The Curious History of the First Pocket Calculator

It was called the Curta, and it proved lifesaving when its inventor was trapped in a Nazi concentration camp

By Cliff Stoll

Johannes Kepler, Isaac Newton and Lord Kelvin all complained about the time they had to waste doing simple arithmetic. Foolscap covered with numbers obscured answers; elegant equations led to numerical drudgery.

Oh, for a pocket calculator that could add, subtract, multiply and divide! One with digital readouts and memory. A simple, finger-friendly interface. But none were available until 1947. Then, for a quarter of a century, the finest pocket calculators came from Liechtenstein. In this diminutive land of Alpine scenery and tax shelters, Curt Herzstark built the most ingenious calculating machine ever to grace an engineer's hand: the Curta calculator.

Advertisements in the back pages of *Scientific American* in the 1960s promised an arithmetic panacea: "The Curta is a precision calculating machine for all arithmetical operations. Curta adds, subtracts, multiplies, divides, square and cube roots… and every other computation arising in science and commerce… Available on a trial basis. Price $125."

With its uncanny resemblance to a pepper grinder, this device—still owned by some lucky people—does everything that your $10 pocket calculator can do. Except that it's entirely mechanical—no battery, no keypad, no liquid-crystal display. You turn a crank to add numbers.

A windup adding machine? You bet. Today I'm holding a Curta in my left hand, grinding out answers with my right. To add, I enter numbers with little sliders, spin the crank, and the result appears in small windows circling the top. I'm literally crunching numbers.

And yes, it multiplies and divides—although I have to spin that crank 10 or 20 times to find the product of two big numbers. There's no on/off switch, but a handy finger ring clears the memory. As for square and cube roots, well, you carry along special tables and remember a few shortcut algorithms.

This is no slide rule that approximates an answer to three or four places. Through the windows on the top, 11 numbers click into place. Hey—your electronic calculator probably can't deliver 11 digits of precision.

Okay, it does arithmetic. So why has the Curta been called "a treasure of our civilization" and "a marvel of technology"? Why do collectors cherish these devices when any cheap calculator works much faster?

Because along with its impressive arithmetical abilities comes the sensation of mechanical elegance and certainty: You set numbers by sliding dials that slip into place with little curtsies. The crank turns with the smoothness of a fine pocket watch. Digits click into position with neither slop nor drag. Each number is engraved in magnesium, and steel gears handle the computation. The Curta purrs as you calculate.

Then, too, this machine was designed to make calculating easy. To avoid errors, separate displays show the entered number, how many times you turn the crank, and the result. De-

IS IT A PEPPER MILL? A camera lens? A pencil sharpener? The handle of a fishing reel? No, it's a mechanical calculator more precise than many electronic varieties. The example depicted on the opposite page is only about four inches tall and two inches in diameter.

TINA WEST


CURTA
STATES PATENT
10, 1950
CALCULATING MACHINE
C. HERZSTARK
Oct. 10, 1950
Fig. 1
Fig. 11

tents—small catches—tell your fingers when each digit is entered and when the answer is ready. It's easy to undo an error, but a ratchet won't let you clash the gears by going backward. And you won't erase your answer by mistake, because the clearing ring can't be accidentally activated.

The Curta calculator combines the precision of a Swiss watch, the craftsmanship of an old Nikon F camera and the elegance of a tango—all in a compact cylinder. In 1950 the Curta's portability startled engineers: a calculator that you could carry! All the more astonishing, then, that this device arose from the nadir of civilization, the Buchenwald concentration camp.

Serious Shrinkage Problems

JUST AS TODAY'S technicians crave featherweight laptop computers, engineers and accountants long yearned for a portable mathematics machine. Thomas de Colmar built an adding machine the size of a piano for the 1855 Paris Exhibition. Fifty years later the Millionaire Calculator could not only add and subtract, it could directly multiply and divide. Yet it weighed more than 60 pounds. For a real pocket calculator, civilization would wait for Curt Herzstark.

