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The IBM Selectric

The typewriter that defined an era

Part 1 -
"The most distinct innovation we ever made"

BY LUCAS DUL

In 1961, IBM launched the IBM-Selectric, a true monument to mechanical engineering, keyboarding, and, most importantly, typing. The machine was wildly successful from the moment it was introduced. Sales projections for the first six months were exceeded in 30 days, and by the end of the year IBM had four times the expected orders: 80,000. This was not IBM's first commercial product, but the Selectric was the first that made its way out of the business world, and into the consumer sphere, turning IBM into a household name for almost five decades.

In 1900, a New York businessman named Charles Ranlett Flint was attempting to build a corporate empire through mergers and trusts. It was a concept he found much success with. His most important company was formed through the acquisition of the Bundy Manufacturing Company, which he renamed the International Time Reading Co., or ITR. ITR specialized in the manufacture of punch clocks. Workers would punch in, and punch out, creating an organized data pool of actual employee working hours. A few years later ITR merged with Dayton Scales. This new merger brought with it a scale that would weigh products and automatically compute charges, an automated form of data processing. The Dayton Computing Scale turned out to be more of a niche product, and the venture began to fall on hard times. In 1911, Flint merged a third company: Herman Hollerith's Tab Machine Co. This was the crown of automated mechanical data organization: a machine that could automatically organize data via punch cards. With the three companies together, Flint renamed the venture, The Computing-Tabulating-Recording Company, an ugly mouthful, but a successful one that pulled in customers like the New York Central Railroad and Eastman Kodak. CTR did very well. Flint then, in 1914, made perhaps his best decision yet, hiring Thomas Watson Sr. to serve as Chairman and CEO.

Think

Watson (1874-1956), the son of a lumber dealer, had worked for almost 20 years for the National Cash Register Company where he had risen to the post of general sales manager. Watson was a strong leader, motivating his staff with training, money and legendary pep talks, and enforcing a strict dress code. As early as 1915, he introduced the concept of "think", the word that would dominate IBM work spaces, advertising and even products to this day, saying: "And we must study through reading, listening, discussing, observing and thinking. We must not neglect any one of those ways of study. The trouble with most of us is that we fall down on the latter -- thinking -- because it's hard work for people to think, And, as Dr. Nicholas Murray Butler said recently, 'all of the problems of the world could be settled easily if men were only willing to think.'"

Watson decided to cut deadweight products, like the scale, and focus on the idea of machines for office use. In 1924, CTR was re-named International Business Machines to strengthen the company's position outside the US. Now, IBM was well and truly born, but it wasn't until 1933 that IBM entered the typewriter market.

Electrics

Electric typewriters were not a new concept in 1933. As early as 1870, Rasmus Malling Hansen had built a battery-driven version of his writing ball; and the 1901 Blickensderfer Electric, with its typewheel, is often (mistakenly) regarded as a fore-runner of the IBM Selectric. In 1924, the

PHOTO PREVIOUS PAGE: (MACHINE) LUCAS DUL; (GOLF BALL) IBM ARCHIVE.COLLAGE: PAUL ROBERT

2 *Charles R. Flint*

3 *Thomas Watson on the cover of Time Magazine*

4 *The typewheel of the Blickensderfer electric*

PHOTO 2: LIBRARY OF CONGRESS PHOTO 3 : WIKIPEDIA CC
PHOTO 4: PAUL ROBERT

5 *The IBM Electromatic*

North East Electric Company began creating electrified typewriters using Remington 12s as the base machine, but once Remington stopped supplying them in 1929, North East began to manufacture their own machine from the ground up under a new company name: Electromatic Typewriters Incorporated. This machine caught the attention of IBM, who purchased rights to it in 1933. IBM invested over a million dollars to redesign the machine, establish research facilities, and create service centers. These service centers were almost as important as the redesigns, providing post-sale revenue for both IBM and their dealers; a concept in heavy play with the later success of the Selectric. After these were in place, the typewriter was sold as the IBM Model 01 Improved in 1935. It was the first successful electric typewriter, and was produced in multiple variants until 1948, when it was replaced by the Model A, with variants running continually for another decade. This decade saw multiple improvements including the ability to swap the type basket. But IBM was first and foremost seeking speed; after all, speed is the number one driver behind electrifying a typewriter. Enter: Horace Smart "Bud" Beattie

