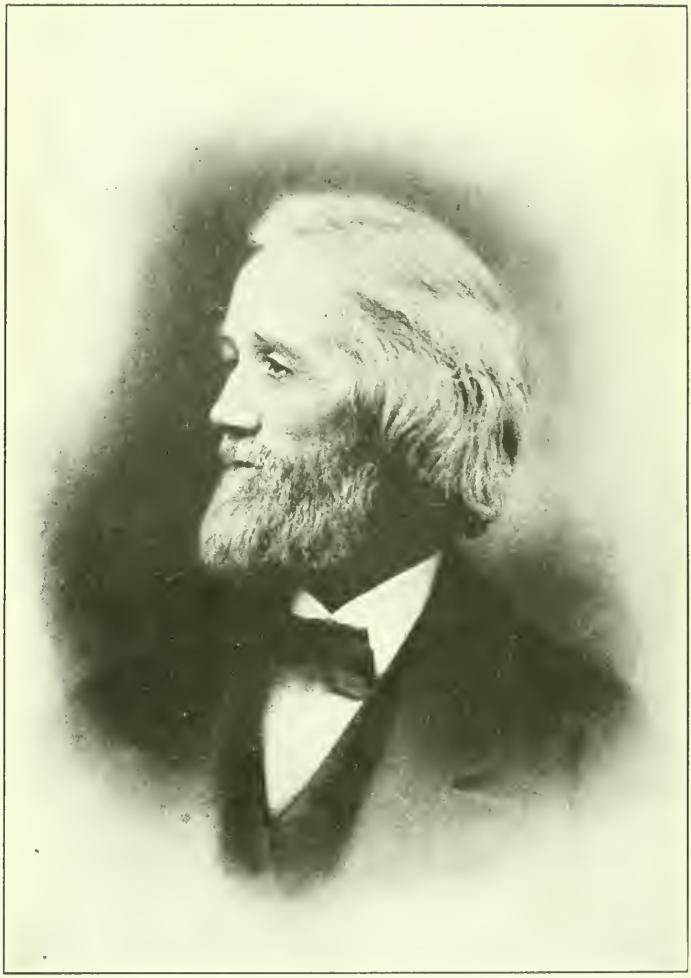


C. Latham Sholes

Inventor of the Remington Standard Typewriter

CHRISTOPHER LATHAM SHOLES

My niece, seven years of age, picked up, an hour ago, a few acorns under an oak of October. From one of these nuts she has pulled away the cup. This cup, dipped in water and pressed upon paper, makes a dozen much better circles than Jessie could draw with either her pencil or pen. And why? Because now she has simply to press one object on another, an acorn cup on a bit of paper, to leave an impression. Without knowing it, she is a Printer. When her forbears long ago came to this art of printing they proved themselves to be human in skill and faculty, and gave token of an immeasurable advance beyond their lowly kindred of the forest and the glade. At first, in all likelihood, they imprinted upon mud and clay the outlines of nuts and leaves, feathers and shells, more in simple sport than from any other impulse. When the arts of making weapons and tools arose, we may be sure that swords and knives, arrow-heads and hammers, were bidden to impress their contours upon clay, wax, and other yielding surfaces. By and by stamps and brands for cattle and horses were produced,—a new step in the art of printing. More important still was the carving of seals. These gradually became larger and more intricate, so as to set forth a tribal record, a deed of sale, a mortgage, or a military proclamation. The point to be remarked is that a printer, wholly devoid of skill, can impress a complicated outline from a crystal or a metal plate every whit as well as its carver or engraver. In the labor of depiction it is this artist who does the chief part of the work; when he has finished, a mere copier, with slight exertion, can reproduce his outlines rapidly and easily. Such is the marvel of printing.

Second only to articulate speech is the art of writing; and the slowness of writing, its laboriousness, its frequent illegibility, have for centuries prompted men of ingenuity to modes of printing instead of writing. Years ago, near Rome, a brass plate was found bearing the name:

CIACAECILI
HERMIAE. SN.

It is about two inches long and nearly an inch wide. This plate could be used either as a seal to save its owner writing his name, or as an engraving from which to print with ink. To keep clean its user's fingers, it had a convenient handle. Ancient, to be sure, is the lineage of like stamps, to-day cast in rubber, and sold for a few cents each throughout America.

Beyond this making of name-plates, a noteworthy step was taken by Italian copyists as long ago as the twelfth century. They engraved elaborate initials upon metal stamps, and impressed these upon their pages. They may have lacked skill enough to execute these letters with pens, or they may have simply wished to save time as they copied a Bible or a Psalter. Long before their time, linen and silk had been printed with intricate patterns from engraved blocks, and this effective plan they applied to the production of books and manuscripts. So gainful was this ingenuity that soon not only initials, but every other character on a page, was printed from stamps, so that whole books were produced from just such simple tools as bookbinders use to impress titles on their volumes. Of books printed with hand stamps, the most famous is the Silvered Book of Upsala, in Sweden. It is so called because its letters are in silver; occasionally these letters are found turned upside down, an error possible to a hand printer,

but not a penman. This work contains the four gospels in the Mœso-Gothic language, and is deemed a relic of the Gothic Bible of about A. D. 360.

