would be invaluable for the entertainment of patients in hospitals and asylums, and as an elocution or language teacher; public speakers could by its use reach unlimited audiences; it would be a vast booster for speed and accuracy in offices,—the boss need only to open a drawer and speak into a receiver. When the typist was ready, she could adjust her ear-tubes and set the machine going, and any time she failed to understand she could reverse the record, and so right herself without calling down wrath!

"Furthermore," said Edison, continuing his prophecies in his own happy, whimsical fashion, "the phonograph will undoubtedly be largely devoted to music—either vocal or instrumental—and may possibly take the place of the teacher. It will sing the child to sleep, tell us what o'clock it is, summon us to dinner, and warn the lover when it is time to vacate the front porch. As a family record it will be precious, for it will preserve the sayings of those dear to us, and even recite the last messages of the dying. It will enable the children to have dolls that really speak, laugh, cry, and sing, and imitation dogs that bark, cats that meow, lions that roar, roosters that crow. It will preserve the voices of our great men, and enable future generations to listen to speeches by a Lincoln or a Gladstone."

Carrying out his idea of preserving the voices of the great, Mr. Edison filed away, in his beautiful country home at Llewellyn Park, a wonderful collection of records embodying the voices of Gladstone, Tennyson, Bismarck, Browning, Henry Ward Beecher and countless other noted personages. The story is told that once upon a time Edison was exhibiting these

"Voices" for the benefit of Henry M. Stanley, the explorer, and his wife. Mrs. Stanley interestedly inquired whose voice he would choose to record, if he might have the pick of all the great men of the past, and Edison instantly answered "Napoleon's," nor could any amount of argument shake him from this decision.

Many years ago, Edison added a further wise suggestion for the use of the phonograph: that of recording the works of the great writers of fiction. He himself dictated a considerable extract of *Nicholas Nickleby,* thus finding that six cylinders, twelve inches long and six inches in diameter would record the entire novel. As yet, however, this part of the phonograph business has not received the attention that is bound to be given it. Think what such a treat would mean to the blind, or to the one who comes home with eyes worn out from the day's strain, or even of the satisfaction to yourself to put on the record of your favorite story, the while you accomplish some task you have been dreading!

Naturally, in its infancy the phonograph was the subject of a good deal of curiosity. To satisfy a universal demand for phonographs

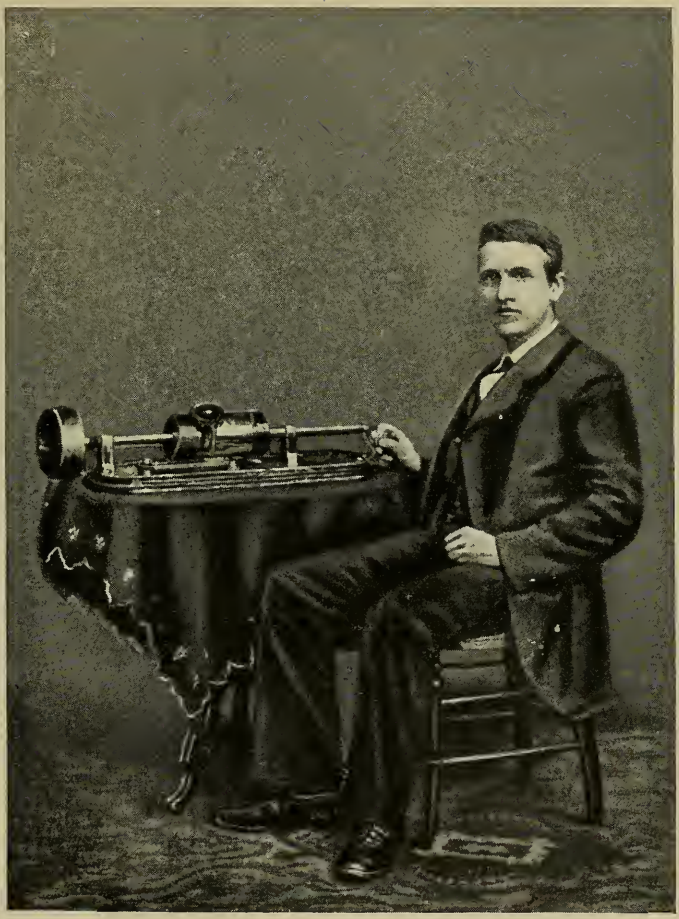
for exhibition purposes, Edison had a number of machines made and turned them over to some of his force to exploit. Needless to say, these fellows had the time of their lives! Great receptions were accorded them wherever they went. In London, for example, Gladstone, Lord Rowton, and the Earl of Aberdeen were the hosts of the hour, and wonderful indeed was the attentive interest, which amounted almost to awe, in the varied program that was given.

In Abyssinia, the record first produced spoke a message of friendship and good-will in Queen Victoria's own voice. Emperor Menelik listened with profound attention, first as the voice came from the trumpet, and then with the ear tubes. After repeating the operation two or three times, he stood for a long time in profound silence; then roused himself and ordered a royal salute to be fired, while he stood respectfully before "the speaking mechanical beast."

In Thibet the phonograph first appeared in Lhassa, the religious capital of the Buddhist faith, in 1897. To this ancient town none but Buddhists are supposed to have entrance. But

hither, one day, traveled a Burmese merchant, with an Edison phonograph to show to the Grand Lama. He knew that in this land prayerwheels were constantly employed to reel off written or printed prayers, and he felt that if he could introduce a machine to speak prayers instead, his fortune would be made. Somehow he had managed to get a record made of one of the sacred Buddhist writings, and the surprise and astonishment of the monarch and his dignitaries may be imagined when they heard the machine declaim what was to them a miracle. Their delight knew no bounds when the monarch himself spoke the beautiful prayer, "Jewel in the Lotus," into the machine, and the cylinder being reversed, the words came back to them in the Grand Lama's own tones! Thereafter, for many days the phonograph was kept busy, and needless to say the fondest dreams of the Burmese trader were realized.

The boys in Edison's laboratory were not slow in finding out that one record might be run over another with astonishing results, and "trick" records formed the side-splitting sport of the noon hour. The possibilities of the



THE YOUNG EDISON AND HIS FIRST PHONOGRAPH
From a photograph

phonograph as a practical joker, too, were not neglected. Indeed, Edison himself set the pace in this latter instance, for nothing has ever given him keener enjoyment than to "get a good one" on some of his friends. On a certain occasion, he hid a phonograph in a guest's room, and then timed the gentleman's retirement to a nicety. Scarcely was he comfortably settled in bed, when a clock struck eleven, slowly and solemnly, and a hollow voice announced in measured tones: "One hour more!" What in the world? The visitor sat up in alarm. Had the hour of doom arrived? For some minutes he waited motionless, and then good sense conquered. He lay down again, but try as he might he could not sleep. He was waiting for the midnight hour! After a century or so, as it seemed, the clock chimed forth, and almost on the instant the awful voice announced: "Twelve o'clock! Prepare to die!" The guest, however, was in anything but a docile mood. Springing from his bed, he leaped into the hall at one bound, there to be confronted by Edison in convulsions of mirth!

Naturally, it is a wide step from the first models of the phonograph to the beautiful mod-

ern adaptations of the builders' art, and many people have had a hand in it. But it is to Mr. Edison and Mr. A. G. Bell, the inventor of the telephone, that we are indebted for most of the improvements in talking mechanism. Tinfoil was found practically worthless—the impressions were imperfectly made and by no means durable. Wax was the next experiment, but it, too, proved imperfect. Next Edison delved into the subject of animal and vegetable oils, trying every known element, both domestic and foreign, and at last, after a protracted session of five days and nights, fixed upon the material used to-day, which is in plain language no more nor less than a special kind of soap! Having found the best material for making records, the next step was to bring their production up to a fine art.

And here again Mr. Edison spared neither pains nor expense. Indeed, the phonograph is the one invention in which he has never lost interest, and upon it he has expended a prodigious amount of energy, putting in night after night in his laboratory in his efforts to secure the most perfect reproduction of sound possible, in all taking out nearly one hundred pat-

ents on improvements. Obviously, the greatest shortcoming of the machine was its lack of realism, and it is upon this point that most of Mr. Edison's efforts have been directed, until now it is baffling even to the most expert ears to distinguish between living singers or instrumentalists and the reproduction or recreation of their work.

VII

THE ELECTRIC LIGHT

Edison had been working with electrical appliances for a decade, and had won his Wizard's title, before the electric light seems even to have remotely occurred to him, and then it came in the form of a question to a statement which the world of physicists and electricians had made conclusive, that subdivision of the electric current was impossible.

"Why?" asked Edison, and, following the habit he had acquired long ago of testing the truth of every assertion, no matter on what authority, he "went to work and monkeyed around," and presently satisfied himself that the learned men were wrong. He was sure that the electric current was not only possible of subdivision, but that the result could be made highly practicable. "There is no reason," he said to himself, "why we can't light our homes by incandescence. Moreover, by the

use of small motors, the same current which furnishes light can be made to run the washing machine, the sewing machine, the churn, and all sorts of household machinery."

That year, 1877, was "carbon year" in Edison's laboratory. The Wizard had just completed the carbon transmitter, and had on hand a half dozen miscellaneous carbon articles. Indeed, carbon of some sort, as we remember, had served him in every one of his telegraph and telephone inventions. Naturally, he turned to carbon at once for first aid. And his initial trial marked the originality that was his in every method of procedure: he lighted a strip of carbonized paper up to incandescence —*white heat*—in the open air, merely to see how much current was required for the process. Of course on becoming incandescent the carbon oxidized and the paper went to pieces, just as Edison had known it would. Various inventors with an incandescent lamp in mind had tried carbon with like results, and it had been discarded by them as hopeless. But the Wizard had accomplished what others had pronounced impossible too often to put credence in anyone's attempts but his own. So now,

having determined the strength of current, he put a like strip of carbon in a vacuum, discharging the air by means of a handworked pump, and this time the carbonized strip burned at incandescence for about eight minutes. Then it oxidized and went to pieces as before, and the Wizard straightway began a contest to prevent this. Various expedients were tried, the most ingenious being coating the carbon with powdered glass, which in melting would protect the carbon from the atmosphere. But all attempts failed, and Edison, not yet ready to give up his beloved carbon, was compelled for the moment to set it aside and try something else.

Experiments were now made with platinum wire, and with such refractory metals as boron, ruthenium and chromium, brought to incandescence in the direct circuit, in connection with powdered silicon and a mixture of silicon and lime and other very infusible non-conductors in glass tubes. Some of these offered possibilities, but they were not simple enough for practical commercial purposes.

Then these interesting experiments were interrupted by the unexpected discovery of the

phonograph. For a year and more Edison's time and attention, day and night, were absorbed by the invention and exhibition of this new miracle. Finally in July, 1878, feeling the need of a vacation, and wishing also to test his tasimeter, an instrument devised by him for measuring heat transmitted through vast distances of space, he joined an expedition to the West to observe an eclipse of the sun. Two delightful months of rest followed, and the Wizard came home keen to take up something new. What this should be was determined by a visit which he now made, in company with Professor Barker, of the University of Pennsylvania, to the brass manufacturing establishment of Wallace & Farmer, at Ansonia, Connecticut. The members of this firm were zealous pioneers in the field of electricity, and Edison saw much about their plant to interest him. For example, the place was lighted by arc lamps—the first the Wizard had seen—but the light was too glaring, too altogether big and bright for indoor purposes.