Born in 1902, Herzstark grew up around calculators. His father sold Remington and Burroughs office machines in Vienna. Within a few years his family built a factory to make calculators. It thrived, and young Curt found himself demonstrating adding machines across Austria.

During World War I, his family's factory made war material. Afterward, with the factory's machines worn out or destroyed, his father took to selling used calculators until the factory could be rebuilt. At the same time, new competition appeared, including Fritz Walther, who had made automatic pistols but now found himself stymied by postwar disarmament. Seeing opportunity in office equipment, he converted his gun factory to one that made electric adding machines.

In the 1930s the calculator business multiplied. "But something was missing in the world market," Herzstark later recalled. "Wherever I went, competitors came with wonderful, expensive, big machines. I'd talk with a building foreman, an architect or a customs officer who'd tell me, 'I need a machine that fits in my pocket and can calculate. I can't travel 10 kilometers to the office just to add a row of numbers.' "

Manufacturers such as Monroe, Friden and Marchant tried shrinking big desk models, like a watchmaker miniaturizing a clock into a wristwatch, but without much success. Visit an antique store, and you may bump into a miniature calculator of yesteryear. The Marchant "lightweight" adding machine weighed 34 pounds, with nine columns of buttons and a carriage sporting 18 mechanical readouts. Two big cranks sprout from the side, reminiscent of a Model T Ford. Accountants lugged them around in suitcases. That's what portable meant in 1935.

> "I looked at everything backwards. What does this machine have to look like so that someone can use it?"

Having seen failed attempts to shrink desktop adding machines, Herzstark, then in his 30s, started anew. "I looked at everything backwards. Let's pretend that I have already invented everything. What does this machine have to look like so that someone can use it?

"This machine can't be a cube or a ruler; it has to be a cylinder so that it can be held in one hand. And holding it in one hand, you would adjust it with the other hand, working the sides, top and bottom. The answer could appear on the top."

Like a good software engineer, Herzstark began with the user interface, rather than letting the mechanism control the design. Instead of using a typewriter-style keyboard, he decided to wrap sliders around a cylinder so you would enter numbers by sliding a thumb or finger. This approach would create an area for the results register around the top of the cylinder, as well as a convenient site for a crank to power the calculator.

Other mechanical calculators used a separate mechanism to calculate every digit in the answer. For instance, the Friden calculator had 10 columns of keys to enter a number, and it had 10 separate sets of calculating gears—expensive and heavy. Herzstark realized that he needed only one calculating mechanism if it could be consecutively used by each input digit. His calculator might have eight sliders to enter digits, but the teeth (or steps) on a single central drum would handle the arithmetic. The drum would allow him to trim the size and weight of his machine.

By 1937 Herzstark understood how to perform arithmetic using a single rotating step drum. Everything would work for addition and multiplication. But his design stumbled over subtraction and division. He couldn't subtract by turning the crank backward, because adding two digits may create a carry condition after the operation, but subtraction requires a borrow be-

Overview/*The Curta*

- The first precise calculator you could hold in one hand was mechanical, not electronic. It could add, subtract, multiply, divide and help give square roots. Unlike analog slide rules, it solved problems to at least 11 digits.
- Its inventor, Curt Herzstark, completed the design while imprisoned in Buchenwald concentration camp during World War II. He adopted novel mathematical and mechanical techniques to save space and weight.
- Widely used by scientists, engineers, surveyors and accountants during the 1950s and 1960s, the Curta lost favor only when electronic pocket calculators hit the market in the 1970s.

forehand. A single arithmetic step drum couldn't properly look ahead to see what might be coming.

"Traveling in a train through the Black Forest, I sat alone in a compartment. Looking out the window, I thought, 'Good grief! One can get the result of a subtraction by simply adding the complement of a number.'"