And now a leap was taken, memorable for all time, and quite without forecast as to the wings it would bestow upon human faculty. Hand stamps, such as were employed in Italy for centuries, were taken to the Netherlands, where they shrank into nothing less than the first movable types. Donatus, an eminent teacher who flourished about 350, wrote for boys a Latin Grammar which bore his name. For centuries after his death it was reprinted from engraved wooden blocks. In Holland, during the fifteenth century, new editions appeared in which movable types were, for the first time, in service. They were rudely cut or cast, so that they stood together somewhat unevenly. But, poor as they were, they built the bridge which led from ancient copying to modern printing. It would seem that Gutenberg only perfected a casting of types, which, in their original manufacture by his predecessors, were faulty both in shape and size. When movable types were cast in uniform molds, carefully cut, hand stamps were ousted from all but a mere corner of their field. In America hand stamps bearing numerals remained in use for paging account books, for numbering tickets, and the like, as recently as 1866, when their slowness of pace suggested the invention of a machine to do their work better and cheaper. Its designer, successful in this modest venture, was thus led to devising the modern typewriter. In this achievement he bade slight blows replace the delineations of the pen, slow and faulty at best. And from the typewriter has sprung a machine more ingenious still, the linotype, in which a lettered keyboard is the initial feature.

Christopher Latham Sholes, the inventor in question, was born in Mooresburg, Montour County, Pennsylvania, on February 14, 1819. The blood of John Alden ran in his

veins, and so did that of New England soldiers who had borne a brave part in the revolutionary war. Both by nature and nurture he was a man of brains, character, and courage. At fourteen he was apprenticed to the art and craft of printing in the office of the *Intelligencer,* at Danville, six miles from his birthplace. At eighteen he was a proficient compositor, with a mastery of his trade much more thorough than would have been feasible in a city printing office, with its departments narrowly subdivided. His familiarity with types, with the mechanism of presses, with the details of printing, was indispensable to him, at a later day, as an inventor.

His elder brother, Charles, a printer like himself, some years before this had gone to Wisconsin, where he was thriving as the owner and editor of the *Democrat,* in Green Bay. Christopher promptly accepted his offer of a post on its staff, and went West for good and all. In his new field he displayed unusual ability, and a trustiness more uncommon still. Within a year he was sent to Philadelphia, then a formidable journey, there to have printed in book form the Journal of the Wisconsin Legislature. He punctually brought home the volumes; they were executed in a style and with a correctness which at once gave him promotion. He was given charge of the *Inquirer,* at Madison, a newspaper owned by his brother. While he held its rudder, he supervised the public printing, a less onerous task in 1839 than now. But his activities, manifold though they were, left him wishing to be still more busy. In partnership with a friend, Michael Frank, he established the *Telegraph,* at Southport, now Kenosha, a journal which maintains its prosperity to this day. Sholes, through his public spirit and transparent honesty, soon became a trusted leader in his new home. This was recognized by his being appointed postmaster in 1843, by President Polk. Then and always he was a man of clear convictions which he honored by use.

He saw an exclusiveness in the churches, a drifting of the lettered few from the unlettered plain people, which he deplored; by way of remedy he took a hand in founding the Excelsior Church, with pure democracy as its corner-stone. Men and women of all shades of belief, and disbelief, were invited to take part in its free discussions of life here and hereafter. For two years this little band of come-outers held together, making a deep mark on the community; then it fell apart like a sand heap, never again to unite.

In politics, Sholes was equally the servant of ideas. He joined the Barnburners' wing of the Democratic party, and fought hard against the growth of slave-holding influences in national lawmaking. As a member of the State Senate, in 1853, he introduced a bill to allow negroes claimed as fugitive slaves the right of habeas corpus and trial by jury. This measure was defeated. Next year a mob in Milwaukee rescued from jail Joseph Glover, a runaway slave, enabling him to escape to Canada. Then came a clash between the State and Federal Courts on the question as to how far a State could protect its citizens from arrest and imprisonment at the hands of national authority. Meanwhile the Chief Justice of the Supreme Court of Wisconsin declared the Fugitive Slave Law to be unconstitutional and void. On the strength of this decision, the State openly nullified pro-slavery laws of Federal enactment, with the outspoken approval of its people. When the inevitable conflict between Slavery and Freedom burst into flame, no State of the Union sent braver troops to the front, year after year, than did Wisconsin. Every fifth male in her population became a soldier, and her death list in the field was no less than 10,752. In all that preceded an appeal to arms, in all that went to bestow victory upon the soldiers of the North, Sholes took an unwavering part, exerting an influence as wide as the State. While a member of the Wisconsin Assembly for Kenosha County, he witnessed a

tragedy which moved him profoundly. This was the shooting of Charles C. D. Arndt, the Representative of Brown County, by James H. Vineyard, of Grant County. Their quarrel had turned on a nomination for a post as sheriff, Vineyard advocating his brother for the place. Sholes published a recital of this murder in the Southport *Telegraph,* where it caught the eye of Charles Dickens, who transcribed it in his "American Notes," with an array of other acts of violence, all due, he maintained, to the brutalizing influences of slavery.