"It was easy to see what it needed," said Edison later. "It needed to be divided. And Barker laughingly suggested that here was a

problem for me. 'Why don't you go at it, Edison, and subdivide the electric light so that it can be got in small units like gas?' I said that I *had* monkeyed with it a bit, and I was convinced that the thing could be done. Then you should have seen their faces! They thought it could not be managed, of course, in any practical way. Farmer had a room in his house, at Salem, lit up by means of electricity, using small pieces of platinum and iridium wire, which were made to incandesce by means of current from primary batteries. But the whole system was crude, and the lamps hopelessly short-lived. A real serviceable incandescent lamp seemed but an inventor's dream. However, I went home fully determined to take up the search, and make good my word."

Three things the inventor had already settled as the essential features of a perfect incandescent lamp:

1. High resistance.
2. Small radiating surface.
3. Capability of working in "multiple arc," or so that each lamp could be turned on or off without interfering with any others on the circuit.

Perhaps the first two items do not mean very much to you, but to the electrician they stand as the commercial key to the whole problem. For they spell the *weight of the copper used,* and so determine the cost of the lamp. And here again the business side of Edison came to the fore. "We can't spend too much on conductors," he had figured to himself. "And if we are going to use wire of a practicable size, the voltage of the current (the pressure which overcomes resistance to its flow) will have to be high." He determined that the desired resistance could be secured at one hundred and ten volts, and this voltage has since been adopted as the standard electric light current.

Now, with a current of relatively high pressure to contend with, it would be necessary to have a burner of a very great resistance. This could only be obtained by reducing the radiating surface. Therefore, the real problem was to produce a hair-like carbon, capable of withstanding mechanical shock, and susceptible of being held at a temperature of over 2000° for a thousand hours or more before breaking. Moreover, a vacuum chamber or globe, for

holding the carbon, must be formed so perfectly and precisely, that, no matter what the conditions throughout all these trying hours, not a hint of air could enter to disintegrate the carbon. And not only this, but the lamps must be so simple in construction, carbon and all, that they could be manufactured at a price within the reach of the multitude.

Quite a problem, taken all in all! "One which I had far rather was in Edison's hands than in mine," said Tyndall, the great English physicist and electrician. And this was by far the most charitable remark made. "The subdivision of the electric light is a problem beyond the power of man to solve," said a committee of scientists, appointed by the British Parliament to canvass the subject.

However, Edison had by this time become well-used to having wise men rise up and call him a fool; so, notwithstanding that he was flying in the face of the well-proven law of conservation of energy which one and all cited, he did not swerve one iota in his purpose, or relax his efforts in the smallest degree. Taking up his experiments where he had dropped them, he worked out various devices to pre-

vent platinum, iridium and such infusible metals from melting. All of these attempts, however, proved useless. But Edison was still optimistic.

He had not yet found the right clue, but he was certain that he would come upon it in time. So with utter disregard for meals, and sleeping only at odd periods of the day or night, the Wizard kept his laboratory going without ceasing. Besides the struggle to find the material for a proper radiating surface, there was the lamp globe itself to be considered. This must be made of glass and absolutely air-tight, and there were, of course, no globes of this style manufactured, and indeed no pumps then in existence for obtaining the desired vacuum. A pump, then, was the first requisite, and to this the inventor gave prominence, for he knew that in this one item lay success or failure. By and by they had worked out a pump that would produce a vacuum up to about the one-hundred-thousandth part of an atmosphere. But this was not yet perfect enough. More study and experiment followed, and after some two months or more of trials and disappointments at last the Wiz-

ard evolved a model that would produce a vacuum up to the one-millionth part of an atmosphere. Now, too, he had perfected a one-piece glass globe, in which all the joints were hermetically sealed during its manufacture into a lamp.

All that remained was the proper material to incandesce—the thing, by the way, which everyone said could not be found! Again the inventor turned to his platinum experiments, and succeeded in producing a fair lamp of high resistance. But it was neither practical nor economical, for its construction involved some thirty feet of platinum wire wound upon a bobbin of infusible material. Moreover, Edison now felt that platinum and all other metals must be abandoned.

What was there left? His old friend carbon. All along he had been threshing this around in the background, and he determined to take up experiments again along this line. It was late at night, and Edison sat alone in his laboratory. As he pondered deeply, cogitating where and how he should begin, his fingers absently strayed to a little pile of lampblack and tar that had been left by one of his assist-

ants. Unconsciously, as he puzzled, these same busy fingers began to roll and fashion a bit of the substance into a thin, wire-like thread, and at length the Wizard, becoming conscious of their action, glanced at what they had done: "Ah!" he asked himself, "how would this serve for a filament for my light?"

Filament! Just what did Mr. Edison mean? He had coined a new word—"a definition-defying term," which puzzled all the scientists who presently brought their great minds to bear upon it.

And in this coinage was a germ which the Wizard felt to be invaluable. Eagerly he called his most valued assistant, Charles Bachelor, and then set to work to have a perfect filament rolled against his arrival.

This was carefully inserted in their now almost absolute vacuum, and the current turned on. An intense glow of light resulted, but to the disappointment of the breathless watchers it did not last. The carbon soon burned out.

"Why?" queried the inventor.

He satisfied himself that it was because it was impossible to get the air out of the lamp-

black. Besides the thread was too brittle. The slightest shock to the lamp would break it. There was, however, proof positive that a carbon filament would work, but not in the form of lampblack and tar.

What should it be?

"Let's try a carbonized cotton thread," said Edison.

Bachelor looked doubtful, but the experiment was begun. A short piece of the prepared thread, bent in the form of a hairpin, was clamped into a nickel mold, and placed in a muffle furnace where it was left five hours. The mold was then removed and cooled. But when it was opened the thread broke. Another thread was put through the same process, only to break before it could be got into the vacuum. And so began a struggle for a perfect filament which lasted two days and two nights. At last a filament was got safely into the lamp, but in trying to attach it to the conducting wire, it broke in two. Again they tried, and finally on the night of their third day of trial, during which one and most of the time both had been on ceaseless vigil, they succeeded in getting a thread in place and the

current turned on. A clear, beautiful light shone forth to reward their patience and persistence.

How happily they watched it! For they knew they looked upon the light which was henceforth to be the principal illumination of the world. And most carefully did they cherish it. Slowly, very slowly, more current was added. The frail filament stood the test bravely, and after a time it shone triumphant in a heat that would instantly have melted platinum wire. For forty-five hours it gleamed with unabated brightness, and then suddenly went out. But its purpose was served. It had shown beyond the shadow of a doubt that the incandescent lamp was entirely possible and practical.

How warmly Edison grasped the hand of his assistant! He felt that those skilled fingers had accomplished what no one else on the force could have done, not even excepting himself. And no less wonderful than Bachelor's hands was his temper: during all the nerve-racking hours over the filament, he had showed not even the slightest hint of impatience. Cheerful, good-natured and untiring,

he was as zealous and interested as his chief in the outcome. He put the first filament into the incandescent lamp, and later he enjoyed the distinction of being the first man to be photographed in the new light.

The cotton filament, however, was not an entire success. It possessed high resistance and small radiating surface, it could be burned in multiple arc, and the cost of production would be comparatively slight. All the requisites, then, had been met save one thing: it had burned only forty-five hours. Edison felt that a commercial beginning could not be made with a lamp that lasted less than one hundred hours. So, after a sleep which lasted straight round the clock, the Wizard plunged into the problem with a new zeal, setting his entire force to carbonizing everything in sight—paper, cardboard, wood splinters, straw, and what not. "In fact," says one of his biographers, "during these carbonizing days nothing was safe—umbrellas, walking-sticks, all vanished, and the probability is that if a lame man had called about that time his crutch would have gone the same way!"

Strange as it seemed, carbonized paper was finally made to stand the tests better than cotton thread. But it did not satisfy the Wizard. And the experiments went on. "Somewhere," he argued, "is the right material, and we shall chance upon it, if we keep up the search." Meantime, the manufacture of incandescent lamps using paper carbons was begun and carried on with a good deal of industry, which required the making of all sorts of special tools for the cutting and safe handling of the filaments, and the construction of the various parts of the lamp itself.

One day the inventor got hold of a bamboo fan, and it followed the way of all other things which came into his hands in those days. Straightway, too, great excitement swept the laboratory. For the bamboo gave better results than anything which had been tried! Immediately Edison began posting himself on bamboos, and soon made the interesting but somewhat overwhelming discovery that there were at least 1,200 varieties of bamboo known, of which about 300 species were used commercially.

Problem: What species had the fan been

composed of? Were there other varieties more peculiarly adapted to his purpose?

Already Edison had spent $40,000 on the incandescent lamp, but this was as nothing. Always when there had been any item needed in his business, he had got it if it was gettable. Now he must have samples of every variety of bamboo grown. And the quickest and best way was to send men after them.

Picture the marvelous wealth of incident and adventure that such a quest promised! For the bamboo flourished in far-away tropical jungles, in the hinterland of China and Japan, the West Indies, Mexico, Ceylon, British Guiana, India, the wilderness of the Amazon; through it lay the runways of the deadly cobra, the trails of the lion and the tiger, and the fierce-trumpeting elephant. Such natives as lived in its vicinity were bound to be treacherous and unfriendly—for we had few cordial international relations in those days. Besides all this, there was the torment of insect pests, the danger from malaria, lack of proper food, and so on and on. But the boys at the laboratory were wild to go. There was a glory in being a missionary of

science, beside which all dangers, disasters, and menaces paled. Nor was this ardor dampened when word came presently that the young man who had rushed off to the West Indies had died of yellow fever on the very day of his arrival. No less than four others immediately petitioned to be allowed to carry on his work! So very soon there were emissaries from Edison in all quarters of the globe, and samples of bamboo and other fibrous plants began to arrive in great bales. People everywhere were interested in the quest, and not a few joined the hunt on their own account, sending in generous samples of the rare specimens they found.

It was William Moore, a New Jersey man, who finally located the species of bamboo which had started the search. Leaving New York in the summer of 1880, bound for China and Japan, a locality especially noted for bamboo, he traveled over some 30,000 miles, pushing his way far into the remote country districts, meeting with no end of exciting experiences and collecting hundreds of specimens, himself roughly testing those which he thought might do before sending them on to his

chief. At last, in Japan, a species was chanced upon which seemed most fitting, and when word came confirming its excellence, Moore at once made a contract with an old Jap to supply the fiber. This man was considerable of a plant wizard. He attacked the job with hearty interest, cultivating and cross-fertilizing bamboo until he got exactly the quality that was required.

None the less thrilling, but perhaps not so hazardous, was the experience of the other men who played a part in this "Romance of Science." None of them, however, found the wonder material, or indeed anything that quite came up to the bamboo which the old Jap was supplying. All in all, this world-wide search for filament material cost Edison around $100,000, and then, ere the last man reached home, the Wizard himself had figured out an artificial compound which seemed likely to be better than any natural product. No immediate change, however, was made in the filaments, but gradually the imports from Japan were cut down, and in a few years the bamboo had wholly given place to a manufactured product.