To find the nines complement of a number, just subtract each digit from nine. By adding a number to the complement of another number, you can simulate subtraction. For example, to calculate 788,139 minus 4,890, first find the nines complement of 004,890: 995,109. Now add 788,139 and 995,109 to get 1,783,248. Remove the highest-order digit to arrive at 783,248. Finally, add one to find the answer: 783,249. Sweet—the same technique is used in computers today.

Herzstark's calculator would retain the single rotating step drum but would have two sets of teeth: one set dedicated to addition, the other to subtraction. Lifting the crank three millimeters would engage the subtraction teeth to perform nines-complement addition. Subtraction would be as easy as addition.

Multiplication and division would be handled by repeated addition and subtraction. And since the results register could be rotated in relation to the input sliders, several shortcuts would speed these operations. For instance, to multiply by 31,415, you don't spin the crank 30,000-plus times; the movable carriage cuts this to 14 turns: five turns for the 5, once for the 10, four times for the 400, and so on.

By late 1937 Herzstark was ready to build a handheld, four-function calculator. Then came Hitler.

CURT HERZSTARK, inventor of the Curta, became familiar with mechanical calculators as a child, because his family produced them. At age eight (*right*), in 1910, he displayed his skill at five- and six-place multiplication problems at the International Office Exhibition in Vienna, earning the label "miracle child." In 1985, at 83 (*below*), he adopted a similar pose.

COURTESY OF RICK FURR

Brought Forth in Buchenwald

IN MARCH 1938 the German army entered Austria. As the son of a Catholic mother and a Jewish father, Herzstark faced trouble. "The first weeks were dreadful. The mob came, then anti-Semites and all terrible things."

German military officers arrived to inspect the factory. To his surprise, they asked him to make precision items for the army. After a one-sided negotiation, his factory began producing gauges for Panzer tanks.

It went well for a few years. "But in 1943," Herzstark said, "two people from our factory were arrested. They had listened to English radio stations and transcribed the broadcasts on a typewriter. The typewriter was identified, and the owner was one of our mechanics. He was beheaded. The second one was imprisoned for life, which was much worse. I tried to intervene for them with the Gestapo. The officer threw me out, saying, 'What impudence, that a half-Jew dares to speak on the behalf of these people!'

"I was invited to testify for these people and arrested—nice, no? My house was searched, and, of course, I never had a trial. I was accused of supporting Jews, aggravation, and having an erotic relationship with an Aryan woman. All fabricated crimes. Later I found that a dozen others were arrested under similar circumstances."

The SS threw him into the infamous Pankratz prison, where torture of Jews was routine. "I shared a cell with 50 others, without anything at all—no beds, no lavatory, nothing. And I was even lucky, as I was sent to the Buchenwald concentration camp.

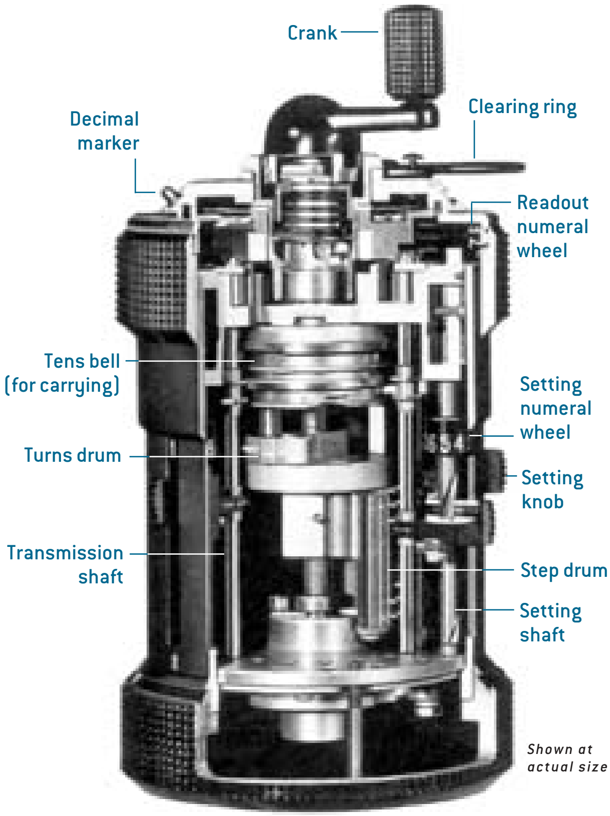
"Once there, I was put in a work unit where I believed I would be buried. It was November, and all I had was a shirt, a pair of prisoner's pants, wooden shoes and a knitted cap. I worked gardening and was completely exhausted.