Errands of business often took Sholes to Milwaukee, where he saw with what rapid strides that city was leaving behind every other in Wisconsin. To Milwaukee, accordingly, he removed, to become editor of the *Sentinel,* and later of the *News.* In Milwaukee, with its comparatively large population, his ability and straightforwardness gave him a wider group of friends than ever. In token of popular regard he was chosen Commissioner of Public Works, and afterward Collector of Customs. Yet it is not as a legislator, an editor, or a public official, that he is remembered. His fame was destined to take its rise from the trade he had acquired as a lad, that of printing. In those days it was usual for newspapers, even in cities, to conduct a department of job printing, as a rule at considerable profit. A strike by Sholes' compositors so angered him that he seriously took up the notion of typesetting by machinery. He built models in which types impressed themselves on wax, but this wax bulged in provoking ridges that spelt utter failure, so he cast his models aside and made peace with his staff. On quite another path of printing he was to win a great triumph, beginning with hand stamps, such as those wielded by Italian copyists centuries before. Sholes, at this time, manufactured a good many blankbooks, tickets, coupons, and so on, all numbered by metal stamps of the old-fashioned kind. One day it oc-

curred to him that he could devise a machine to perform this work much more neatly and quickly. He discussed this project with a friend, Samuel W. Soule, like himself a printer, and a man of decided ingenuity. They began work at once in a small room on an upper floor of a mill owned by Henry Smith, an old friend. This two-and-a-half story building, in simple ashlar, stood on a narrow strip of land between the Milwaukee River and the Rock River Canal. Here, day by day, Sholes drew his plans with Soule's aid, and here their model gradually took form, proving to be a thorough success in a final test. On the same floor of the mill was the workshop of another tenant, Carlos Glidden, the well-to-do son of a retired ironmonger. Glidden was an inventor, too, and he was developing a spader which he believed would outdo the work of any plow on the market. Naturally, there arose many a colloquy betwixt the three inventors regarding their plans, with much debate of the weak points disclosed as their experiments followed one another.

Sholes and Soule duly patented their numbering machine on November 13, 1866. Shortly afterward they showed it to Glidden, as it turned out capital work at a pace far outstripping that of manual labor at its best, and with infallible correctness. Glidden exclaimed: "Sholes, why cannot you build a machine to print letters and words as perfectly as these figures are struck off here?" This query had doubtless often been put to other inventors, but now it was asked of the man who was to give it a triumphant response. But not at once, although the idea took firm root in Sholes' mind, and kept him on the lookout for any information that would serve his turn. He who seeks, shall find. In July, 1867, Sholes came upon a description, in the *Scientific American,* of a writing machine for which a great deal was claimed. It had been exhibited in London by its inventor, John Pratt, of Centre, Alabama. Its de-

scription was accompanied by an editorial prophecy since fulfilled in all but its closing words: "A machine by which it is assumed that a man may print his thoughts twice as fast as he can write them, and with the advantage of the legibility, compactness, and neatness of print, has lately been exhibited before the London Society of Arts, by the inventor, Mr. Pratt, of Alabama. The subject of typewritting is one of the interesting aspects of the near future. Its manifest feasibility and advantage indicate that the laborious and unsatisfactory performance of the pen must, sooner or later, become obsolete for general purposes. Legal copying, and the writing and delivering of sermons and lectures, not to speak of letters and editorials, will undergo a revolution as remarkable as that effected in books by the invention of printing, and the weary process of learning penmanship in schools will be reduced to the acquirement of the art of writing one's own signature, and playing on the literary piano above described, or, rather, on its improved successors."

Pratt's machine struck Sholes as complicated and liable to get out of order. He believed that he could devise mechanism more simple, and at least as efficient. Soule had been a helpful partner in the numbering machine, a success from the start; would Soule embark with him in this second project? Yes. Glidden, who had given Sholes his first push from the shore, was received as a third partner: he was to contribute the necessary funds. A conference was held as to plans, which were sketched in a preliminary way. First of all a writing machine must write, but how was its paper to be imprinted? Soule suggested the scheme, never excelled, of placing convergent typebars on the rim of a circle, so that each might strike the center. Whether this design was original with him, or borrowed, is not to be ascertained at this distant day. It first appeared in the writing machine of Xavier Progin, in 1833; it presented itself

again in the embossing machine of Alfred E. Beach, in 1856. Other inventors had gone astray in sliding their typebars through a horizontal circle, rotated on a vertical axis, as Charles Thurber did, in 1845. When an operator wished to print "A" he turned the ring until "A" stood over the printing point. He then depressed the "A" typerod so as to leave "A" printed on the paper beneath. This mechanism, much too slow for business, survives in toy machines.