Horace Beattie, who had worked with IBM since 1933, filed a patent in 1939 for a single element typewriter. Of course by this point, single element typewriters were nothing novel. Throughout the late 1800s and early 1900s, single element typewriters were aplenty. Some machines such as the Blickensderfer and the Bennett used a drum element. The Hammond and the Keystone used type shuttles. The Munson (later called the Chicago), Crandall and the hugely successful Mignon shared cylindrical type elements. It was a well-established theory that the less the machine had

6 *The Poughkeepsie plan in 1947*

PHOTOS 5&6: IBM archive

to move to ready a character, the faster one could type. In 1940, Beattie filed another patent, now for a mushroom-shaped type element. Beattie continued to slowly develop this idea among his many other responsibilities, notably the IBM 709 calculator—the foundation of IBM computers.

Another IBM engineer, John Hickerson, filed for U.S. patent #2895584 in 1955 after polishing the final concept of a semi-spherical single element that would print via tilt and rotation. This idea was groundbreaking, and Watson later called it "the most totally distinct innovation we've ever made as a company."

Together with his team of engineers, Beattie spent the next several years laying down the groundwork of the IBM Selectric typewriter. Several patents were filed by himself and Hickerson along with other members like Frank Becker and Leon Palmer. 1955 gave us the first complete concept of the IBM Selectric. In 1957, Bud was promoted to Laboratory Director of the Lexington Lab, and Director of the Electric Typewriter Division, and the Selectric was well underway.

7 *A 1961 ad for the Selectric*

The skin

The final piece to the puzzle was the exterior design. This was handled by Eliot Noyes who joined IBM officially in 1956 to lead the Corporate Design Program. Noyes began his career as the curator of Industrial Design at the Metropolitan Museum of Art, and later opened his own firm where he was hired by IBM. One of his first projects was the design of the IBM C series electric typewriters in 1955, shown in his U.S. patent #177921. With the success of this design, he was subsequently asked to design the Selectric, and filed patent #192829 in April of 1961, three months before it launched. Noyes believed in the motto "good design is good business," and applied that to his work where he prioritized simplicity of form. Noyes' design also was strongly influenced by the curves of the typing element at the heart of the machine. The resulting swooping curves of the Selectric helped launch a new era of '60s space age design. Noyes later went on to design the Selectric II and III, as well as a few terminals, but it is for his work on the original Selectric that he is most fondly remembered.

By the time the IBM Selectric was finally launched in 1961, it had taken around seven years of intense designing and engineering. Encased in Noyes' sleek outer shell, the Selectric was a typewriter that would forever change the way we interact with the written word. It was the most complex consumer mechanical object ever created, and it quickly became the industry standard, a success which turned into 25 years of market domination and the near elimination of competitors' electric office typewriters from the market.