"Spiritually at zero, I thought, 'I have to die.' I was called before Buchenwald's commanding SS officer. He had my life history in his hand and said, 'You have delivered gauges and instruments to the army. Listen closely. If you follow our commands obediently, you may find life bearable. I order you to work in the factory connected with the concentration camp. If you do well there, you may be able to live.'"

Alongside Buchenwald, the Nazis had built a slave-labor factory to make machinery for secret military projects. The managing engineer placed Herzstark in charge of precision parts to be shipped to Peenemünde—launch site for ballistic missiles. For the next two years, he made components for V2 rockets.

Being responsible for the section that made mechanical parts, Herzstark visited different places in the factory. At first, other

A LOOK INSIDE



Shown at actual size

AS AN OLD MANUAL SAYS, "The little Curta is a precision instrument." The step drum that performs addition and subtraction (*above* and *at right*) has 37 layers, each half a millimeter thick. A separate component—called the tens bell—participates in carrying. Each digit in the numeric readouts at the top (*see diagram at bottom left in box on opposite page*) is three millimeters tall—easily readable at arm's length. Early Curtas had eight setting knobs and 11 digits in the results register. Later versions had 11 input digits and gave 15-digit answers.

prisoners thought he was an informer. "They soon found out that I was no spy. For example, I talked to a machine operator: 'You are making this part well, my friend. You are industrious, but you've been told to do a simple process on an expensive machine. I will report that the machine is not being used efficiently, even though the prisoner is doing model work.' In this way, I became acquainted with people from Luxembourg, France, Denmark and many other places.

"Naturally, comrades came to me and said, 'Curt, you have a certain influence. Can't you bring this or that prisoner into the factory? He will die otherwise.' So I would set up an inspection station in a factory hall, seat a [captive] lawyer there and give him a micrometer."

"The SS guards checked our operations, and if there was really an inspection, there would be a sudden concert of coughing. Then the lawyer knew that danger was coming and to look industrious. But I was anxious because the comrades always wanted more from me. I knew if this came out, I'd be under the cold ground the next day. But fate helped me again.

"As the Germans retreated from Italy, they took production machines with them. One day in Buchenwald, we received two truckloads of office machines. I unloaded them, and local factory owners came to inspect them. One person kept looking at me as if he knew me. 'Herzstark?' 'Yes, Herzstark,' I answer. 'Walther,' he answers."

Fritz Walther. Herzstark's old competitor was now back to making guns. "He laid a pack of cigarettes on a lathe for me. 'Now it's all over,' I think. Accepting a gift is strictly forbidden, no? But my guard saw it and didn't want to see it. I was allowed to put the cigarettes in my pocket."

Within wartime Germany, Walther was a celebrity. He recognized the prisoner Herzstark as more important than any Italian booty and informed the concentration camp commander of his prize.

Soon after, the managing engineer took Herzstark aside and told him, "'I understand you've been working on a new thing, a small calculating machine. I'll give you a tip. We will allow you to make and draw everything. If it really functions, we will give it to the Führer as a present after we win the war. Then, surely, you will be made an Aryan.'

"'My God!' I thought to myself," Herzstark said. "'If I can make this calculator, I can extend my life.' Right there I started to draw the calculator, the way I had imagined it."

The SS didn't lighten Herzstark's workload, but he was allowed to spend his spare time on the calculator. "I worked on the invention Sunday mornings and in the evenings after lights-out. I worked in the prison, the workroom and where we ate. I drew up the machine in pencil, complete with dimensions and tolerances."

