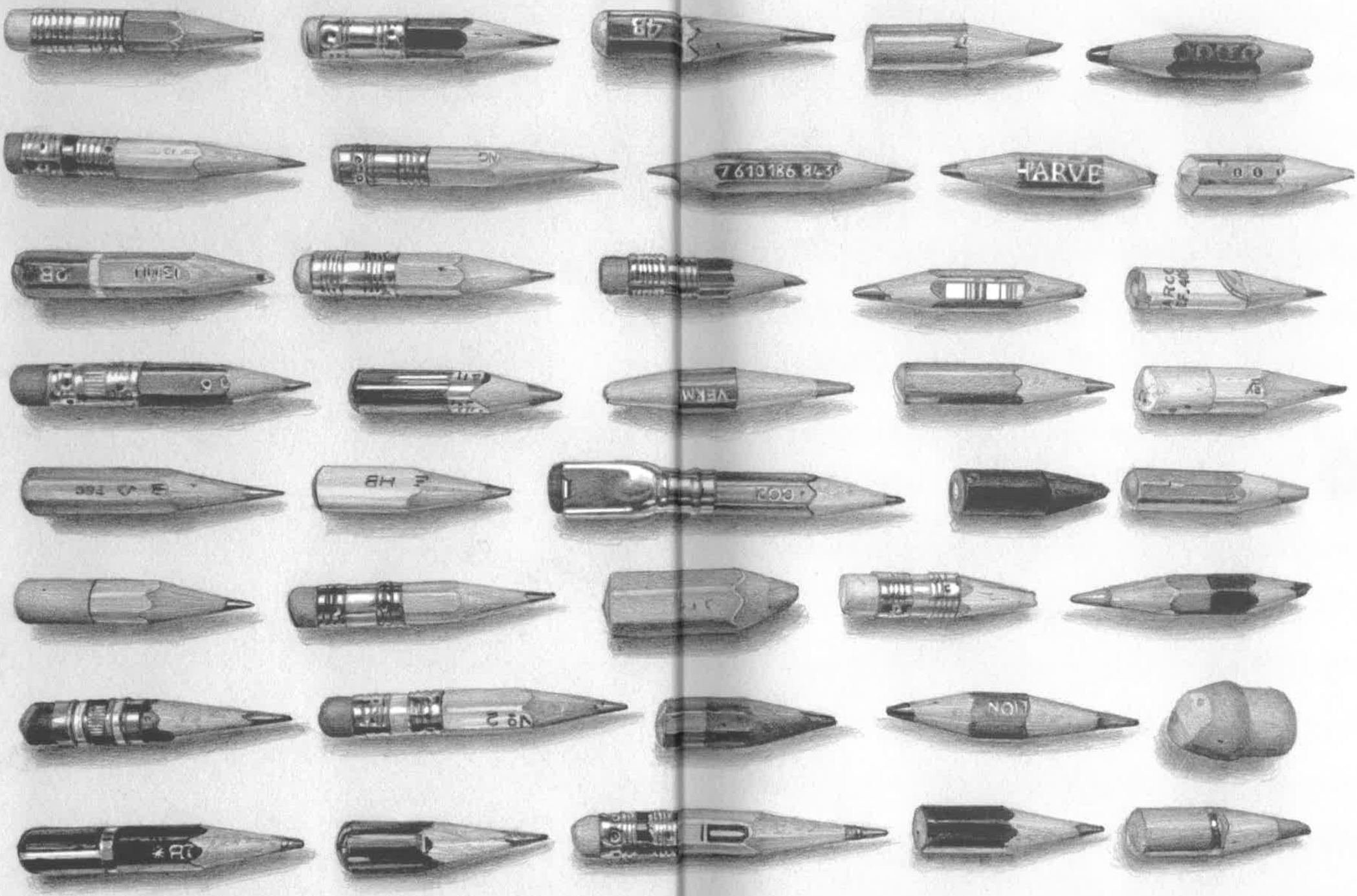
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THE PENCIL PERFECT