About ten years ago tungsten began to replace all other filaments in the incandescent lamp. Then the average candle power per lamp was 19; to-day it is 52. Tungsten cuts the cost of the light about one-third and gives a steadier, more perfect illumination than the carbon-filament types. Two pounds of tungsten will supply about 50,000 electric bulbs, for each filament is only 1-1200 of an inch in diameter. The current passing through the filament heats it to such an intense degree that the red rays are eliminated, and it is the red rays which make the ordinary electric light so hard on the eyes.

Inventing the incandescent electric light was, as it turned out, a mere bagatelle compared with the herculean labors into which it at once plunged the Wizard. But he had foreseen all this, and delighting as he always had in obstacles, their triumph was to him the keenest enjoyment. And they also formed his chief reward! For no sooner was the light an achieved success, than there sprang up a mushroom growth of inventors, each of whom labored under the delusion that he was the man who had invented the incandescent electric

light. Prior claims rose like magic everywhere. One indefatigable press-writer added to the turmoil by stating that the electric light had been in use as far back as the thirteenth century, and in proof thereof quoted from a volume of *Sorcery and Magic,* published in 1852.

From the first the public looked upon the incandescent electric light with favor; but it had two very stiff competitors—gas and the arc light, in which politics and finance were pretty heavily involved, and no end of bitter feeling was shown. Eventually, however, it was made clear, as Edison tried to point out in the beginning, that the incandescent light was not a hated rival which must be crushed. It did not seek to take the place of the arc light where that method was undoubtedly best and cheapest, such as in the lighting of streets, factories, and large halls. This was a field in itself, as the continual growth and improvement of the arc light has proven. It *did* seek to supersede gas for ordinary indoor lighting purposes: why shouldn't it? It was incomparably better. And gas still had ample space for operation. Subsequently it was proven that the incandes-

cent lamp was actually a booster for the gas works, and to-day in most cities the two industries are combined.

All in all, Edison's incandescent light data fills some two hundred note books, set down in plain, unvarnished English, in the Wizard's fine copper-plate writing. And almost in the beginning of the first one, the "prospectus book," is an entry which says much, viz; *Object of Incandescent Light*: To effect exact imitation of all done by gas, so as to replace lighting by gas by lighting by electricity. To improve the illumination to such an extent as to meet all requirements of natural, artificial and commercial conditions."

A large program! But one which never for a moment "stumped" the Wizard, notwithstanding the great number of obstacles which must be overcome in setting his system in operation. As soon as possible after the discovery of the paper-carbon filament, a row of lamps was strung among the trees at Menlo Park, and the contest was on. Almost at once the attention of the world was attracted, and the visiting thousands found it wonderful indeed when told that one of the tiny lights—which

needed no matches to set going—would burn day and night for more than a week, and in all that time the globe would not once get hot enough to burn one's fingers! More than all else, however, was the fact that the lamp would burn in any position, and that any lamp in the string might be turned on or off without interfering with the others.

It was plain to all that this new light, free from odor, sputtering, and danger from fire, was the ideal home light. It promised no end of comfort, convenience and beauty, and they asked how they could go about to secure it. And for this the Wizard was ready. He had set his heart upon lighting the city of New York, by way of setting the ball rolling, and he presently invited the New York board of aldermen out one evening to see his exhibit. A special train was run for their benefit, and the effect of the hundreds of brilliant incandescent lamps glowing among the trees of Menlo Park was beautiful and remarkable in the extreme. It had a deep effect upon the visitors, just as Edison meant that it should, and he got what he wanted—permission to go ahead

and build a great central station where consumers might obtain electricity.

Such a vista of problems as were now before him! To begin with, there was little that he could buy, or that anybody could make for him. Outside of his own laboratory there was no one who knew anything about incandescent electric lighting. Factories for the manufacture of new and novel apparatus—dynamos, switchboards, pressure and current indicators, meters, lamps, underground conductors, service boxes, man-holes, specially made wire, and what not—must be built and equipped; artisans must be trained, for even among his most trusted men there were few who knew how to get a filament in place and exhaust a globe. He must, also, find just how much gas was used in New York, in order to determine the strength of station required, and this information, which of course the gas company would not supply, would have been for some difficult indeed to secure, but for Edison it was, as he says, "The simplest thing in the world!" He hired men to canvass the city, and make a note of the number of lights burning in the various

days of the week. It was then easy to compute the problem.

Having determined the strength of the station required, and the amount and cost of the materials necessary to put it in operation, he turned the financing of the matter over to his lawyer and warm personal advocate Governor P. Lowry, who eventually succeeded in raising the capital necessary, under the firm name of the New York Edison Illuminating Company, and the project was launched. Out at Menlo Park a lamp factory sprang into being; over in Washington street, Kruesi set up the manufacture of tubes; a second-rate machine shop was turned into a first-class dynamo establishment; another man who had been making gas fixtures was glad to supply sockets and some other necessary parts. Then negotiations were begun for lots on which to build the station. Edison hoped that by buying in some out-of-the-way street the necessary site might be obtained fairly cheap. But New York real estate rose to alarming proportions, and finally two old buildings, not at all what he wanted, were bought for $150,000. Then the inventor faced the next difficulty.

He must have a big output of electricity, and being forced to put up with a small station, a high-speed engine would be a necessity. But there was none. Drafting what he thought would meet his requirements, Edison went to an engine factory to order a one hundred and fifty horse-power engine that would run seven hundred revolutions per minute. "It is impossible!" said the manufacturers. But, after some argument, they finally agreed to build such an engine, and in time the ungainly thing arrived and was set up on a shale hill out at Menlo Park. Then such a hubbub as arose! The whole hill shook with the swift revolutions, and there was all kinds of mischief to pay. At length, however, the engine was tamed down to three hundred and fifty revolutions, which was all Mr. Edison really needed, and it seemed so easy-going and practical that five more engines were ordered.

Various delays followed, but at length the order was filled and an attempt was then made to run two of them in parallel. And then chaos broke loose! "Of all the circuses since Adam was born we had the worst then," says Edison. "One engine would stop, and

the other would run up to about a thousand revolutions, and then they would see-saw. What was the matter? One set of governors was running the other as a motor. I then put up a long shaft connecting all the governors together and thought this would end the matter, but it didn't."

Nor were they ever able to get these engines to work in satisfactory harmony. At length, Edison, feeling that "he didn't want his customers to count the heart-beats of his engine in the flicker of their lamps," was forced to go to another engine draughtsman, Gardiner C. Sims, who built him a one hundred and seventy-five horse-power engine, making three hundred and fifty revolutions. This proved to be what was needed. Indeed, there was small chance of its going wrong, for Mr. Edison had now made an exhaustive study of steam engines. He knew their weak points to date, and he was ready with suggestions to remedy them. One thing was a poser. No engine of the type they desired had ever been built for continuous running. The oil cup for self-lubricating was unknown; every four or five hours it was necessary to stop and oil up.

Edison said this wouldn't do; any engine to suit his purpose must keep going. Eventually Sims solved the problem with the drop-feed oil cup, a type of which is now generally used on all engines.

At last all was ready. On Saturday night, September 4, 1882, the current was first turned on to the mains for regular light distribution in the city of New York, and it stayed on for eight years with only one slight stoppage. One of the original Sims engines first put on the job ran twenty-four hours a day for three hundred and sixty-five days before it was stopped. Crude enough it was in many respects, but it did the work, and served as the father of the modern power-plant engine—another vast field which thus owes its rise to Edison.

A glimpse of that first electric light station would be an eye-opener to the modern electrician. Few indeed of the instruments that now seem indispensable were to be had. There was not even a central switchboard! Each dynamo was controlled by its own individual switch. The feeder connections were all on the first floor at the front of the building, and the general voltage control apparatus was on the

floor above. "In those days we used the old chemical meters," wrote Edison, in an account published long ago in the *Electrical Review*, "and these gave us a lot of trouble, for, as they contained two jars of a liquid solution, there was always a danger of freezing in the cold weather. So I set to work to negative this difficulty and succeeded, as I thought, by putting an incandescent lamp in each meter with a thermostat strip, which would make a contact through the lamp when the temperature fell to forty degrees. That idea, simple as it was, caused us a whole lot of trouble. The weather became cold, and then the telephone in our office began to ring every five minutes and people would say—

" 'Our meter's red hot. Is that all right?'

"Then someone else would call up and say, 'Our meter's on fire inside, and we poured water on it. Did that hurt it?'

"As to voltmeters, we didn't have any. We used lamps. And I hadn't much use for mathematicians either, for I soon found that I could guess a good deal closer than they could figure, so I went on guessing. We used to hang up a shingle nail, tie it on a string along-

side one of the feeders, and used that for a heavy current ammeter. It worked all right. When the nail came close to the feeder we screwed up the rheostat a little, and in this way kept the lamps looking about right."

Eventually Edison worked out solutions to the various problems which interfered with the smooth running of his lighting system, but anything like the number of these would be hard even for the electrician of to-day to guess at: a fine copper thread to serve as a fuse wire for the prevention of short-circuiting; instruments of one sort and another for measuring the current; the "three-wire" system; the "feed and main" idea; dynamos, motors, and engines; plans for underground wiring and for distributing systems, their control and regulation; the perfected incandescent lamp of to-day which will run twelve hundred hours; and so on and on.

"Broad as the prairies and free in thought as the wind that sweeps them," Edison is yet "fussy" and exacting to a degree. Much of the work in giving light to the world might have been delegated to subordinates. But this was not the Wizard's way. Here, there and

everywhere he superintended the work of installation in person. Nor did he merely stand around and give orders; day and night he lent a hand wherever it was needed, and always he was the busiest man on the job. No clock regulated his hours; he stayed by until physical weariness absolutely compelled him to rest. Then, as often as not, he lay down on a pile of tubing in the cellar of the Pearl Street station.

"It is worth pausing just a moment," we are told in *Edison: His Life and Inventions,* "to glance at this man taking a fitful rest on a pile of iron pipe in a dingy building. His name is on the tip of the world's tongue. Distinguished scientists from every part of Europe seek him eagerly. He has just been decorated and awarded high honors by the French Government. He is the inventor of wonderful new apparatus, and the exploiter of novel and successful arts. The magic of his achievements and the rumor of what is being done have caused a wild drop in gas securities, and a sensational rise in his own electric light stock from $100 to $3,500 a share. Yet these things do not at all affect his slumber or his

democratic simplicity, for in that, as in everything else, he is attending strictly to business, 'doing the thing that is next to him.' "

But it was just this same careful attention to detail that spelled the Great Wizard's success. It needed an Edison not only to invent the incandescent electric light system, but to put it into working operation. And how wonderful have been the subsequent results! In the whole history of industrial progress there has been nothing to compare with the far-reaching sweep of the electric light. Twenty years after the invention of the incandescent lamp there were $750,000,000 invested in electric light plants in the United States alone, while across the water the industry was advancing in world-wide strides. To-day we can scarcely imagine what it would be to do without the conveniences of the modern electric lighting and power devices. They are the daily, unobtrusive but useful servants in every home.

VIII

THE KINETOSCOPE, OR MOVING PICTURE MACHINE

If Edison had no greater claim to fame, it might still be said of him that he probably did more to interest and amuse the world than any other man. No sooner had he invented the phonograph and made music possible for the multitude, than his attention was attracted to another problem:

"Surely," said he, "it ought to be possible to do for the eye what has been done for the ear —moving pictures should be entirely possible!"