Meanwhile the Allies bombed Germany. "We'd leave the factory and go outside during lunch. Always we saw the American planes in Christmas tree formation and not one defending aircraft. Afterwards the bombs came, one saw the flashes and counted eight, nine, 10 seconds. You'd calculate the distance by multiplying by 333 meters. But one day the Christmas tree flew towards us. Now we knew this was coming to us and were terribly afraid. I ran into a small forest, hid my nose in the moss and covered my ears. It started the next moment, banging and roaring.... When I put my head up, everything was smoky and I could barely breathe.

"Several hundred prisoners were hurt that day, terrible when one sees such a thing. Of course we saw equally horrible things in the daily camp. When they hung someone, we had to watch until he finally died. Terrible. They hung people so they died slowly, a wretched death.

RICK FURR

THE CURTA IN ACTION

A COUPLE OF ARITHMETIC PROBLEMS show how the Curta works. To learn how to multiply, divide, and find square roots or to play with a Curta simulator, follow the links listed in the More to Explore box on page 99.

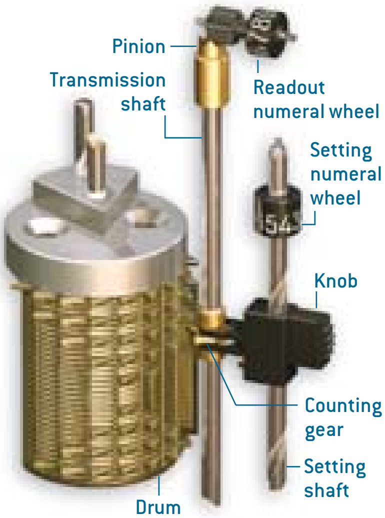
ADDITION

Add 32 + 41 + 49.

1. Spin the clearing ring once to set the results register and the turns counter to all zeros.

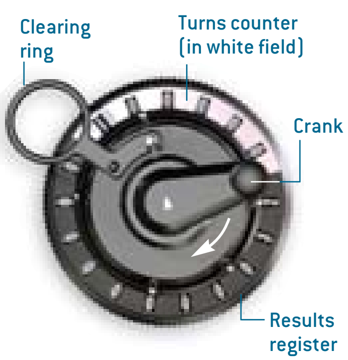
2. Input 32 by sliding down the two setting knobs at the far right until the numbers 3 and 2 appear in the windows under the CURTA label (*right*).

As you move a knob, you cause a grooved setting shaft (*at bottom right of diagram*) to turn an attached numbered dial—the setting numeral wheel—to show the number you select. As you slide the knob, you also drag down a counting gear encircling a second axle—the transmission shaft. In this example, the gear for the tens place gets positioned so it can engage with a layer of the step drum that has three teeth protruding from it, and the gear for the ones place gets positioned next to a drum layer sporting two teeth.



3. Turn the crank one full rotation.

This maneuver spins the step drum once, causing the teeth to turn the counting gears, which spin their transmission shafts. Pinions at the top of those axles spin readout numeral wheels, which make a 3 and a 2 appear in the results register (*right*).