And yet the Thurber design, faulty in the disposal of its typerods, displayed a feature of cardinal value; its paper was borne on a cylindrical carriage, or platen, and this Sholes adopted in his second model. It remains to this hour an indispensable part of every standard machine. Sholes devised the letters, all capitals, a spacer, and other details equally important. But no one of the three partners undertook any systematic inquiry as to what their predecessors had done, so they troubled themselves to devise novelties which worked badly, when they might have laid hands on old contrivances that worked well. In their first model Sholes built a keyboard resembling that of a piano, with two rows of keys:

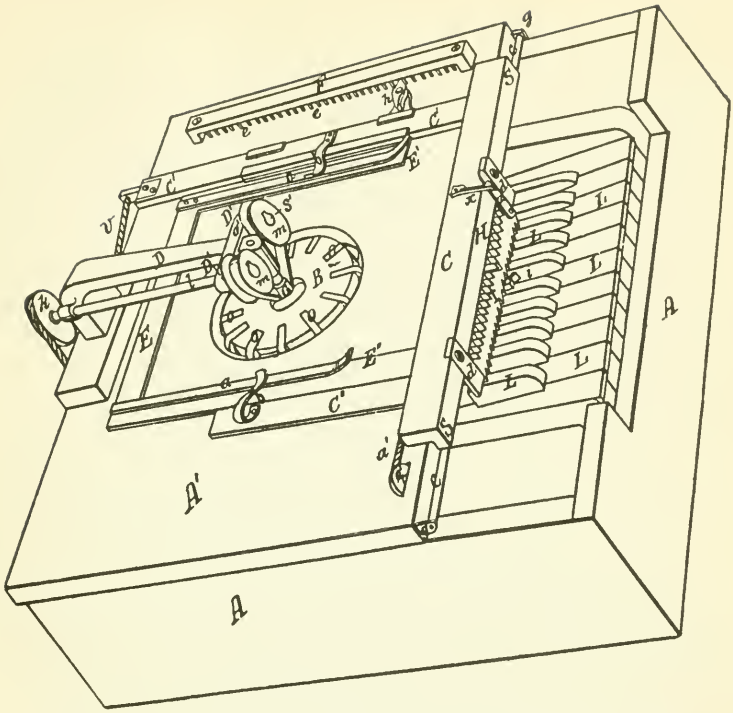
3 5 7 9 N O P Q R S T U V W X Y Z
2 4 6 8 . A B C D E F G H I J K L M

He did not know that Dr. William Francis, of New York, in his remarkable machine of 1857, had introduced keys of the peg form now universal, and arranged them in four rows so as greatly to shorten the journeys taken by an operator's fingers. Sholes at length abandoned his piano keyboard at the instance of his model-maker, Matthias Schwalbach, a builder of tower-clocks in Milwaukee. As we have just seen, Sholes in his first keyboard gave his characters a strictly alphabetical and numerical order. He soon changed this for the present order of disposal which,

like the compartments of a printer's case, places the characters oftenest used nearest to the working center. As patented on July 14, 1868, the claims of Sholes, Glidden, and Soule were: (1) A circular annular disc, with radial grooves and slots to receive and guide the typebars so that they struck the center. (2) Radial typebars to correspond with this disc. (3) A ratchet to move the paper-carriage by the breadth of a tooth when a key was struck. (4) A hinged clamp to hold the paper firmly on its carriage.

Frederick Heath, of Milwaukee, as a lad was employed as a messenger by Mr. Sholes as he began to devise his typewriter. On the wall of Mr. Heath's office he has framed a rough, uncouth model of the first machine invented by Mr. Sholes. "His original idea," says Mr. Heath, "was to have his keyboard fashioned after that of a piano, and there you have it. The first row is of ivory, duly lettered; the second row is of ebony; and then, as you see, a third row, made up of letters and characters that are little used, is in the form of pegs. The framework is of wood, with the leverage below, and the basket form of typebars above closely resembles those of some machines in use to-day. The original model was very clumsy and weighty. The writing was on a tape of tissue paper, and the platen was fastened to the body of the boxlike affair. The writing could not be seen till it was completed, and when the document was once removed from the machine there was no way by which it could be replaced with any degree of certainty that the lines would correspond with those previously written.

"Mr. Sholes was collector of customs of the port of Milwaukee during most of the time that he was engaged in devising his typewriter, and later he was Comptroller of the city of Milwaukee. While acting in this latter capacity, it fell to his lot to enter into a contract, on behalf of the city, for the paving of certain streets. He had the contract



First Patent, Sholes, Glidden, and Soule, June 23, 1868

Key-levers, L, vibrating on the fulcrum, M, with the inner fingers, *u*, reaching under the typebars, so that the keys act directly on the types.

The spacer or ratchet, I, combined with the bifurcated lever, H, connected with the bar, T, pivoted at *s* and resting across the arms of the keys, L, so that striking the key-faces will work the teeth of lever-forks up and down and into the notches of the spaces, so as duly to move the paper-carriage.

The pins, *e*, fastened to the table A′, combined with the pawl, *h*, and the spring, *l′*, to give the paper-carriage a certain and regular cross-line movement at a right angle to the space movement from line to line.