It was not a new idea. Indeed, we often hear it said that there is no new thing under the sun, and this is especially true when applied to "the movies." Though barely twenty years have elapsed since the unrolling of the first motion picture reel, the idea of motion pictures goes back to the old Egyptians and their crude picture writings.

Long before Edison was born, a beginning

of considerable moment in the moving picture art had been made. This was the invention of the zoetrope, or "wheel of life," an ingenious little toy, consisting of a disc painted over with pictures of some animal or figure, such as a boy skating, in various stages of motion. Underneath each picture was a narrow slit. By slipping the wheel on a pin and whirling it rapidly before a mirror, one might see through the openings the object represented, apparently moving forward by jumps. Often a very laughable and realistic effect was secured, as you may discover for yourself if you care to experiment.

Simple as this contrivance was, from it came the suggestion of the magic lantern and the screen, and by and by somebody brought forth a scheme that was rich in possibilities. This was the method of passing a row of pictures between the light and the lantern lens, and by using a shutter to close the lens from the light for an instant, while the picture was slipped forward, to give the effect of motion. The success of this plan and of the zoetrope, of course, lay in moving the pictures fast enough to deceive the eye into thinking that it regis-

tered constant unbroken movement. In short, advantage was taken of a point which had long been known to scientists:

"There is," said they, "such a thing as *persistence of vision,* or a habit of our brains to see an object that is no longer there. This impression lasts about one-twenty-fourth of a second: if you can substitute the next picture in that time the eye will not detect the brief gap made by making the change."

The problem, then, lay not in counterfeiting motion, but in taking exact pictures of things in motion. And this proved difficult indeed. For dry-plates and sensitized films were entirely unknown, and the wet-plates then used did not adapt themselves to speed. It seemed impossible to work out any sort of commercial scheme.

At length, in 1878, Edward Muybridge, an English inventor living in San Francisco, having secured some fairly rapid wet-plates, conceived the idea of setting a number of cameras in a row, and taking successive pictures of a horse as it passed by. Later, following up this silhouette idea, he took pictures of various other animals, and of men running. Freakish

indeed were these pictures when viewed singly, but whirled rapidly on a large "wheel of life" they presented a fairly unbroken picture. The defect was that the screen mechanism, while it showed violent motion, yet registered no progress—the object remaining always exactly in the center of the screen.

Early in the next decade dry-plates were introduced. But still there was a decided handicap. The plates were heavy, and only a limited number could be used. "This difficulty will be more readily understood," says one authority, "when it is realized that a modern motion-picture play lasting fifteen minutes comprises about 16,000 separate and distinct photographs." Clearly there was no possibility of handling such a host of plates. What was to be done?

"Ah!" mused Edison, standing now on the outskirts of the field and looking over the situation, "the thing promises to be decidedly interesting. In order to portray natural movement, pictures will have to be taken, say from forty to sixty per second. And the pictures once secured, a machine will be necessary to show them. I think I'll take a hand!"

And this, notwithstanding that the problem involved a realm of science to which he was an absolute stranger—photography. He had not so much as taken a snapshot, or developed a plate; had, in fact, hardly seen a camera. But this only made the problem more alluring!

"We shall never get anywhere with cumbersome glass plates, and a multiple of cameras," he decided shortly. "What we need is a film, capable of taking one impression after another in quick succession."

Of course nothing of this sort was to be had, and the Wizard immediately added a photographic laboratory to his establishment, and set in motion a train of experiments to secure what he wanted. From the first Edison felt that celluloid—originally known as Parkesine, from its inventor, Parkes—was the most likely material for films. Two difficulties, however, proved insurmountable barriers: it was not manufactured in thin enough sheets, and one of the substances used in developing ate up the celluloid. At this juncture, Charles Eastman, the inventor of the Eastman kodak, who had been struggling with the film problem for five long years of the most indefatigable re-

search and endeavor, came forward with the first successful long strip of film. Now, indeed, the way was open for the movies: for the celluloid film bears as much relation to the moving pictures of to-day as the petrol-motor does to the flying machine—it made success possible. Without the celluloid film, cinematography must have remained purely an experiment; it could never have reached its present huge commercial importance.

Now, all that remained was to devise a camera by means of which the required number of pictures per second could be taken, and this part of the problem would be solved. But do not imagine that this feat was as easy as it sounds! All who have used a film camera will have some appreciation of the problem. To begin with, a long roll of film would have to pass so smoothly behind the lens, that at every inch it could be stopped, the shutter opened for exposure, then closed again, and the film passed on to the next halt. Moreover, this operation must be done rapidly, not less than twenty to forty times a second, and throughout a long length of say perhaps a thousand feet of film.

Who but an Edison would undertake such a problem, or guarantee at the outset that such a device could be made with sufficient exactness that each picture would join so perfectly one with another that continued motion would be shown? After much experimenting, however, the trick was turned; in the summer of 1889, the first modern motion picture camera came into being. From that day to this the Edison camera, with such improvements as time has developed, has been the accepted standard for securing pictures of objects in motion.

With its invention, things took a lively turn at the Edison laboratories. "Black Maria," a studio painted black inside and out, was set up in the dooryard, and so arranged that it could be swung around to face the sunlight, which came in through a skylight in its sloping roof, and the boys posed to get pictures for their chief's working models. The machine for the portrayal of the pictures was yet to perfect. And such stunts as they pulled off! From Fred Ott's luxurious ear-splitting sneeze, with its ludicrous grimaces, on to somersaults, standing on their heads, wrestling, playing leap frog, dancing, feats of horsemanship,

divers working jobs, and what not, which produced no end of interest and amusement for the force when thrown on the screen. Edison himself was asked to take his turn before the camera, but no amount of persuasion could get him to do it.

Everyone is familiar with the Pathé feature photoplays. But few know that Charles Pathé was the first great pioneer in the moving picture world as we know it now. To him belongs the honor of the first motion picture feature, a scant two hundred feet in length, portraying the first story ever produced at a movie. To him also must be credited the production of the first comedy, the first drama, and the first of the long picture reels. More than fifteen years ago Pathé began reproducing in picture form the works of the great novelists and playwrights, and the story of the difficulties which he met and overcame, could they be set down here, would reveal the progress in motion picture art.

All this, however, would be setting the cart before the horse, which was in truth the real order of the development of the movies. First the pictures, and at length after many trials

and failures, the machine for projecting them —the kinetoscope, as Edison christened it, but dubbed "the peep hole machine" by the boys and later by the people who saw it for the first time at the Chicago World's Fair. The pictures could be viewed by only one person at a time, and that through a "peep hole;" furthermore, there was a continuous movement, which at times caused the image to be both faint and blurred. An ingenious "toy" it seemed, with little or no future before it.

But defective as it was, the kinetoscope yet had in it the germs essential to produce the modern motion picture machine, the cinematograph of to-day. The story, however, of the numerous improvements and inventions, the hours of puzzlement and groping, by which it was evolved, and the various people who had a hand in it first and last, is too long and complicated to tell here. Naturally it cost a good deal of money, and it is probable that this invention took at least a hundred thousand dollars to make it a commercial success, and as much more to get it going. Indeed, the Bronx Park (New York) studio of the Edison Company, a magnificent structure built of glass,

with all the properties and stage settings of a regular theater, of itself cost nearly that sum, to say nothing of a second New York studio, not nearly so elaborate, and the numerous directors, actors, and minors necessary to produce the introductory films.

To-day photoplay has soared to heights undreamed by the inventor. And the reason is not far to seek, so wide and inexhaustible is the range of material. "Making the movies" opens up an interesting, and in some instances, at least, most profitable business. Nowadays parties setting out on hunting and exploring expeditions aim to make their motion picture outfits cover expenses and leave a comfortable balance besides. One man on a big African game tour is said to have netted $50,000; another, exploring in the Northern icefields, found himself, thanks to his motion picture camera, richer by $30,000. While in the studios of the various film companies are starred divers interesting careers, and opportunities afforded to countless hundreds to make a livelihood. All this is another story, of course, but it shows the breadth of the avenues thrown open by Thomas A. Edison, and

another indebtedness of the world to this man whose inquiring mind delighted in the upturning of problems and their subsequent solution —the man who was never so pleased as when facing a serious difficulty. "It seemed to stiffen his backbone," said one of his co-workers, "and made him more prolific of new ideas."

IX

OTHER INTERESTING INVENTIONS

Someone once asked Edison what he considered the secret of achievement. His reply was terse and to the point: "Hard work, based on hard thinking." Certainly this is the foundation on which his own phenomenal success was built. He knew no idle moments. While on his trip to Wyoming with the astronomers, in 1878, he got the idea of building an electric railway, and as soon as the tremendous rush into which the incandescent lamp plunged him had somewhat subsided, he began the construction of a stretch of track at Menlo Park, and at the same time started to build an electric locomotive to furnish the power.

We have so long accepted electric railroads as a matter of course, that it is difficult now to understand how any engineering expert ever could have doubted their practicality. Yet such was the case. When Edison's short stretch of road—barely a third of a mile—was

opened for operation, May 3, 1880, the world again flocked to his door, but it took a stout heart to make an initial trip, for there were some steep grades and sharp curves in that brief course, and few had faith that the queer-looking locomotive would or *could* keep to the track.

Certainly there was some cause for doubt. An odder looking train had never before been coupled together. The locomotive itself seemed such only by courtesy; it consisted of an ordinary flat car on a four-wheeled iron truck, with an Edison dynamo for a motor. One had to take on faith the statement that it had a capacity of twelve horse-power, and that electric current was generated at the machine shop, and carried to the rails by underground conductors. There were three cars: one flat freight car, one open awning-car, and another, a box-car, which the boys sportively called the "Pullman," on which Edison had fitted a system of electromagnetic braking.

"I well remember," said the late Charles T. Hughes, who was Edison's chief assistant on the electric railway project, "a certain day when Mr. Henry Villard, of the Northern

Pacific, sent one of his mechanical engineers, Mr. J. C. Henderson, to see the road in operation. Edison, Henderson, and I rode on the locomotive. Edison ran it, and just after we started there was a trestle sixty feet long and seven feet deep, and Edison put on all the power. When we went over it we must have been going forty miles an hour, and I could see the perspiration come out on Henderson. After we got over the trestle and started on down the track, Henderson said: 'When we go back I will walk. If there is any more of that kind of running I won't be in it myself.' "

And this seemed to be the sentiment generally! Few engineers could see utility and a future in electricity for transportation, and their doubts were shared by the capitalists to such an extent that it was several years before the project had any show whatever for business. Edison, however, knew that it was bound to come, and he went on improving the scheme, planning a low-cost storage battery, and taking out a great number of patents, many of which showed foresight when the electrifying of streets began in real earnest.

To-day the initial electric railway of the

world lies in ruin and decay in the general desertion of Menlo Park, but the locomotive which finally succeeded in demonstrating its worth has become the property of the Pratt Institute, of Brooklyn, and here in prominent display it preaches to the students a wordless and incentive sermon of faith and never say fail

Not long after the kinetoscope had got under way, Edison happened one day to be walking along the seashore, when he came across a patch of black sand, not unlike gunpowder in appearance. Of course a query at once bobbed up, and he carried home a pocketful to see what its composition was. As he poured it out upon the table, a passing workman accidentally dropped a big magnet across the heap. At once, the tiny black grains which had been mixed with the sand immediately left it and clung to the magnet. Examination proved the black grains to be the very purest of magnetic iron.