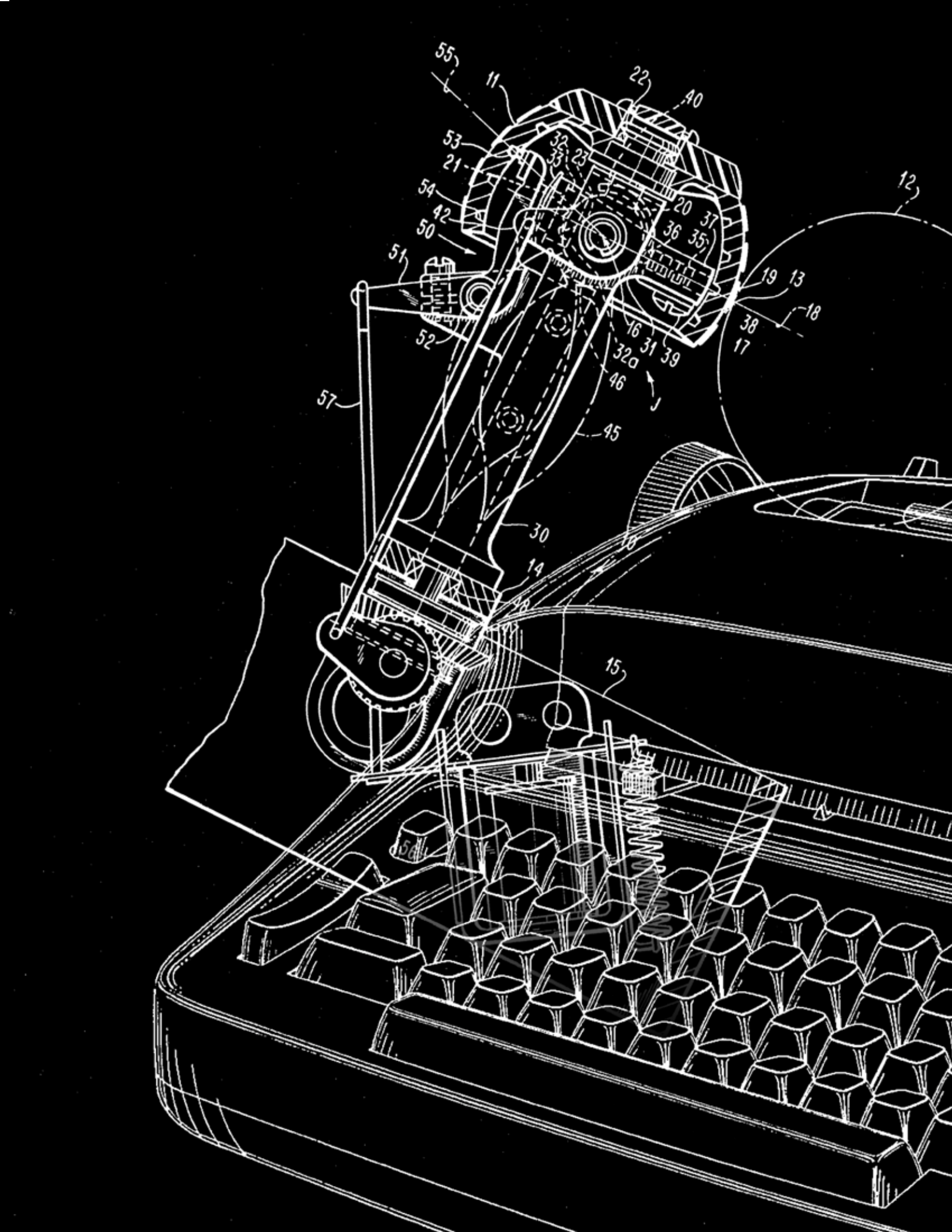
The speed, accuracy, and print quality were unparalleled, and the innovation in both the mechanics and the keyboard laid the groundwork for modern computing. ■

In part II, we'll have a closer look at the technical brilliance behind this revolutionary typewriter.