The spring-clasps, *b*, attached to the bars, C and C′, on a line through the middle of the platen, G, combined with the springs, *a*, attached to the bar, E, hold the paper on its carriage smoothly and tightly.

The spools, *m*, combined with the gudgeon, *s′*, the shaft, *l*, the pulleys, *k* and R, the band, *v′*, the cord, *v*, the weight, W, the ratchet-wheel, V, the pawl, *t*, and the bar, P, pivoted to the back of the case, A^2, feed a fresh part of inking ribbon to each type successively.

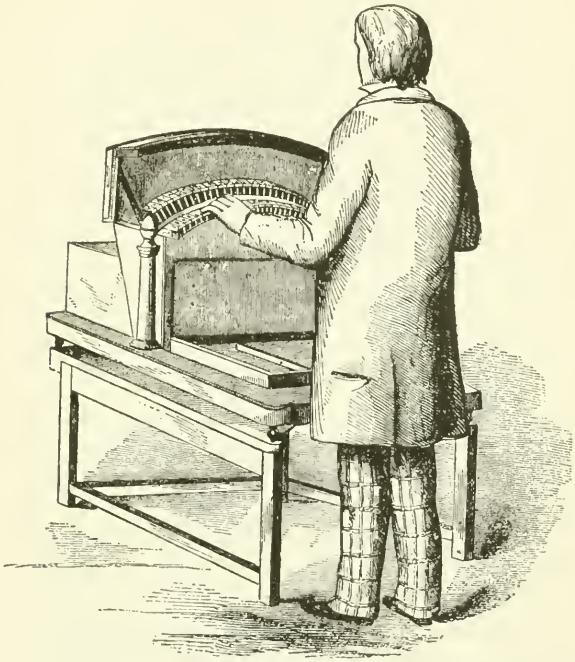
written on one of his machines, and this is claimed to have been the first official document ever produced on a typewriter. In that machine, only capitals appeared; lowercase letters came later as an addition. For his first model Mr. Sholes used an old kitchen table which he found in a garret." *

It has often been asked, why did inventors so ingenious as Foucault in 1849, and Beach in 1856, limit their machines to mere embossing, so that their services were restricted to the blind? Simply because they were unable to contrive a simple and trustworthy inker. This was contributed by Dr. Francis in 1857, as he produced the inked ribbon now in general use. Such a ribbon is virtually dry under a light touch; under the sharp stroke of a typebar it readily parts with its color. Sholes employed this ribbon in his first machine, and was ready to use carbon paper as an alternative. To-day carbon paper is employed solely for duplication; ribbons are the chief source of ink. One or two popular typewriters use inkpads, and find them satisfactory.

In that grimy old mill on the Rock River Canal there were interludes to lighten and brighten the toil of experiment. All three partners were chess players of more than common skill, and they often turned from ratchets and pinions to moves with knights and pawns. Ever and anon a friend would drop in, and the talk would drift from writing by machinery to Reconstruction in South Carolina, or to the quiet absorption by farms and mills of the brigades mustered out after Appomattox. Then, with zest renewed, the model was taken up once more, to be carried another stage toward completion. One morning it printed in capitals line after line both legibly and rapidly. Sholes, Soule, and Glidden were frankly delighted. They determined to let their friends see at once what they had achieved, so they wrote

* "Typewriter Topics," New York, April, 1909.

hundreds of letters on their typewriter to correspondents far and near. Just one of these letters hit the bull's eye. It went to James Densmore, of Meadville, Pennsylvania, who