"Ah," said Edison, slowly, turning over in his mind the train of ideas which the incident had set in motion, "I believe magnetic attrac-

tion could be employed to separate metal from low grade ores."

The more he thought about the project the more feasible it seemed. Straightway he began to block out a scheme that ultimately resulted in what is now known as the magnetic ore separator. But, like most of his other inventions, this feat sounds easier in telling than it was in doing. As a matter of fact, the Wizard put nine solid years into this labor, inventing not only the ore separator but a tremendous amount of new and novel machinery to aid in its operation, including gigantic crushers and pulverizers for tearing down the mountains bodily and reducing them to powder, and marvelous conveyors, which wound in and out, turning corners here and yonder, delivering material from one bin to another, making a number of loops in the drying-oven, filling up bins, and passing on to the next one when full, with an automatic action which seemed almost human in intelligence, and spoke volumes for the inventor's genius and engineering skill.

Last but not least, Edison crowned his labors by building the little town of Edison, in

Sussex County, New Jersey—a town that shortly came to be known as the most up-to-date mining town in America. People came from far and near to see in operation the immense magnetic ore separators. There were nearly five hundred of them in the plant, turning out something like two hundred and fifty tons of finished product per hour—and to admire the model homes of the miners, lighted by electricity and fitted with all modern conveniences. Here, in the vicinity of Edison, the Wizard held 16,000 acres, his pick of the ore regions, secured by a marvelous survey of country twenty-five miles in width and from Canada to North Carolina. And here, in the 3,000 acres immediately surrounding the mills, it was estimated there were over 200,000,000 tons of low-grade ore—enough to supply the whole United States iron trade, including exports, for seventy years! A vast source of wealth in hills and mountains that had been hitherto regarded as waste land!

And then came the first hitch in the proceedings. When the separated ore was put on the market in quantity, it was found that few furnaces could handle it in powder form. An-

other invention would be necessary to make it available, but this did not trouble the Wizard for long. He solved the problem by making a machine for molding the powdered ore into "briquettes." Now the great rocks went in at one end of the works, and a stream of briquettes, at the rate of sixty per minute, poured out at the other. Moreover, the trade approved of the handy briquettes, and orders came in most gratifyingly. Hard work, persistence and deep thought had conquered. For five years Edison had scarcely been at his home in Orange, only on Sundays, so deep and perplexing had been the difficulties that he was obliged to meet and overcome.

Just as everything seemed exceedingly bright and promising, and the Wizard was beginning to look about him for a new field of endeavor, suddenly out of a clear sky came a fatal bolt. Rich mines of pure Bessemer ore had been opened in Minnesota; this product began to flood the market at a price that absolutely killed Edison's manufactured ore—$3.50 a ton against $6.50. It was useless to go on, and the Wizard faced the hard fate that had taken so many arduous years of labor and

some two millions or more of funds all for naught.

The magnetic ore separator was not a total loss, however. It is still considered the best and simplest method of separating iron from low-grade ore, and is in use in many parts of the world.

Now, if ever, Edison showed his true caliber. "No use crying over spilled milk," said he. And in the very same moment that he ordered his works shut down, and turned his back upon the doomed town of Edison forever, he was actively engaged in figuring *what to do next.* It was imperative that some money-making enterprise be set afloat at once; for the ore-crushing plant had borrowed heavily, and Edison proposed to see every debt paid.

Two things seemed most feasible. He would salvage what he could of the ore-machinery and turn it to account in making Portland cement—a project which he had been contemplating for some time; and he would get out a storage battery which did not use lead and sulphuric acid.

"Surely," he said, "nothing is more needed

than the latter invention. I don't think nature would be so unkind as to withhold the secret of a good storage battery, if a real earnest hunt for it is made. I'm going to hunt."

Thus, with every thought fixed on the future, Edison was soon too busy to bemoan the past. Shortly he was engaged in reading up everything he could find on cement, and convinced himself that, with the splendid crushing machinery he had on hand and some further inventions which he knew he could make, he would have no difficulty in putting out a finer cement product than was on the market. The next thing was to find a suitable location for the plant, and the money to finance it. While these were pending he experimented with the storage battery.

First, with true Edisonian logic, he made a study of the storage batteries then known, to number their defects, thus arriving at a definite idea for his own invention—"a battery that should be cheap, light, compact, mechanically strong, absolutely permanent, and generally *fool* proof." Qualifications, perhaps, that mean little to us, but which, in truth, were to call out "more original thought, work,

perseverance, ingenuity, and monumental patience," according to one of his biographers, than any invention which he had yet tackled. Indeed, says this authority, "if Edison's experiments, investigations, and work on this storage battery were all that he had ever done, I should say that he was not only a notable inventor, but also a great man. It is almost impossible to appreciate the enormous difficulties that have been overcome."

Edison had determined not to make an acid battery, and so, in the very beginning he was literally plunged in the dark and absolutely without guide posts of any kind. What alkaline should be used as an electrolyte, and what should be the character of the active agents used? He had no idea what materials to combine, and at least ten thousand trials were made without securing even a hint. Any one but an Edison would have given up in despair. To the Wizard, however, the failure of one experiment simply meant something else that he had eliminated, and he was that much nearer his goal.

Seeing presently that he was apt to run the whole gamut of chemical elements, he estab-

lished a plant at Silver Lake, New Jersey, and settled down to a day and night contest. And here, in time, it was found that *theoretically* iron and nickel possessed the desired properties; but how to get these elements into a proper condition of activity for practical storage battery purposes was a problem which took countless experiments—*years* indeed of hopes and fears, of many disappointments, and of final successful realization. At last came the Edison cell, containing a solution of potash, in which were immersed steel plates containing oxide of iron and oxide of nickel.

In connection with the storage battery, as with other of his inventions, no end of machines and processes had to be designed and built for the quick and easy manufacture and assembly of the various parts, to say nothing of all manner of rigid tests that the Wizard designed to bring the work up to the high degree of perfection which he had set as the model of efficiency. And throughout it all he never once lost hope nor patience, sure at all times that victory was just around the corner, and that he had only to persevere to win the ultimate goal.

Work upon this invention had to be set aside many times. Edison always had countless irons in the fire, and those were especially busy years. One thing, at first, kept continually bobbing up—the cement problem. Just as he got deeply on the trail of the possibilities of iron and nickel, he was advised that everything was now ready for the engineers to lay out the plans for the cement works.

"Humph!" said Edison, "I intend to do that myself," and set busily to work with pen and paper.

All day and all night and sometime into the afternoon of the next day, he planned and blocked, until at length there was before him the full specifications for the plant, which was subsequently built on just those lines. Moreover, it is said that if to-day it were necessary to rebuild these immense works, no vital change would be necessary. Taken altogether this was an engineering feat which grows marvelous indeed, when we remember that Mr. Edison was a novice at the business. None else but the Wizard could in twenty-four hours' planning have provided without an

error or oversight of any sort for that half-mile series of buildings and machinery arrangements, including not only the crushing, mixing, weighing, grinding, drying, screening, sizing, burning, packing and storing of the finished product, but for an extensive system of smaller details: such as a subway extending from one end of the plant to the other for carrying the steam, water and air pipes and the electrical conductors; a system of needle valves and clever gravity and filter contrivances by which two men can manage the automatic oiling of the tens of thousands of bearings throughout the plant; and another marvelous arrangement for accurately weighing out the proportions of cement-rock and limestone. The latter, Edison figured, was an item altogether too important to be left to human agency, so thoroughly and so accurately must it be done. No guesswork or haphazardness could possibly be permitted, if uniform results were to prevail.

"Suppose," said he, "that the man at the scales should get to thinking of the other fellow's best girl. Fifty or a hundred pounds

of rock, more or less, wouldn't make much difference to him, but it would play havoc with the uniformity of the product."

So he devised a hopper-fed scale which is set at certain figures, so that, the moment the scale-beam tips, an electrical connection automatically shuts off the stream of rock and limestone, coming each in a certain quantity from its own bin, and no more can be run until the load is moved.

Cement-rock and limestone are crushed and mixed together, then pulverized to the last degree and burned in a kiln to form cement. It comes out in the shape of balls or "clinkers," about the size of lump sugar, which must again be ground and screened to the finest possible degree before the finished cement is ready to be bagged and barreled by machinery for the market. By the early methods, kilns were invariably built with a capacity for turning out about two hundred barrels of clinkers every twenty-four hours. This seemed too slow. Edison decided to build kilns with a capacity of one thousand barrels every twenty-four hours—a determination that old cement makers considered a colossal bluff. How

could he—a man who never in his life had made a single barrel of cement—jump into the very heart of things and increase the production four hundred per cent? He would fall down hard, that was all!

"Humph!" said Edison. And he went ahead, building huge cylindrical shells or kilns, one hundred and fifty feet long, of cast iron lined with fire-brick. These, however, when put into service, fell terribly short of the mark set, though they doubled the number of barrels the old style kilns were turning out in the same length of time. But in the end the Wizard triumphed; indeed he went one better, succeeding in turning out eleven hundred barrels instead of one thousand as he had first sought to do.

This chapter grows long, but we should fail to show the wide scope of Edison's genius if we closed the list of interesting inventions without mention of his typewriters, mimeographs, electric pens, addressing machines, compressed-air apparatus, methods of preserving fruit, wire-drawing, circuit directors, and telegraph signaling apparatus, among the

more than thousand inventions and patents which are set down officially to his credit.

In this connection it is interesting to note Edison's term, "invention." Some things that are commonly covered by this word are, he tells us, mere "discoveries" or "scratches"—something that might have been revealed to anybody. The phonograph was a "scratch," he avers; so, too, was the motograph or chalk telephone receiver. But how many men, think you, would have had the inventive genius to have gone on and developed the "scratch"? The "scratches" in Edison's list were few. For the most part, his inventions were born of hard thinking, close application, and a persistence that was not satisfied until a triumphant goal was reached.

"Edison," said one of his admirers once upon a time, "could unerringly pick out the most perfect pebble on the beach."

And so he could! But it would not have been an instantaneous Wizard-like process. He would have made a careful, painstaking sorting of the pebbles one by one. It was in this manner that most of his inventions were developed. Any door that was double-locked

or barred with a "no admittance" tag had the strongest possible attraction for him. There was no such word as "fail" in his dictionary.

Two inventions of Edison's, the tasimeter and the odoroscope have been invaluable in the world of astronomy and hydrography. The former has already been mentioned as of value in measuring the distance of the planetary bodies. It is also of extreme service in determining heat rays. The odoroscope is likewise particularly sensitive to heat and to moisture. It is useful in determining the pressure of gases and vapor, and its principles are active in the making of barometers, hydrometers and such instruments. Edison has also invaded the world of medicine, having produced in his laboratory, primarily for the relief of a friend suffering from gout, a remedy that is now universally used in the treatment of that disease, and which came into being because the Wizard doubted the statement that uric acid was insoluble. It was a closed door that must be unbarred.