PHOTO 7: IBM ARCHIVE

PHOTO 8: IBM ARCHIVE

8 *Manufacturing the Selectric – 1961*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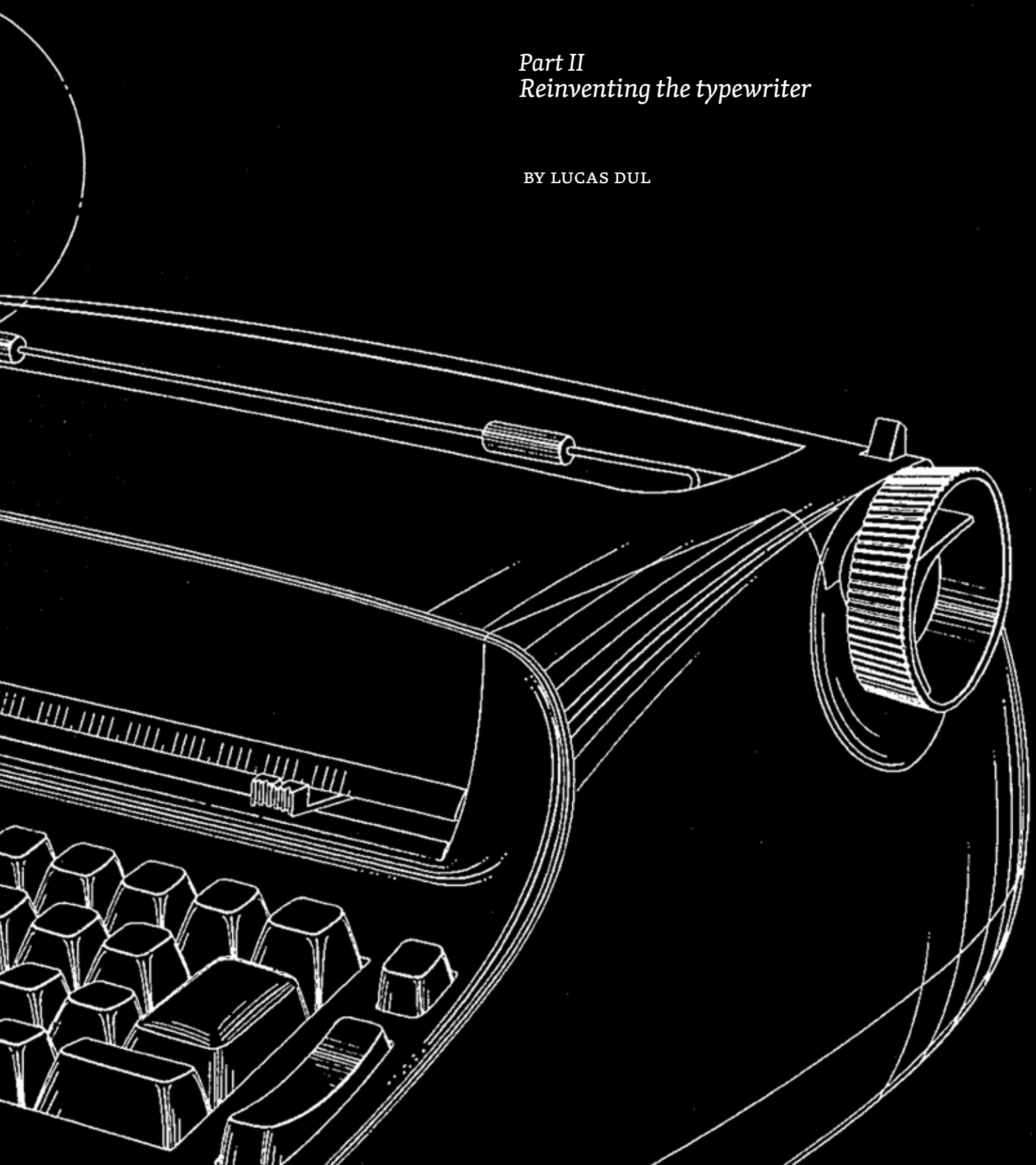
The IBM Selectric

Part II
Reinventing the typewriter

BY LUCAS DUL



In our previous issue (*ETCetera* 137) we discussed the history of IBM and the illustrious Selectric typewriter. In this article, Lucas Dul dives into the mechanics of it all, to explain the unique technology of this writing machine that functioned like an analog computer.