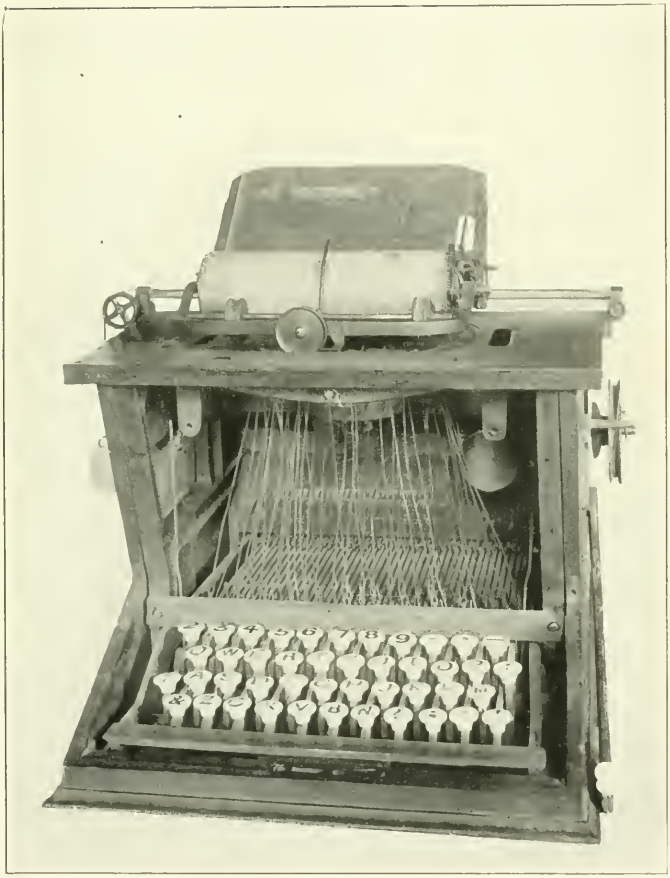
FOUCAULT'S PRINTING KEY FRAME, BY WHICH THE BLIND MAY WRITE

Shown at the Great Exhibition, London, 1851. All the letters of the alphabet, in high relief, are fixed on the upper end of a metallic rod, made to slide longitudinally in a channel of its own. They are disposed like the ribs of a fan, each rod showing its letter both at the upper and lower ends. All the letters converge to a center. When a letter is embossed, the paper moves sidewise by the breadth of a letter. At the end of a line, the paper moves perpendicularly by the breadth of a line.

took fire at this demonstration that a writing machine was about to supplant the pen. He was sagacious enough to foresee a wide and profitable acceptance for the type-

writer, so he asked the price of a share in its patent. The partners were greatly cheered by this proof that their invention already had a cash value. They held a hurried conference, and agreed to offer Densmore one-fourth of their patent on his paying all expenses to date. He said "Yes," without a day's delay, and this before he knew what the expenses were. It was the following March when he first saw the machine, and he examined it with no indulgent eye. Its creators had meanwhile embodied vital improvements on their original design, and they were rather proud of the machine as it stood. Densmore bluntly declared that it was good for nothing except to show that its underlying principles were sound. He urged the trio to proceed with further improvements, and promptly, for which he would advance all needed funds. At this stage of affairs, Soule and Glidden retired from the scene, leaving Sholes and Densmore in sole possession of the patent, and whatever harvest it might yield in time coming.

They manfully attacked the defects of their model, and patiently built other models, about thirty in all, each with some change, usually intended to reduce friction and heighten speed. Both Sholes and Densmore expected that stenographers would be among the first and best buyers, so they sent experimental machines to a leading reporter in Washington, James Ogilvie Clephane, who afterward greatly helped Ottmar Mergenthaler, inventor of the linotype. Clephane was so unsparing in his tests that not seldom he reduced a machine to ruin. His judgments, too, were so caustic that Sholes, forbearing though he was, lost his temper at last. Said he to Densmore: "I am through with Clephane!" Densmore's comment was: "This candid fault-finding is just what we need. We had better have it now than after we begin manufacturing. Where Clephane points out a weak lever or rod let us make it strong. Where a spacer or an inker works stiffly, let us make it



SHOLES TYPEWRITER, 1873

[Museum, Buffalo Historical Society.]

KIRBY HOUSE, MILWAUKEE, WISCONSIN, SEPTEMBER 2, 1872.

MR. INGERSOLL,---YOUR LAST LETTER CAME THIS MOR-NING.

I WILL BE READY TO PROSECUTE THE CONTINUATION OF THE EXAMINATION AT THE TIME YOU SET,---MONDAY, THE 16T OF THIS MONTH, AT CORRY.

I WILL BE THERE ON THE MID-DAY TRAIN.

I EXPECT TO BE ABLE TO DO AS YOU WISH ABOUT CON-TINUING IT TILL WE ARE BOTH THROUGH.

RESPECTFULLY,

JAMES DENSMORE.

work smoothly. Then, depend upon Clephane for all the praise we deserve."

This counsel was heeded, and Sholes further improved his models in the light of objections from Washington. When the total output of machines had risen to fifty or so, produced at an average cost of $250, Sholes and Densmore concluded that they had learned from Clephane as much as he could teach them, for the present at least. They were convinced that the time had come when their typewriter could challenge examination by an expert mechanic of the first rank, who would look at their machine with a fresh eye, and advise them as to its manufacture for the markets of the world. Their choice fell upon George W. N. Yost, whom they at once invited to Milwaukee.

He subjected their latest model to a thorough inspection and to repeated tests. He suggested several changes in matters of detail; and he declared that what the machine now required was precision in manufacture. He recommended Sholes and Densmore to take their typewriter to Eliphalet Remington & Sons, at Ilion, New York, where it could be produced and constantly improved. The Remingtons were then manufacturing firearms, sewing machines, and farm tools, all of the highest merit. Their plant included lathes, drop forges, and other machinery of the latest and best patterns. Every part of each of their pistols or rifles was accurately copied from a model to the one-thousandth part of an inch. This system, applied to typewriters, would minimize friction to the utmost, while rendering it easy to renew parts broken, or worn out of true. More important than its admirable plant was the staff in charge of its experimental work. This staff was the prototype of many such staffs now busy throughout America. At such electrical centers as Schenectady and Niagara Falls, at the headquarters of oil, steel, paper, and sugar manu-

facture, groups of experts to-day coöperate in attacking new and difficult problems, developing a team-play which earns golden rewards.