Mention has been made elsewhere of the "Notion Books" which went hand in hand with all of his inventions. These volumes—plain

ordinary blank books originally—numbering upwards of one thousand, are kept on the open shelves of his library, and are free to the inspection of all those who are permitted the intimacy of the house. Here in these pages in his own handwriting, are to be found the inventor's ideas, sketches, and memoranda, not only on the inventions which have been made patent to the world, but on countless other lines that he touched upon and jotted down to be taken up at a later day—material enough, it is said, to fill several life-times—and here, better than elsewhere, can be seen the great range and activities of the Wizard's mind, which was, as one of his co-workers pointed out, a thing that defied cold print, and that, indeed, could scarcely be comprehended, even by those who were in daily association with him.

Always before beginning to work on any subject, Edison studied all that was to be known about it. Then, more likely than not, he started just at the point where authorities agreed that no entrance could be made. In consequence, he reaped a reward where others failed.

"Edison could find more ways of doing a thing than any man I ever knew," said one of his staff. And he cited an instance which occurred during the ore-works period. One of the engineers had come to Edison with a drawing concerning the installation of a certain piece of machinery.

"It is surely awkward enough," observed the chief, at the first glance.

"I know it," the engineer replied; "but there is absolutely no other way for it."

"Humph," grunted the Wizard, "do you mean to tell me the thing can be done in no other way?"

"I certainly do," returned the man.

Edison said no more, but the next day he silently laid a sheet of paper on the engineer's desk, showing *forty-eight* different ways to solve the problem!

Naturally, the wide scope of the inventor's genius furnished unblushing space-writers with a vast amount of copy from time to time. For instance, there was the tale of his attempt to illuminate the heavens, which came out shortly after his exhibition of the electric

lamps at Menlo Park. It was averred that what people thought was the evening star was none other than an electric lamp Edison had sent up in an invisible balloon!

Another equally absurd, but just as widely believed report, was to the effect that the Wizard had practically completed a device for melting snow as fast as it fell. "This," said the versatile liar, "will make many a city boy, who has to shovel snow from the sidewalk, very happy, but it will at the same time rob many a poor man of a meal that he would otherwise get for doing that work. The invention will have its greatest utility in clearing transcontinental railway tracks."

Another "news" item, more ludicrous perhaps than either of these just mentioned, was a fictitious report, by one of the disgruntled reporters whose card under the door was disregarded, to the effect that Edison had just invented an extremely practical shirt, which was shortly to be placed on the market. This remarkable garment had a bosom composed of 365 shining layers, and was designed to last a year—all that was necessary for the wearer to present an immaculate front each morning,

being just to strip off the soiled top layer. Edison himself, it was claimed, had worn one of these shirts many months, and considered it one of the most useful of his many inventions. That there *were* men to whom such a shirt would appeal was soon proved by the letters, enclosing checks for a supply, that came pouring in from all quarters of the globe, until the office was fairly swamped, and the inventor became so wroth that he declared if he had hold of the author of the much-copied skit, he "wouldn't need a shirt or anything else on his back for some time."

X

EDISON AND HIS WORKMEN

Someone has said that there is only one thing Edison could not do: he could not stop work. He himself put it naïvely, "I shouldn't care to loaf!" Year in, year out, time was unnoted, sleep forgotten, food untouched, and rest practically unknown, while he pursued some elusive problem. And so miraculous was his resistance that he looked twenty years younger than his age, at seventy-five, and could still work twenty-four hours at a stretch if need be, without feeling the strain. Thus he perhaps failed in being able to understand any lack of endurance in others.

"I have often felt," says Mr. Upton, Edison's mathematician in the memorable work at Menlo Park, "that Mr. Edison never could comprehend the limitations of the strength of other men, as his own physical and mental strength have always seemed to be without limit. He could work continuously as long

as he wished, and go to sleep the instant he closed his eyes. . . . He always kept his mind direct and simple, going straight to the root of troubles."

And well might Upton add this last remark: for the Wizard was prone to check up the work he required of his mathematician in a very practical manner. Here is a case in point. One day Edison appeared at Upton's office with a pear-shaped bulb in hand—the forerunner of the electric light glob

"Please calculate the cubic contents of this thing in centimeters," said he.

It was an abstruse problem, but Upton was as much a genius at figures as his employer was at invention. The more difficult a solution, the better he enjoyed it. He had taken a degree at Princeton and finished in Germany under Helmholtz, the renowned juggler of integral and differential equations. So he went to work with skilful ease, drawing out the shape of the bulb on paper and getting an equation of its lines. Before he had half finished, however, Edison was back for the answer.

"Huh!" said he, when he had taken note of

the elaborate proceedings, "I would simply take that bulb and fill it with mercury. Then weigh it, and from the weight of the mercury and its specific gravity, I'd get it in five minutes."

"A pretty good guesser," Edison styled himself, by way of accounting for his rare ability of arriving instantaneously at correct solutions, and he has had many a long and victorious wrangle with those who sought to pit their mathematical deductions against his common sense. "The greatest bugbear I had to contend with in building the Central Electric Light Station," he tells us, "were the mathematicians. My first dynamos were all built on guesswork. And they came pretty generally up to the required power!"

Guessing and rule o' thumb methods, however, are fit procedures only for a Wizard. And the same held true of Edison's whole method of work. He was more likely to be found hard at it in his laboratory at midnight than at midday. The hours of the day and the days of the week did not enter into his schedule. His heaviest work in the way of inventions was done at night. It was then that the

best ideas came to him. Nor was this because of the quiet of the surroundings—there was no such thing as quiet around his laboratory. Always he maintained day and night shifts, and the place resounded with ceaseless bustle and activity at all hours. From much of the hubbub, however, Edison's deafness mercifully freed him, and he further possessed the rare and wonderful gift of absolute concentration. He could settle upon some one point and remain fixed, though the house were to tumble in ruins about him.

This same habit of concentration, coupled with an extremely active "forgetting," often got the Wizard into rather laughable complications. The story is told that once upon a time the inventor went down to the town hall to pay his taxes, and finding himself one of a long line of strangers, he soon fell into a brown study over a certain problem which was puzzling him. Mechanically stepping up as the one in front moved on, he presently found himself in front of the official, who asked his name; and for the life of him Edison could not tell! Whether he would have recollected is not known, for as he stood, red and con-

fused, a gentleman stepped up and held out his hand, "Tom Edison, how are you?" he cried, and the difficulty was over.

On another occasion, Mr. Bachelor took advantage of this combination to work a fine practical joke on his employer. The Wizard had been working for several hours on a certain problem, and having reached the limit of endurance had stretched out on a table, with two books for a pillow, and gone instantly to sleep, first giving orders to be wakened at nine o'clock with breakfast on hand. Mr. Bachelor, coming into the room shortly before that hour to eat a breakfast which he himself had ordered, smiled to himself over the remnants of the meal and rose to immediate action when Edison's basket appeared. Carefully bundling it and his own dishes out of sight, he turned on the "calmer." This was an instrument usually used to stop the collapsed fellow-worker from snoring. It consisted of a broad ratchet-wheel, with a crank, into the teeth of which played an elastic slab of wood. Turned with a quick motion, the racket it produced was worse than a cyclone. Not even Mr. Edison's deafness was proof against it. Rising

with the perfect equanimity that is always his, he turned toward the impromptu breakfast table, and was told that his meal would be forthcoming shortly. Being still very sleepy, the Wizard promptly dozed off while he sat waiting. Quietly Mr. Bachelor placed the remnants of his own breakfast before the Wizard, and then made a noise that roused him. Seeing the empty dishes, Mr. Edison straightened up, regarded them absently, and taking out his after breakfast cigar sat down to enjoy his usual smoke, entirely oblivious of the fact that he had not broken fast at all.

Apropos of Edison's evenness of temper, one of his biographers states that "No man in the laboratory has ever seen Edison 'let himself go'; and though his eyes may take on the sternness of a Napoleon, his anger never expresses itself outwardly." He had, moreover, a considerable executive ability, and a remarkable faculty for handling abrupt situations. In the old days of the Pearl Street power house, the experts who had been trained to seal the filaments into the globes formed a union, and knowing that it was impossible to manufacture lamps without them, took on all

sorts of airs. The manager found it almost impossible to control them, and he went to Edison saying that something had to be done. "Rest easy," said the chief, "I've seen this coming." And the manager returned content. Presently, because he refused to tolerate and reinstate a smart-Aleck whom he had fired, the union notified Edison that they were going to quit. "Very well," said Edison, calmly, "that will be all right!" And the nonplussed men, taken at their word, could do no less than make good on it. Then the Wizard quietly brought down from the loft some machines which he had invented to take their places, and the discomfited union stayed out forever!

Illustrative further of Edison's calm temperament and unfailing patience, and the fact that it was impossible to ruffle him, the following tale has been many times repeated. For days an experiment had been going on which required the use of dozens of large tumblers. In one experiment alone over four hundred of these had been destroyed, and the experiment itself had proven a complete failure.

"Well, Mr. Edison," said his tired assistant, hoping against hope that this would be the end, "what shall we do next?"

"Well," returned Mr. Edison, disturbed in his thoughts for the moment, and looking reflectively at the mountain of broken glass, "I guess the next thing will be to get some more tumblers!"

In one of the main rooms in the laboratory at Orange is the stockroom, where everything that could possibly be used in scientific experiments may be found, and some of it in quantities that will last for years. It is an astonishing place, long and narrow and quite high, with thousands and thousands of small drawers reaching from the floor to the roof. And judging from the labels on these drawers what could even a wizard hope to do with such an odd assortment? Needles, shells, macaroni, teeth, bones, hoofs, resin, glass, feathers, peacock's tails, gums, every kind of rope, wire, twine, and cord, varnish and oils of all sorts, skins, human and animal hair, ten thousand or more chemicals, and in short, almost every known thing under the sun. Time was when

new employees were attracted to the standing offer of a prize for the mention of any substance used in science that was not among those present. Now only the merest greenhorn thinks he can add to the list!

One of the first essentials which Edison required in a workman was that he be able "to keep his tongue between his teeth." Always there are secrets in the laboratory that must be guarded, and did his workmen gossip about affairs outside, the trend of his investigations would soon be known, and no end of harm be worked thereby. There was one room, Edison's sanctum, which no one might enter without permission, and thereby hangs another tale.

One day a new boy was hired to guard this door. He was taken in hand by one of "the boys" and instructed very seriously as to the nature of his duties. He was a zealous lad, who had been most carefully chosen, and he took up his work full to the brim of its importance. Shortly after he had mounted on duty, along came a shabbily-dressed man in a yellow duster, who essayed to brush past him with only a cheery "Hello!"

Instantly the boy had the stranger by the arm: "You can't go in there," he said positively.

"Why not?" asked the man, regarding him keenly.

"Because that's Mr. Edison's room—the place where he does his most special thinkin' and inventin'. No one can go in without a written permission, else he sends out for 'em."

"I see," said the man. He turned quickly away, and presently came back with the man who had trained the boy.

"Bill," said that worthy hurriedly, himself no little excited and confused, "what is the matter with you? This man you have kept out is Mr. Edison! I'm surprised——"

But he got no further. The chief stopped him instantly. "I won't have the boy scolded for doing exactly what you told him to do," he said laughingly. "He's a boy after my own heart, and I'm sure he is going to be just the fellow we want here."