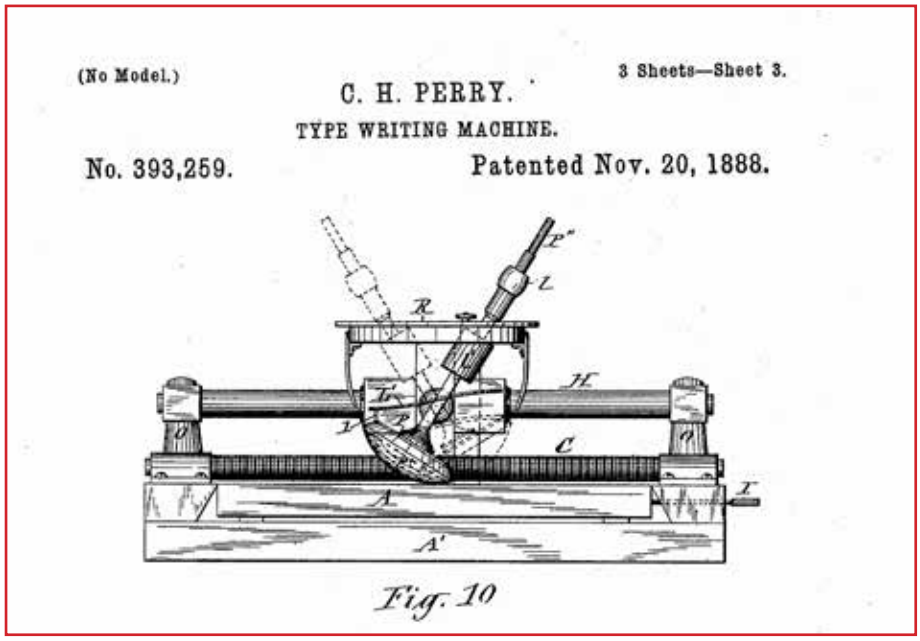
When the IBM Selectric was launched in 1961, engineer Horace Smart "Bud" Beattie stated in an interview that the design team had had "to forget the past fifty years of typewriter design." This is that story.

Beattie had already started work with IBM in 1933, as a draftsman and later engineer in the East Orange lab in New Jersey working closely with Thomas Watson. In 1939, Beattie filed a patent through the Canadian branch in Ontario which depicted a new typewriter design. This patent, CA393372, shows what Beattie referred to as a "printing method," a single element typewriter, which employs a wheel of type divided into groups of characters – alphabetical, capitals, and numerical. The machine would select the group of characters, and the character within the group, before printing the chosen character on the page. In 1940, Beattie filed another patent for a type element; one a spitting image to an 1888 patent filed by a Doctor Charles Perry of Woodstock Illinois, US393259. Perry's typewriter patent details a curved dish-type element very similar to that of the Lambert typewriter, and Beattie's subsequent 1940 patent US2661683 shows a nearly identical design on its final pages. Beattie dubbed it the "mushroom" type element.

In 1944, the Poughkeepsie Lab opened, with Beattie as Product Development and Lab Manager, which came with a team of engineers, among them, John Hickerson. Working with Hickerson, Beattie continued to tinker with the mushroom design though it evidently wasn't working out. While meeting with Watson at the Kenyon Estate in Poughkeepsie, Beattie showed off the prototype of the mushroom element operated by Hickerson. Beattie later recounted that moment between the three of them in an interview: "John turned it on, and it started to bob and wobble around. Mr. Watson sat there mesmerized. Then he broke out laughing and said: 'Bud, you must have been drunk when you designed that thing!'" Work later moved to the IBM headquarters lab in Lexington, Kentucky, and it was in this lab that the mushroom element was cast aside.

Bulb of inspiration

Beattie was reportedly changing a light bulb in his Lexington home when he had the sudden inspiration to change the shape of the IBM element to something more round, rather than dish-like. John Hickerson filed for patent US2895584 in 1955 after polishing the final concept of a semi-spherical single element that would print via tilt and rotation. This idea was groundbreaking, and Watson later called it "the most totally distinct innovation we've ever made as a company."


(No Model.) 3 Sheets—Sheet 3.

C. H. PERRY.

TYPE WRITING MACHINE.

No. 393,259. Patented Nov. 20, 1888.