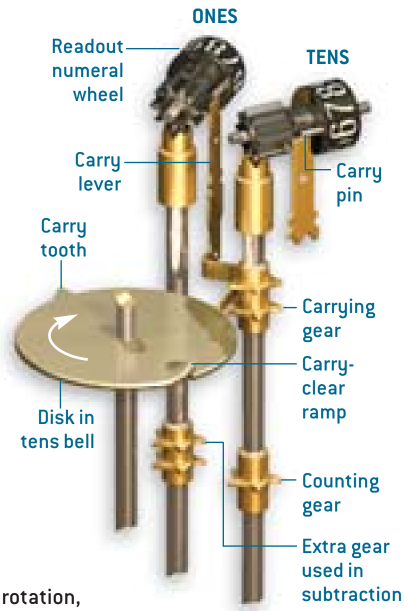


4. Set 41 by using the ones and tens knobs again.

5. Turn the crank to add 41 to the results register, which then shows 73.

6. Set 49, turn the crank and view the answer (122) at the top.

This last addition requires the Curta to carry a 1 to the tens place. When the readout numeral wheel atop a transmission shaft passes 9, a carry pin extending from the wheel depresses a rod (the carry lever) that pushes down on a carry gear encircling the transmission shaft of the next higher place (here, the tens place), positioning the gear to interact with the tens bell. As the bell revolves, a tooth on a disk in the bell turns the gear, causing the readout numeral wheel on the second shaft (the tens-place axle) to advance by one digit.



SUBTRACTION

Calculate 139 – 78.

1. Clear the machine.

2. Set 139 as you would for addition.

3. Turn the crank one full rotation, placing 139 in the results register.

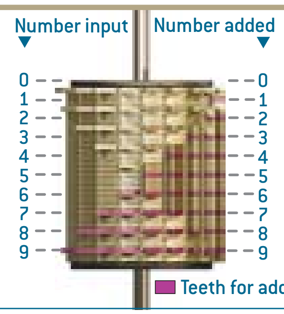
4. Set the number 78.

5. Lift the crank to its upper position, which aligns the gears of the transmission shafts with the "subtraction" parts of the drum (*right side of diagram below*). Turn the crank once.

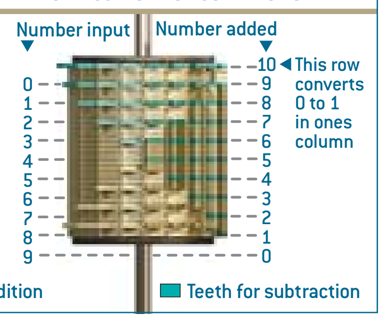
6. Read the answer in the results display: 61.

The Curta subtracts by adding complements of 9. When the crank lifts the drum, a setting of 7 aligns the counting gear on the transmission shaft with a drum layer having two teeth, an 8 aligns with one tooth, and a 0 aligns with nine teeth. A turn of the crank adds 21 preceded by a series of 9's to 139. On paper, a 1 would appear at the far left of the sum, giving a wrong answer. But the leftmost transmission shaft of the Curta has no carry lever, so the extra 1 disappears. Lifting the crank also serves another purpose. The ones-place transmission shaft has two counting gears. The extra gear has no role in straight addition, but when the crank is lifted, this gear engages the teeth in the layer above the other gear. As the drum turns, the upper layer adds 1 to the ones column, making the result here 61 instead of 60.

DRUM POSITION FOR ADDITION



DRUM POSITION FOR SUBTRACTION



GRIFF WASON; SOURCES: CLIFF STOLL, RICK FURR AND WWW.VCALC.NET

"Some guards were not so bad. If an older SS was there, he often said to me, 'Ha, what's new? What kinds of machines will we look at today?' The young SS were the most dangerous. If they found an opportunity, they would be very cruel. If a prisoner annoyed them, they would shoot him, because it was necessary, wasn't it?"

Herzstark had pretty much completed his drawings on April 11, 1945, when he saw jeeps coming from the north. A soldier in the front seat called out, "You're all free." They were Americans; some were Jewish boys who'd fled before Hitler came to power. Because they could speak German, they had been assigned to the forward area.

Buchenwald was the first concentration camp freed by Western forces. Some American soldiers vomited at the sight of bodies stacked 10 deep. Looking back, Herzstark shook his head at the experience. "It was incomprehensible. If I'd been a lawyer or something, I would have died miserably. They would have sent me to a quarry, and in two days I would have a lung infection and it's all over. A thousand died like this. God and my profession helped me."

The Crown Prince Calculates

A FEW DAYS AFTER the Americans liberated Buchenwald, Herzstark walked to the city of Weimar with his plans folded in his pocket. He brought his drawings to one of the few factories still standing, where machinists examined them. He remembered the technicians' response: "It was like scales falling from their eyes. The solution was clear, and there was nothing more to think about." Though penciled in the concentration camp, Herzstark's designs were so clear that it took only two months to make three prototype calculators.