Often people of note and friends of Edison's of life-long standing felt themselves aggrieved at the iron-clad rule of *No Disturbance* when he had a knotty problem on hand.

Not one of his employees, however, dared disregard this placard, and the keeper of the door was often put to his wits' end of diplomacy. One day a very pompous gentleman chose to be particularly irate at what he regarded as the office boy's over-caution.

"Look here," he said, severely, "Tom Edison and I were pals, years ago. I *know* he will be glad to see me. I should say so! Let me pass, boy. I'll vouch for you, and no trouble will result. There isn't any one around here knows Edison as well as I do."

"I don't know about that," returned the lad shrewdly. "Mrs. Edison was here this morning, and after waiting for two hours had to go away without seeing him. Orders is orders. You'll have to wait!"

One thing Edison would not tolerate among his employees was a dreamer. Dreams are impractical things, and seldom the output of the man who hustles. Neither is a genius a requisite. According to the Wizard's way of thinking, there is more in an ounce of perseverance than in a pound of genius. "Genius," says the proverb, "is an infinite capacity for taking pains." Edison had a much better defi-

nition. "Genius," said he, "is two per cent inspiration, and ninety-eight per cent perspiration." And all those who have gone any distance up the ladder of fame and fortune agree with him.

"Some inventors are born," said Edison, "but a lot more of them are made." And as proof of this he pointed with pride to the long list of Edison employees who have themselves become inventors of renown.

Recently the world was considerably stirred over the publication of a list of examination questions which Edison had submitted to a host of applicants. Only thirty of the five hundred passed through the ordeal with colors flying, and there was a general feeling among those who failed—college graduates, most of them—that the test had not been fair. For the Wizard was not content with sticking to general text-books and the subject in hand: "He roamed up and down the ages, invaded a dozen arts and sciences and ranged the heavens from the sun to Betelgeuse. There was no complaint because he asked, Who was Leonidas? But when he sought to fathom the mysteries of the Chinese windlass, and de-

manded to be told the kind of wood kerosene barrels are made of, his college critics felt that he was not playing the game according to their rules. There was no harm in asking, Who was Plutarch? But to make the same inquiry in regard to the late Mr. Bessemer was a very different matter."

And what was the inventor's object? Simply to test, not only what the young men had learned in school, but what they had learned out of it. Were they satisfied entirely with their college degree, or did they keep up a course of outside reading, covering the more recent developments of science, invention and the arts? Progress was ever Mr. Edison's watchword. Broad as the plains in his own thought and interests, and quick to branch out into new trails, no one knew better than he that the man who is not ever studying and reading has lost something invaluable—the first sharp craving to learn. Such a man has no future: "A vital something in him has died, and his intellectual finish is not far off."

Always Edison exhibited plain common-sense and originality in testing men. When J. H. Vail, of the old trusted Menlo Park

staff, first appeared before Edison, he had the nerve to apply for the job of overseer in the dynamo-room. The chief looked him over quizzically and then with a curious little glint in his eye, led him to a pile of junk heaped in a corner.

"Put that together," he said, "and let me know when it is running."

"All right, sir," said the would-be overseer promptly, and he hung up his coat and went to work. "I didn't have a shadow of an idea what I was up against," he said later. "But I got a liberal education finding out. The mess proved to be a dynamo. And when I had it together and in fine running order I got the job."

Edison was often criticized as tyrannical to a degree. He was, indeed, painstakingly exacting. His business required every expenditure of patience and care. With the man who exercised thought and showed a desire to do well, he had unlimited patience. It was to the careless, indifferent, and lazy individual that he was a terror for the short time they were permitted to stay with him.

"Why did you let so and so go?" he was once asked.

"Oh," replied the Wizard, soberly enough, "he was so slow that it would take him half an hour to get out of the field of a microscope!"

XI

EDISON AND THE PUBLIC

"A thoroughly comfortable and undeniably human man,"—this was the characterization long ago applied to Edison, and no coinage of words could suit him more admirably. Says one of his biographers, "Those portraits, so familiar to all, showing the inventor with his head resting upon his hand, and a solemn, dreamy look in his eyes, as he listens to the phonograph, are all wrong. Edison is the exact reverse of a dreamer, and always has been—he never gives himself time to dream, and his chief characteristics through life have been marvelous alertness, indomitable determination, and mercurial energy. His eyes are more often laughing with suppressed humor than solemn with thought. When he was a young man, and no one knew him, he was shy in disposition and seldom spoke of himself or his doings. When he became famous,

he did not 'grow out of proportion to himself,' but was the same simple, unaffected *human* being that he had always been. He has about as much conceit and self-esteem as there is air in one of his own electric globes, and the thing he fears most in life is a 'swelled head.' "

He was always glad to talk about his inventions, but let the conversation sheer to himself rather than to his work and he shut up like a clam, becoming shy and diffident to a degree. Apropos of this, here is a bit of conversation that once followed an allusion to Edison's genius, in his presence.

"Stuff!" said he emphatically. "Genius is simply hard work, stick-to-it-iveness, and common sense."

"True enough," agreed the one corrected, E. H. Johnson, Edison's manager at that time; "but you must admit there is something more. Batch here (Mr. Bachelor) and I both have those qualifications. But, though we knew quite a lot about telephones, and had worked hard on 'em, we couldn't invent the chalk-receiver, as you did, when our English agent cabled for a non-infringement on Gra-

ham's patent. Then, again, what do you call the subdivision of the electric light?"

"Electric current," substituted Edison.

"To be sure," agreed Johnson quickly. "And who made that distinction? The scientific world had been struggling with subdivision for years, using what all considered common-sense. And what was the result? They said the thing could not be done! Then you come along, look the ground over, and start off in exactly the opposite direction. Subsequently this proves the right way to turn the trick. It seems to me that the procedure comes pretty close to Webster's definition of genius."

"Huh!" muttered the Wizard, and at once changed the conversation.

Perhaps no man in all the world made a poorer "lion," and yet few have had more illustrious and valuable medals and decorations showered upon them. Some years ago a committee asked the privilege of showing this collection at a certain function. "Why-ee," said Edison, "I have no objection—none at all, provided you think folks would find the gewgaws interesting, which I very much doubt."

The committee were sure of this point, however, and the case containing the prizes was brought. Some of these not being sufficiently explanatory, the Wizard was asked to tell with what invention they were connected, and, though he tried to be obliging, it was soon apparent that he *had forgotten all about it!* For the life of him he couldn't tell the circumstances under which he had received at least half of the honors, and it was then that Mrs. Edison decided to take a hand. She appreciated and valued the tokens, if her husband did not; and she quietly appropriated the case and has since constituted herself its chief custodian. No doubt but for her watchful care most of the medals and decorations would have been lost or stolen long ago.

In keeping with his objection to being lionized, Edison abhorred banquets and public dinners, and for the same reason he was chary about taking foreign tours, observing that he could not "stand all the kindnesses which are showered upon him!" He, however, participated in a few events especially unique. One of the most remarkable of these being given by the American Institute of Electrical Engi-

neers, on the occasion of Edison's fifty-seventh birthday and the twenty-fifth anniversary of the incandescent electric-light, at which time was founded the "Edison medal." Seven hundred distinguished guests faced the Wizard as he sat, much to his embarrassment, in front of a grand display of flags, lighted by a brilliant pyramid of fifty-seven electric bulbs. Above his head was a little painting of his birthplace at Milan, Ohio, decorated with the shield of the "Buckeye state," and the escutcheons of New Jersey and New York. Miniature models of his various inventions, made of sugar, stood here and there about the table; the menus were elaborate works of art, stamped with a bronzed bust of the inventor and bearing his autograph; while the ices were frozen in the shape of dainty electric bulbs and borne in models of motors, dynamos, switchboards, phonographs, and what not, typical of the Wizard's marvelous array of inventions. Thousands of electric bulbs strung along the galleries, and festooned about the walls lent a wondrous brilliance to the scene. At the inventor's right hand was the original duplex sender, the toastmaster, at

the receiving end, having one of the early quadruplex devices, and between the two went the flashes of welcome and Edison's reply. A special feature of the evening was the reading of many fine messages of congratulation and best wishes, received not only from various distinguished individuals in America, but from England and the continent, and to which the toastmaster added the following especially well-chosen eulogy:

"As I am about to propose the health of our guest, let me say there should be encouragement in the founding of this medal to-night for every struggling, ambitious youth in America. Let our sons recall and applaud the cheery little newsboy at Detroit; the half-shod, half-frozen operator seeking bravely a job along the icy pikes of the Central States; the embryonic inventor in New York grub-staked by a famous Wall Street man for his first stock-ticker; the deaf investigator at Menlo Park who wreaked novel retaliation on his affliction by preserving human speech forever with his phonograph; the prolific patentee who kept the pathway to the Patent Office hot with his footsteps for nearly forty years; the genius,

our comrade, who took this little crystal bulb in his Promethean hand, and with it helped to give the world a glorious new light which never was before on land or sea—Thomas Alva Edison."

Another banquet which perhaps exceeded the one just mentioned in elaborateness was that styled a "Magnetic Dinner," and given in Edison's honor, at the Hotel Astor, April 15, 1905. Here the president of the club, acting as toastmaster, made an exceedingly unique and interesting speech, in which the guests and certain Edisonian inventions helped out in a pre-arranged tableaux, highly pleasing to the inventor when he could forget his own modest blushes.

The entertainment began when Colonel Chandler named the quadruplex transmitter. At once, to Edison's amazement, a concealed instrument began to "dot" and "dash" in a marvelously rapid style, while the three hundred guests sang:

"When they tell the stories now of the way they used to send,
And the record-breaking work they used to do;

And the way, every day, they would roast the other end,
We are sorry that those happy days are through."

It was the old air of "My Grandfather's Clock," a favorite with Edison, and his expressive face fairly beamed with delight, as he added his own voice in a spontaneous hum to the melody. At the next signal came a whirring ring of 'phone bells and "Hellos," both gruff and silvery, while once again the whole company broke into song. And so it ran down the pathway of the Wizard's inventions, until finally the incandescent lamp was reached, and then suddenly every light in the room went out, save the wax candles, which had hitherto stood almost unnoted, and once more the voices of the company rose:

"It was just like this in the olden days,
Which have passed beyond recall;
In the rare old, fair old golden days
It was just like this, that's all."

Abroad, kings, noted scientists, distinguished men of all ranks have united to do Edison honor, and while he appreciated their efforts, it is certain that he would have been

far better pleased with less pomp and ceremony. Returning from one of these tours, he is thus credited with describing his days in Paris:

"Dinners, dinners, dinners, all the time! But in spite of them all, they did not get me to speak. Once I got Chauncey Depew to make a speech for me, and I got Reid, our Minister there, to make three or four. I could never get used to so many dinners. At noon I would sit down to what they called *déjeuner*. That would last until nearly three o'clock, and a few hours later would come a big dinner. It was terrible. I looked down from the Eiffel Tower (where he himself was the guest of honor) on the biggest dinner I ever saw, given by the Municipality of Paris. I saw 8900 people eating at one time. Now I feel I must starve for a few months in order to get straight again after all those dinners. I wonder they didn't kill me."