To such a group of organized constructors Sholes and Densmore displayed their typewriter, early in 1873. It was agreed that the machine should remain at Ilion to be improved, tested, and, in all likelihood, manufactured on a large scale for home and foreign markets. Thus, at last, the typewriter ceased to be a mere experimental model among other such models, and took its place as a practical and vendible article, like a sewing machine or a harvester. It had been put together by amateur mechanics; it had been developed under the fire of an unrelenting critic; it had been examined and amended by a distinguished inventor; it was now to undergo standardization in a great modern factory, to be produced with the utmost strength of material, the least possible liability to derangement, and the highest feasible speed.

The Remingtons took hold of the typewriter with both hands. They saw its possibilities, and brought these into actualities, step by step. They felt sure that the patent was well worth buying, so they bought it, Sholes and Densmore consenting that the machine be called the "Remington." Sholes for his interest accepted a lump sum, which tradition places at $12,000.00. Densmore wisely preferred a royalty, which yielded him a million and a half. Sholes continued to reside in Milwaukee, where, with the assistance of his sons, Louis and Zalmon, he built new models of typewriters, constantly simplified in design and lightened in touch. The latest and best of these machines, "The Sholes Visible," displays not only the line being written, but all that is written. Its typebars are each in a single unjointed piece, L-shaped, and operate in a guide from the instant of pressing a key until its type impresses the paper. In fewness of parts, perfection of alignment, and durability, this

machine is distinctly superior to any predecessor from its inventor's hands.

Never stalwart in frame, Sholes had hardly passed his prime when his weak lungs became infected by tuberculosis. He fought this fell disease most bravely for nine years. Then, on February 19, 1890, he succumbed, leaving six sons and four daughters to mourn him.

Good reasons, we have seen, attracted Sholes and Densmore to the Remingtons. The same good reasons brought to that firm James H. Hammond, with a model of his typewriter, embodying not typebars, but a typewheel, against which his paper was rapped to be printed. While the Sholes and Densmore machine was preferred by the Ilion manufacturers, the Hammond typewriter has found favor with a large public, chiefly through the perfection of its alignment. Its types are arranged on a rotating cylinder. Sister machines employ only a segment of a cylinder, and find that enough. These three plans,—convergent typebars, a typewheel, and type on the segment of a wheel—are the only successful modes of construction thus far devised.

Upon these three well seasoned plans, hundreds of different typewriters have been invented: most of them now obsolete and forgotten. Less than twenty machines supply ninety-nine per cent. of the market. Each of these survivors is suitable for some particular field of work. Most of them are adapted to ordinary duty in offices, where hundreds of letters, bills, or reports must be despatched every day, asking only a fair quality of output. Other machines execute the precise and neat work which commends itself to teachers, scholars, and editors, to ladies who write their own letters. One or two machines appeal to travelers who insist upon a light and simple mechanism, unaffected by the jars and hazards of journeys by land and sea. But the designers of such machines work within limitations, and are

thoroughly aware that their models cannot be placed in the front rank.

The typewriter, as it left Sholes' hands, simply provided (1) means for hitting the paper with types at due intervals; (2) moving the paper a suitable space after a stroke; (3) moving the paper lengthwise at the end of a line; (4) striking a bell near the end of a line. To these facilities have since been added: (5) means of retracing a line in correcting an error; (6) varying the distances apart at which lines may be written; (7) using a shift-key so that at will one of two characters may be written by each key. An upper case "B" and a lower case "b" are, let us say, engraved on a block attached to the "b" key. When that key is struck "b" will print, as "B" is too far off to impress itself. Lowering the shift-key moves the carriage into such a position that "B" imprints itself when the key is struck.

To know the typewriter at its best we must use a standard machine built for office work. We will find it admirable in its accuracy and beauty of characters, its range and speed. It writes in every language of the world, including the Jewish, which proceeds from right to left, a direction opposite to that of ordinary script. Typewriters have been adapted to producing musical scores. In machines whose product is to be read by blind folk, Braille and other codes replace the usual characters. In an ingenious machine a stenographer is provided with shorthand symbols instead of ordinary letters. Last of all, electricity has been invoked to lessen the toil of manipulation which, continued hour after hour, becomes fatiguing.

No penman, however skilful, can match the legibility and compactness of a typewriter. When he writes a letter with a pen, he can take a single copy, and no more, on a wet sheet of tissue paper in a letter press. A typewriter with a brass platen affords as many as sixty copies from carbon paper. With similar carbon sheets a bookkeeper can at

one operation write an entry in a sales-book, and duplicate its lines for a bill. A tabulator, controlled by a touch, keeps all the figures of an account in their proper columns. Yet more: an attachment, smaller than a lady's watch, adds and subtracts these figures with precision, so that they may be printed as totals or remainders. This recalls that Sholes first of all invented a numbering machine, which feat, as we have seen, led him to devising his typewriter. His successors in one instrument unite computation with writing.