But just as contracts were being drawn up, the Russian army arrived. Herzstark knew the score: he grabbed the prototypes and headed for Vienna, taking the machines apart and putting the pieces in a box. "If someone had looked in, it was like a toy," he said. "The whole thing was disassembled."

He traveled to Austria by walking, sleeping on floors, and bartering cigarettes for a train ride. His family's old factory was unusable. With nothing but his three models, Herzstark filed for patents and tried to get someone to invest in his idea. Remington-Rand, the American office machine firm, displayed some interest but never called back. The government of Austria turned him down. Europe was in cinders, without the infrastructure to start new projects.

Yet the prince of Liechtenstein had been thinking about developing industry in his country. At the time, Liechtenstein was almost entirely agricultural; its major industry was the manufacture of false teeth. Invited to the court, Herzstark showed his models to royalty, ministers and patent specialists. "In his castle the prince himself calculated with it. Family members watched as well as professionals. The prince was immediately enthusiastic and said this project was the right one for the country. He received me charmingly, and we had a four-hour conversation."

All went well at first. Liechtenstein created a company, Contina, and then floated loans and issued stock. Herzstark served as technical director, received a third of the stock and was to receive a royalty for each machine sold.

Herzstark advertised in the Swiss newspapers for mechanics willing to begin a new career. Contina rented a hotel ballroom where Herzstark's machinists built the first 500 Curta calculators. They went on sale in 1948 and were promoted at trade shows and in technical magazines. Six months later an American department store tried to order 10,000, with an option for more. Instead of latching onto this order, the finance director decided it was beyond the company's capability, dooming the Curta to mail-order sales and an occasional specialty store.

The demand was there, however, and Contina expanded from the ballroom to a proper factory, ramping up production to several hundred per month. With this progress, the financiers behind the company pulled the rug out from under Herzstark—reorganizing the firm and annulling his stock. Like Edison, Tesla and so many other inventors, Herzstark would be squeezed out of the profits from his own creation.

"Then came a stroke of good luck that I could not have imagined," Herzstark said. "The patents were still in my name."

PAGE BACK 34 years and seven months to see the Curta advertised in the June 1969 issue of *Scientific American.*

THE AUTHOR

CLIFF STOLL is best known for breaking up a ring of hackers during the early days of the Internet, as described in his best-selling book *The Cuckoo's Egg*. His other books include *High Tech Heretic: Why Computers Don't Belong in the Classroom* and *Silicon Snake Oil*. Although his Ph.D. is in planetary science, he now rebuilds mechanical calculators, makes Klein bottles and occasionally teaches physics. He lives in Oakland, Calif., with his wife, two children and a pair of cats he pretends to dislike. Stoll thanks Rick Furr, Jan Meyer, Jack Christensen and Chris Hamann, experts on the Curta, for their generous assistance, and the Charles Babbage Institute at the University of Minnesota for making available computer historian Erwin Tomash's 1987 interview of Curt Herzstark. The quotations in this article come from that transcript.

Early on the trustees hadn't wanted to take over the patents in case of litigation—they wanted Herzstark to take the heat if someone challenged his invention. Because the company had never acquired the patent rights, Herzstark forced them to come to terms. Throughout the 1950s and 1960s, he actually made money from his invention.

After the success of the first calculator, Herzstark designed a slightly bigger model, increasing its capacity from 11 to 15 digits. But thereafter the only thing that changed significantly was the shape of the carrying case. Setting a rare record in the computing industry, Herzstark got the design right the first time.

For two decades, the Curta calculator sold steadily, touted as "the Miniature Universal Pocket Size Calculating Machine with reliability derived from rational, robust construction." As Herzstark predicted, engineers used the miracle machines to find satellite orbits, surveyors to keep track of transit positions, and traveling accountants to balance books. One New York bank manager was amazed when an auditor appeared without a briefcase-size calculator yet tallied the books down to the penny.