Simple food, moderately eaten, was ever his rule, and he kept an eye on the scales. If he found himself losing or gaining in flesh, he promptly increased or decreased the food supply. Thus for nearly a quarter of a century,

his weight stood approximately at 175 pounds, and the same tailor made his modest suits without change from the measurements furnished him years before. Edison cared little for meat, but was "long" on fruit and pie. He regarded as a necessity his after meals' cup of coffee and a good cigar—"a good working stimulant," he called them. As for cigarettes, "they are deadly," said he. "It is not the tobacco, it is the acrolein produced by the burning paper that does the harm. We sometimes develop acrolein in the laboratory in our experiments with glycerine. I can hardly exaggerate its dangerous nature."

The Wizard was as chary of sleep as of food. Six hours out the twenty-four was enough. How could he stand it? Here is his own answer: "Easily enough, because I am vitally interested in what I do. I don't live in the past." (A happy way of saying that he did not worry.) "I am living for to-day and to-morrow. I am interested in every department of science, art and manufacture. I read all the time on astronomy, chemistry, biology, physics, music, metaphysics, mechanics, and other branches, in fact, all things that

are making for progress in the world. I get all the proceedings of the scientific societies, the principal scientific and trade journals, and read them. I also read some theatrical and sporting papers and a lot of similar publications, for I like to know what is going on. In this way I keep up to date, and live in a great, moving world of my own, and, what's more, I enjoy every minute of it."

And here, in these few brief sentences, is contained the reason why, when it was seen that our country would be drawn into the World War, Secretary Daniels turned to an old white-haired man out in Orange, New Jersey,—to Thomas A. Edison. And this is why that to this man, "seventy years young," must be credited perhaps the biggest "bit" done by any one man for the service of his country throughout the whole period of the war—and that freely, gladly, without thought of any further fame or reward. Putting aside his own business affairs and giving up his beloved experiments and investigations, the Wizard turned single-heartedly to the call, accepting the office of president of the Naval Consulting Board, with the provision that he be

intrusted with scientific investigation only. Forty inventions, in the year and a half of war, is the almost incredible total that he and his assistants worked out for the solution of the mechanical problems at sea. The record of it all would make an interesting book in itself. Again Edison had fared forth into practically an unknown field: he was essentially a landsman; all his work so far had been for the furtherance of progress on shore. But with his usual self-confidence he did not for a moment entertain any doubts of his ability in this new field. His triumphs, accomplished at an age when most men have retired to the chimney-corner, are more wonderful than if he had indeed, as some credulous persons expected, invented a marvelous electrical machine to annihilate at one stroke the armies of our enemies. It is the record of a man of vigor and activity, used to hard work and hard thinking, and to depending with faith and sureness on his own resourcefulness,—a man who although the total of his gifts to the world was already very great, still found his keenest pleasure in meeting the vital problems of his fellowmen.

XII

EDISON IN HIS HOME

Surprising as it may seem, Edison was a particularly domestic man. He retired to his own home as to a castle when the hours at the laboratory were over. It required considerable diplomacy to lure him forth again for the evening, and no matter how important the engagement he positively refused to don a dress suit. As his telegrapher friends were once fond of saying, Edison, whatever else he might be, was no "dude"; clothes simply failed to interest him, and he was democratic enough to follow his own tastes. In deference to his wife and family, he finally laid aside the old linen duster, the "masculine Mother Hubbard," which was once his favorite working garb, and his clothing became less noticeable for hard usage. But he was always, as an aggrieved assistant once declared, "The poorest man at dressing that ever lived, and doesn't care what he wears, save that he will

have spotless linen and an old-fashioned white string tie."

Edison was twice married. His first wife, Miss Mary E. Stilwell, was an intelligent, sweet-tempered girl, one of his working force at Newark and well-loved by all. She came to him shortly after the death of his mother, and the new home was presently set up in "The Homestead" at Menlo Park, and here were born their three children, Mary Estelle and Thomas Alva Edison Jr.,—lovingly nicknamed by their father and the staff as "Dot" and "Dash"—and William Leslie, and here, after her marriage and the family's removal to Orange, Mary or "Marion Estelle," made her home for some time before going to live in Germany. The wife and mother died in 1884, at the most intensely busy period of Edison's career, and for weeks and months thereafter his workshop and his chemical laboratory held him as in a vise. Locked in, he worked for sixty hours or more at a stretch, eating and sleeping only when tired Nature refused longer to withstand the strain.

Then Providence interfered. Business called Edison to Akron, Ohio, to the home of

MR. AND MRS. EDISON ON AN OUTING

Showing him on one of the rare intervals when he was loafing

Lewis Miller, the pioneer inventor of the then famous Miller harvesting and threshing machinery, a millionaire and a man of culture, being the founder of the present Chautauqua movement. And here Edison met the daughter, Miss Mina, a young and beautiful girl, who was deeply interested in all that interested her father, and who had happily given him more than one practically helpful idea as they planned and worked together at the shop. It was a case of love at first sight, and the two were married within a year. Now, Edison's hermit-days were over. No longer could he busy himself in work "up to his eyes" and stay hidden. Mrs. Edison took upon herself the wife's part of keeping her illustrious husband happy, healthy, and "human." She insisted that he have a regular hour for lunch, and leave the laboratory at a certain time in the evening, and she held her point so gracefully and tactfully that the Wizard, though he laughingly dubbed her a nuisance, gave in, and added quite truthfully that he was glad to have some one to take care of him. Of course, there have been lapses of "working-fever," but it is doubtful if the Wizard, as the years went

by, would have been able to accomplish so much had not his wife staunchly insisted on system and regularity, and kept the household machinery running with a beautiful precision which made their home a place of deep and abiding peace.

An attractive home, indeed, is that of the Edisons, one of the most beautiful in all New Jersey. The house is of the style known as Queen Anne, handsomely fashioned of brick and wood. The wide porch is covered with purple wistaria, and fairly radiates comfort and repose. Inside is the cozy cheer and beauty of the old English country house. Glenmont, it is called, and the location is in Llewellyn Park, at the foot of the Orange Mountain. Edison was so fortunate as to purchase the beautiful estate complete, including the blooded stock in pasture and stables, furniture, library, conservatories, and artistic treasures which had taken ten years to collect, from the former owner, just after his second marriage.

"Of course it is much too nice for me," he said, in showing his newly-purchased paradise to a friend, "but it is not half nice enough for

the little wife!" Mrs. Edison, however, was as well pleased as he, and quietly set about certain additions divined from her own capable sense of beauty and fitness, until the whole place was presently eloquent of matchless taste and skilful management—Edisonian, in short.

Mr. Edison's scientific library, one of the most exhaustive to be found anywhere, is kept at the laboratory within easy access of all. And as a rule he left such books there. Mrs. Edison helped him, early in their first days together, to an understanding that the mind profits by a little leisure. Edison was struggling with a pretty hard problem—a problem that insisted on going home with him, when his wife came for him to take their usual little before-dinner drive. Finally it drove him to the library, and there he walked back and forth, up and down, round and round, until his unrest brought Mrs. Edison to his aid. Catching up a book, she stopped before her husband.

"Have you read this?" she asked, quietly.

Mr. Edison, always courteous, paused and took the book. *"The Count of Monte Cristo,"*

he said, reading the title. "No; is it good?"

Mrs. Edison enthusiastically declared that it was a fine story, and she was sure he would enjoy it.

"Well," smiled Edison, "I guess I'll start it right away."

And forthwith he settled himself comfortably, and soon became so absorbed in the fascinating tale that he read straight on through the night, reaching the last word just as the morning sun peeped in at the window. Then he fared forth to the laboratory. He did not return to lunch, but at night he declared that the Count of Monte Cristo was a mighty fine fellow, he had certainly helped him to crack an exceedingly hard nut.

Edison liked detective stories, of the kind that "wasted no time getting down to business." He liked to jump into an intricate plot on the first page and to find the tale unfolding with no abatement of interest until the climax was reached. Emile Gaboriau, the French novelist, who produced M. Lecoq, a pioneer Sherlock Holmes, never failed to interest him, and he was a sincere mourner when this king of detective-story writers died. Edgar Allan

Poe, too, was a favorite. He read over and over the adventurous tales of Flammarion and Jules Verne, and many of the masterpieces of Scott, Dumas, Hawthorne, Dickens, and Ruskin. Dante also gave him many delightful hours, and in one of the library windows is a sash of stained glass, designed by Edison himself, from which the head of the great Italian writer shines down in a wonderfully solemn and realistic manner. A great fireplace takes up one side of this charming room, and there are all manner of cozy nooks and corners here and there where one may pass delightful hours.

All in all, Edison's home and family life was an ideal one, and in the fullest measure he reaped a rich reward in happiness and contentment. In his closing years he "quit the inventing business," but he still had a "thousand and one irons in the fire."

In the evening of his life, standing on the threshold of a new, mysterious, fascinating and so far unfathomable field, Edison toiled on a final invention—an apparatus designed to enable those who have left this earth to communicate with those who remain!

Something of the nature of this instrument

and the theories he has evolved regarding life have been given to interviewers, and they are interesting in being what we would expect from the Wizard of Electricity, who affirmed that neither he nor any other human being knew one-billionth part of what is likely to be known about electricity ages hence, that we must give a brief glimpse of them here, even though Edison warned his interviewers: "Mind you, I am promising no results. All I'm saying is that if those who have 'passed on' are so circumstanced that they can or want to communicate with us, my instrument will make it possible. And, should such a thing take place, there is no doubt but that we would be brought an important step nearer the fountain-head of all knowledge, nearer the Intelligence which directs all."

Scientists tell us that our bodies change once in every seven years, that is, that no particle that is in the make-up of our bodies at the beginning of one seven-year period remains at its end. "We are creatures of environment," says the proverb. And from these two points Edison made an interesting deduction. Our bodies, according to him, are made up of

myriads of small individuals—"life units"—so tiny that a thousand of them gathered together would still be invisible to the highest power microscope. These life units work in squads, or "swarms," as Edison preferred to call them, and he figured that there are leaders among them, just as among humans, which do the thinking and directing. Naturally certain conditions make it impossible for certain swarms to exist.

We have much to learn regarding life and death. And, says Edison, "The more we learn, the more we understand that there is life in things we have been accustomed to call lifeless." As an example, he cites the parts of a chicken that went on living at the Rockefeller Medical Institute long after the chicken of which they once formed a part had died.

All of the higher swarms are deathless, Edison concluded. "When we die, these swarms of units, like swarms of bees, so to speak, betake themselves elsewhere, and go on functioning in some other form of environment."

His theory of communicating with the spirit is based upon the supposition that the swarm we call "personality" exists after death in a

hereafter such as we all love to think about and imagine. "And if it does," he affirmed, "then it is strictly logical and scientific to assume that it retains memory, intellect, and other faculties and knowledge that we acquire on earth. This being true, it is reasonable to conclude that those who leave this earth would like to communicate with those they have left here. No doubt, however, the degree of material or physical power which they possess must be very slight. Accordingly, the thing to do is to furnish the best conceivable means to make it easy for them to open up communication with us, and then see what happens." The avenue offered will, of course, be electrical.

With this vision of the other world, we must conclude the life story of a man who, perhaps of all others who have ever lived, has made us realize most fully the infinite powers accorded to all mankind.