Fig. 10

Over the next several years, several patents were filed by Beattie and Hickerson along with other members of the team like Frank Becker and Leon Palmer. The latter two developed the mount head for the element. Leon Palmer held the most patents in regards to the Selectric, and it was his genius that devised the method of character selection which became a game changer in mechanical computing due to its binary to analog conversion. This development paved the way for more intuitive computer interfaces, encompassing both advanced input and output as opposed to the limited punch card creation of the earlier Electromatic and similar models. 1955 gave us the first complete concept of the IBM Selectric in all its glory, represented by Palmer's patent, US2879876. This detailed the combined efforts of the entire team, depicting the round type element, the operational camshaft assembly, as well as Palmer's repeating mechanisms and early revisions on a pulley controlled tilt and rotate mechanism. In 1957, Bud was promoted to Laboratory Director of the Lexington Lab, and Director of the Electric Typewriter Division, and the Selectric was well underway.

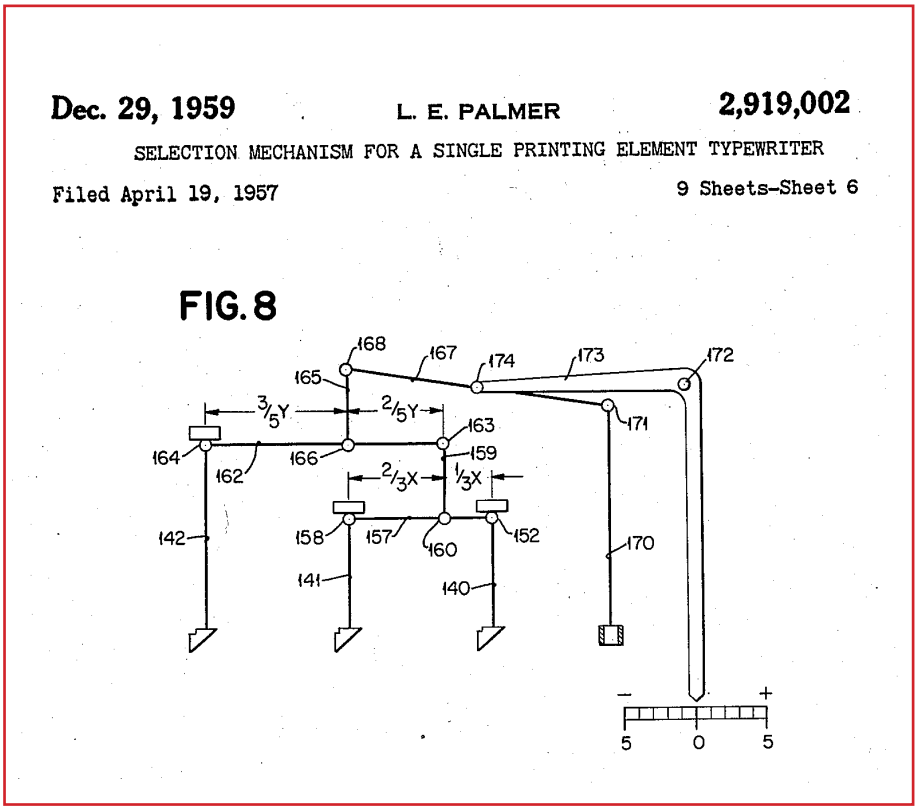
When asked about the design process in an interview in 1961, Beattie said that they had had to "forget the past fifty years of typewriter design." And forget they did. The individual letters were no longer tied directly to the key, rather each key was assigned a binary code that was decoded into two coordinates: tilt, and rotate.

As previously mentioned, single element typewriters were not a novel idea, but the engineering behind the golf ball's method of tilting and shifting is what marks it as unique in that classification. Although it looks simple in principle, each character must be both precisely molded to print flat against the page regardless of the tilt of the ball, and match the circumference of the platen. The element is arranged in 22 columns and four rows, the top row and front facing column being designated as the home position with an arrow. The character selection system developed by Leon Palmer is also an incredible feat of engineering. The heart of this mechanism is a binary to analog converter known as a whiffletree. It is based on an ancient agricultural tool originating in the second century that is designed to distribute force evenly among a series of stiff linkages, as in harnesses for animals pulling carriages. How it works inside the IBM is simple, yet complex. It translates the key press into very precisely controlled tugs on either cable controlling the tilt and rotation of the type element. I will attempt to explain the magic of the Selectric in its simplest terms.