Long ago typewriters entered into rivalry with printers as well as with penmen. A circular, or a program, was transferred from a typewritten sheet to a gelatine mold from which forty to fifty copies could be neatly struck off. To-day a better method yields as many as two thousand copies, and with more despatch: the types of the writing machine are used to cut a stencil in a film of stiff wax from which, on a small rotary press, copies are rapidly printed in ink. These and many another golden harvest are to-day reaped from machines derived from Sholes' great invention. In all machines, heavy or light, simple or intricate, elegant or solid, certain principles of design are indispensable for success. Let a few of these principles be reviewed:

The carriage must be strong and move firmly in its slide, and the typebars should have a leverage as simple and rigid as possible. These features insure good alignment, always in evidence. Nobody can tell from a glance at a page at what pace it was typewritten; but a glance at once detects any irregularity of line. When a machine is solidly built, both quick operation and heavy manifolding are borne for years with little wear and tear. Operators usually demand speed, and speed requires a rapid escapement. However rapid an escapement may be, it is never instantaneous, so that, with a swift pace, good alignment is difficult. This shows how two wants may oppose each other, so that no machine whatever can satisfy in the highest degree every

want. Perfect alignment must be paid for in a slight reduction of speed. At very quick paces there is an unavoidable loss of neatness, and an increase in errors.

Next to speed, an operator desires ease of working. He does not always get it. Some machines are more than twice as resistant as others. In stiff machines, with a long play or dip of the keys, fatigue sets in early in the day, to be registered in lapses due to no other cause. Ball-bearing carriages were introduced about 1896, easing the labor of operation in a remarkable degree. Where these bearings are placed in V-shaped runways, there is at times a liability to uneven wear, causing sluggish movement of a carriage. Most machines of the best grade are now fitted with roller-bearings, which wear uniformly and give no trouble.

Operators like a quick and easy machine: their next preference is for a machine with its writing in plain sight. Blind machines came first, and many typists became so accustomed to them that they cling to them still. These operators, through sheer force of habit, when they work a visible machine, are apt to lose somewhat of their self-confidence, and refer too often to their notes. With blind machines they keep their eyes on these notes, except at odd moments when they glance at their keys. But to-day the majority of beginners adopt visible machines, and with advantage. They are thus enabled to note an error, and correct it, with the minimum of trouble and delay. Visible machines are steadily gaining ground, and will in a few years, in all probability, hold the field.

Shift-key machines ask shorter trips from an operator's fingers than machines without a shift-key. Here another case of force of habit comes to view. A typist brought up on a "Yost," or a "Smith-Premier" machine, with its double keyboard, may be induced to adopt a shift-key machine. But in a few weeks or months the operator is apt to return to the old machine. Yet these instances grow fewer

year by year. For most purposes shift-key machines economize time and energy, and with this advantage they are driving their competitors from the market. In some minor tasks, cataloguing and directory work, for example, where there are frequent changes from small letters to capitals, and vice versa, an old-fashioned machine may turn out more work in an hour than any other.

A machine as radically novel as the typewriter, discovers, or creates, as you please, a round of aptitudes unimagined before its advent. When the Sholes machines first appeared their operators were perforce clumsy and slow. Practice soon heightened their speed, and operators to whom speed was impossible simply dropped out of the running. From that time to the present hour, the pace of working has gradually increased. This is due, in part, to better machines,—of easier touch, of keyboards not only more compact, but so arranged that an operator's fingers take the shortest paths possible. To-day, also, more fingers of each hand are brought into play, and are better taught their business, than when typing was a novelty.

Thirty years ago beginners seldom used more than one or two fingers of the right hand, employing the left hand scarcely at all. To-day touch-systems teach the use of all the fingers of both hands, instructing the thumbs to move the space-bars and shift-keys. These systems, when mastered, greatly promote speed. An expert operator of the first rank keeps his eyes fixed on his "copy," never glancing at his keys, which, indeed, may be blank. In acquiring this remarkable facility the first step is to cover two or three characters with paper, so that the learner must feel for them. When the places of these characters have become familiar, two or three more characters are hidden from view, and so on, until the whole keyboard is blank. At exhibitions, a pace may rise to 200 words a minute, so as to advertise the "Speedwell," let us say, as the conqueror.

But words thus shot on paper may have been committed to memory, or may be so familiar as to be written with much greater ease than the words of an ordinary dictation or copy. What means most to an employer, day by day, is the net amount of really good work that a typist turns out. A lightning pace is bought too dear at the cost of many errors. Employers agree that the typists who serve best are men and women of education and culture, who are never in doubt about spelling or syntax, or the best form to give a sentence. A typist of this class may strike the keys with but one or two fingers, and yet leave far behind an operator who is master of the touch system, but who lacks training and the literary sense.

"It is well," says Arthur G. Seal, of New York, "for every beginner to learn under a competent teacher, so as to form only good habits, and understand, from the start, all that may be done with a machine. Pupils at first are apt to strike keys too hard. A light, firm touch is best. Operators who keep time with their keys find their toil distinctly lightened, just as in telegraphy."

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BY

GEORGE ILES

Author of "*Flame, Electricity and the Camera*," and "*Inventors at Work*"

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