"'My God!' I thought ... 'If I can make this calculator, I can extend my life.' Right there I started to draw...."

Curiously, sports car enthusiasts around the world adopted Curta calculators, reckoning speeds and distances in rallies. Toggling the numbers by feel, navigators would quickly calculate their ideal driving times without taking their eyes from the road. The Curta's small size fit the confined quarters of a sports car, and—unlike early electronic calculators—the device was unfazed by bumps, vibrations or voltage spikes. Even now, vintage car rallyists enjoy the challenge of mechanically calculating their travel times.

Just as battery-operated quartz watches pushed aside windup watches, electronic calculators eclipsed Herzstark's invention. After a run of 150,000, the last Curta calculator was sold in the early 1970s. Hasn't been a mechanical calculator made since.

Herzstark left Contina in the early 1950s, afterward consulting for Italian and German office machine makers and living in a modest apartment in Liechtenstein; back then, technowizards didn't buy million-dollar spreads. The government of Liechtenstein recognized his accomplishments only after he turned 84; he died not long after, in 1988.

Still Working after All These Years

YOUR ELECTRONIC POCKET calculator will solve problems faster than the Curta. And a desktop computer does wizardry compared to it. Perhaps the Curta's only use is to balance your checkbook during a blackout.

Yet as I hold Herzstark's lilliputian calculator, passed down from my first astronomy professor, I'm acutely aware that this machine has outlived its first owner and doubtless will live beyond its second. As the instruction manual says, "Your Curta will last you a lifetime, and remain an indispensable aid always ready to hand. You can be entirely confident of its precision; the little Curta is born of long experience in the field of calculating machines. It is manufactured... by international specialists in fine mechanics, with superior quality metals. No artificial materials whatsoever are used in its construction." (I can't imagine reading, "Your Excel program uses no artificial materials" or "Your Pentium microprocessor will last a lifetime," although both statements are true.)

I figure that I don't own something until I understand it, and I can't understand it until I see how it works. So armed with a magnifying glass, tweezers and jeweler's screwdrivers, I unscrew the barrel to uncover 600 parts: gears, shafts, pawls and pinions.

I delicately remove eight setting shafts, each machined with a spiral groove and designed without collaborators, assistants or even drafting tools. I see the ingenious step drum mechanism, first penciled under impossibly wretched circumstances. I touch lightweight alloys, revolutionary in their day. I feel a tactile finesse, which transcends half a century of calculating progress. Entirely confident in the Curta's precision? Absolutely.

On my now reassembled 50-year-old calculator, I divide 355 by 113. With my thumb, I slide the setting knobs on spiral axles, then turn the crank to stash the first number in the machine. I enter the second number, lift the handle and rotate it again. The Curta's counting gears engage the nines-complement cogs of the step drum. Steel transmission shafts translate this motion through right-angle pinions and then into the results register. As I turn the handle, control, logic and digits rotate around the crankshaft. Two dozen spins later my answer snaps into tiny windows.

Before me is an approximation to pi and more. At once I'm holding the lineal descendant of the first calculating machines, the acme of Western mechanical craftsmanship and a monument to one man's vision overcoming a wall of hostility. SA

MORE TO EXPLORE

Antique Office Machines: 600 Years of Calculating Devices. Thomas A. Russo. Schiffer Publications, 2001.

The Universal History of Computing: From the Abacus to the Quantum Computer. Georges Ifrah. John Wiley, 2001.

Information on the Curta, including a manual with operating instructions, can be found at Rick Furr's Web site: **www.vcalc.net**

Try Jan Meyer's Curta simulator at **www.vcalc.net/curta_simulator_en.htm**

Greg A. Saville will show you the details of a Curta's disassembly at **http://home.teleport.com/~gregsa/curta/disas**

Find calculating algorithms at **www.curta.org**

For road rallies where you could use a Curta, visit **www.VintageRally.com** or **www.scca.com**