Selector rods

The IBM Selectric is powered by a single motor which delivers what IBM refers to as "positive power." This motor directly turns the selection, or cycle, shaft on the left of the machine, and the operational shaft on the right side of the machine. The operational shaft is in constant motion and contains the mechanisms, latches, and clutches for the tab and return system, the backspace, and space. The left cycle shaft only rotates when the cycle clutch is released, allowing the machine to take character input and print it onto the page. The characters are, of course, input via the keyboard. Each key is attached to a key lever that presses down on a linkage called an interposer which is designed to move a set distance to engage one of six selector rods that run the entire width of the keyboard. Each selector rod represents one bit of information, the smallest computational value—a yes or a no, a one or a zero. These selector rods rotate depending on the pattern of teeth on the interposer, which then pulls on latch interposers. Each of the latch interposers is connected to a selector latch which directly interfaces with a whiffletree. Each key has its own unique interposer which shifts to make a specific and unique selection among the six selector rods. At the same time the selection is made, the interposer also applies a downward force to a cycle rod which engages a series of levers thereby releasing the cycle clutch on the left end of the machine, and allowing the cycle shaft to rotate. This rotation is geared on the left of the machine to engage the filter shaft and the print shaft. The filter shaft is what actually applies lateral force to the interposer to make its selection among the six selection rods, and the print shaft brings the type element up to strike the page.

Once the selection of six selection rods is made, and the selector latches are disengaged, the selector shaft assembly (released by the cycle clutch) rotates and lowers the differential assembly plate, a large aluminum bracket which the selector latches onto. This plate pulls down on the selector latches that have been selected to remain on differential assembly. These latches directly interface with one of two whiffletrees. Tilt on the left, which controls the four rows on the golf ball, and rotate on the right, which controls the 22 columns of the golf ball. The tilt tree is a lot simpler, since the golf ball only needs to tilt to one of four positions. This is where it becomes necessary to understand the whiffletree as a binary to analog converter. The tilt whiffletree needs a total of two bits of information to make a series of four distinct moves: home, tilt one, tilt two, and tilt three. The home character "Z" requires no tilt to print, and is represented by (00), neither latches are pulled by the differential assembly. The letter below it, T, requires one unit of tilt and the right latch is pulled down, an action represented by (01). To print


Dec. 29, 1959 L. E. PALMER 2,919,002

SELECTION MECHANISM FOR A SINGLE PRINTING ELEMENT TYPEWRITER

Filed April 19, 1957 9 Sheets-Sheet 6

FIG. 8

the third row, or tilt two, the left latch is pulled down and the right latch remains. Since the actuating linkage above both latches is offset to the left, it travels a greater distance with a single pull from the left than it does from the right (utilizing some basic trigonometry). This is represented as (10). Finally, as you might have guessed for the lowest row, both latches re pulled down (11), and the entire assembly is moved to its fullest extent. The rotate side, on the other hand, requires four bits of information which together control rotation for only 11 columns, not the full 22 (an additional 7 th bit of information controls shift which rotates the element 180 degrees). Back in home position, typing the home character "Z" also requires no rotate. So the binary input for this character in terms of rotate is (0000) or for tilt and rotate (000000). The type element will either rotate five columns to clockwise, or five counter clockwise, all controlled by the last bit of information. In order to rotate counterclockwise, the last latch is engaged, and the last information bit is (1). Rotating five places counterclockwise past "Z" gives us 2, 5, 6, 0, and 9, respectively. The lowest point of rotation to type "2" is coded as (0101), and following down the line to 9 gives us (0011) (0111) (1001) and finally (1111). For clockwise rotation, the pattern repeats, but the last bit is a (0). Sounds complicated, and that's because it is. I had to have two snacks to figure this thing out. Two. To sum it up, typing the letter "I" which is in the third column on the right side and the third row down, the Selectric encodes (100111).

Once the selection is made, the bits are encoded and translated into tilt and rotation, the machine advances the carrier one space per usual. Though the escapement is more complex than most conventional typewriters, as well as non-rotary, it functions much in the same way. For the grand finale, everything that I have discussed with you in the past two paragraphs happens in the span of seven milliseconds. In lay terms, the IBM Selectric can theoretically print a character 14 times in the blink of an eye. In practice, the complexity of this machine prevents this from happening as each stroke needs to be reset to home before the next key can be pressed. Failure to do so will result in damage to the machine. As a result, the keyboard on an IBM only has a single key rollover, meaning you can only depress one key at a time thanks to a ball bearing race under the interposers. There is only enough room in the race for the width of a single interposer, which spreads the bearings out, preventing any other keys from being depressed until the continuation of a stroke is completed. Absolutely brilliant.

The Selectric assembly room

Computer links

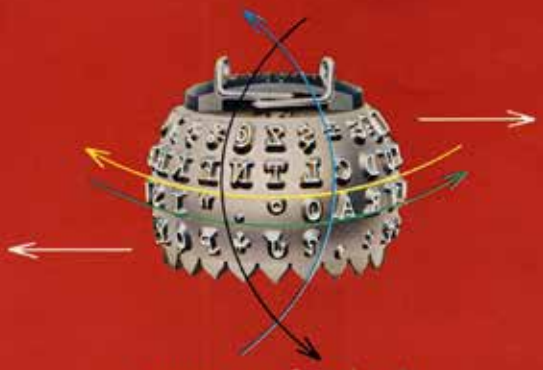
The Selectric was a building block in the foundation of modern technology. The 6-bit binary decoder afforded the Selectric the unique ability to be used as a mainframe terminal. Yes, this typewriter could be hooked up as both an input AND output for a computer. Although it didn't follow the ASCII character table in favor of the traditional 88-character typewriter layout, it still remained a useful tool in the world of computing. The IBM 2741 Terminal was a modified IBM Selectric that closely resembled the II, released in 1965; surprising since the II itself wasn't released until 1971. This terminal was meant to be used with the IBM System 360, proving, in the words of Watson, that "there was nothing IBM couldn't do."

It was not until 1984 that IBM offered its first major alternative to the Selectric products, the daisy-wheel-based Wheelwriter. By the time the Selectric line was retired in favor of word processors in 1986, over 13 million units had been sold. It found its way into both the home and office, onto the big screen, behind best-selling novels written by the likes of Hunter S. Thompson and Isaac Asimov, and it wrote the documentation necessary for sending man to the moon. The speed, accuracy, and print quality were unparalleled, and the innovation in both the mechanics and the keyboard laid the groundwork for modern computing. ■

PHOTO LEFT & IMAGE RIGHT: IBM ARCHIVE

the IBM Selectric Typewriter

faster . . .



more productive!

It took a completely new kind of typewriter to meet the demands of today's business for more speed and production. And in meeting those demands, the new IBM SELECTRIC™ Typewriter offers a new way to write. Its touch—the smoothest, surest, ever perfected—invites top performance from any typist. The moving paper carriage and typebars have been replaced by the precision-engineered single element, pictured above. Poised lightly over the paper, it pivots, tilts, skims across the page, writing at rapid speed. Potential speed becomes practical speed, thanks to a stroke storage system that releases type characters in sequence no matter how fast the typing. That's why it is such a favorite in offices converting from manual to electric typewriting. Its ideal application is in high output stations concentrating on volume production. For, besides speed, the IBM SELECTRIC Typewriter minimizes maintenance with a promise of great reliability and durability. Want to change type face? Don't change machines. With an IBM SELECTRIC Typewriter it's easy to switch from one type style to another. And changing the single-unit ribbon cartridge is just as easy. Ask your IBM representative to demonstrate what this newest addition to the IBM typewriter line can do for you. IBM.