The Untold Story of a Cultural Icon

by **Caroline Weaver**

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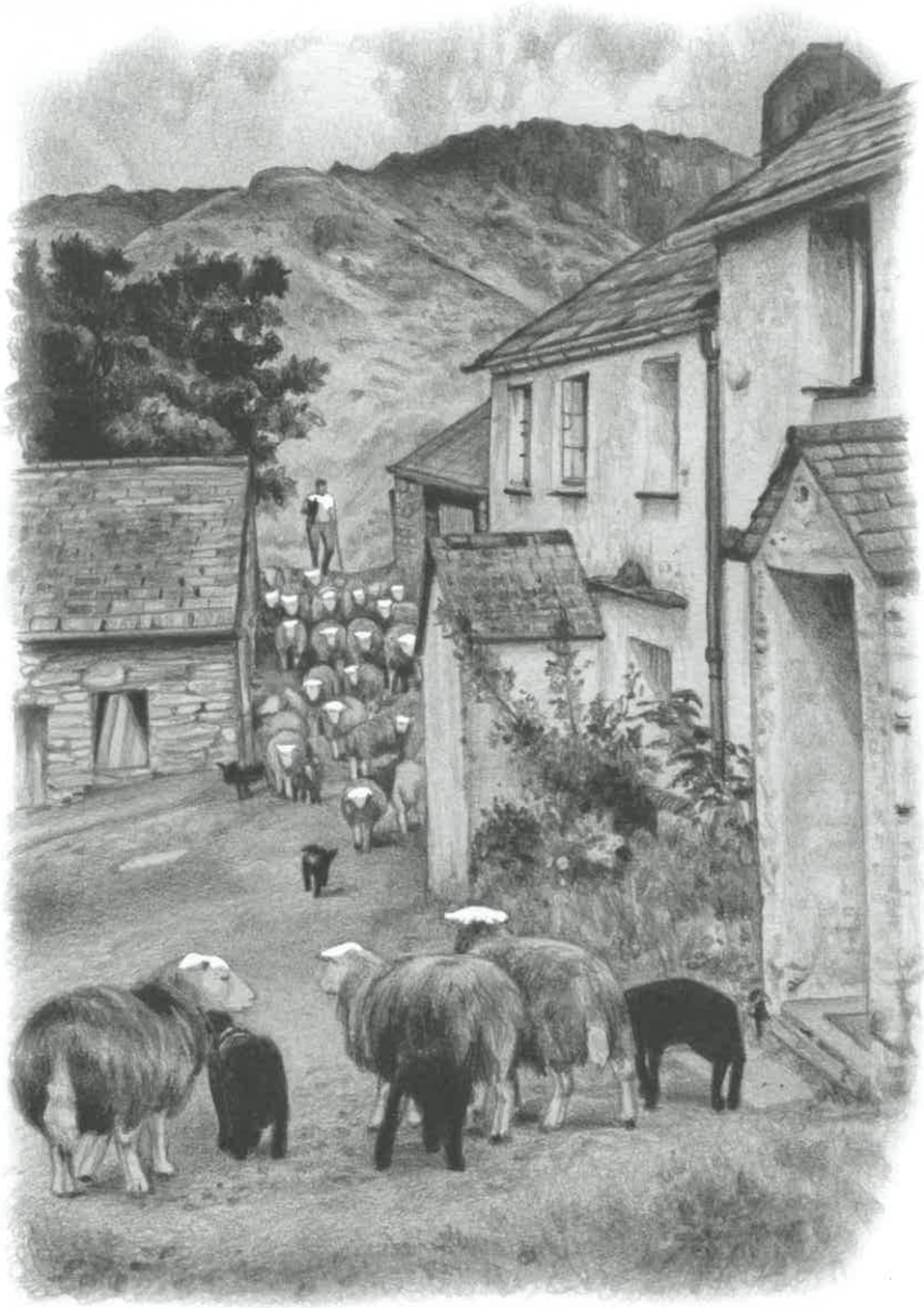


The Borrowdale mine, situated in England's picturesque Lake District, was the source of some of the highest-quality graphite of its time. It had its heyday in the early 1600s.

The *Discovery* of Graphite

The pencil has always been defined by a single ingredient. It's dark in color, slippery, erasable, and has a sort of metallic quality to it. Without it, the pencil couldn't exist.

The discovery of this substance is a bit of a mystery, usually told through romanticized stories of serendipitous encounters. It can be found on almost every continent in the world, though one place is especially recognized as its origin.

As the story goes, sometime in the 1560s in the Lake District in England, an extraordinarily strong gust of wind uprooted a large ash tree (some accounts claim it was oak) in the lush, sprawling hillsides of the North West. The crater left in its place gave way to the single most crucial discovery in the history of the pencil. Found underground in the county of Cumbria was a deposit of an unknown mineral substance, the very substance that we call graphite.

Who actually found the tree and recognized the new material's potential, no one knows for sure. Most stories related to the origins of graphite are undocumented and have been told so many times over that they've become the stuff of legends. One tale tells of a shepherd who encountered the deposit while tending to his sheep. He immediately found the new substance useful for marking and tracking his flock and was credited for being the first to appropriate the graphite. Another speaks of a mountaineer who came upon the tree during a hike and noticed black powder stuck to its roots.

What we do know is that graphite wasn't exactly a new material, it just wasn't a widely known one. It's also unknown how far back its existence dates, but tales have been told about its use in just about every era of humankind. During the Neolithic Age, it was allegedly used to paint pottery. There are accounts of graphite being found in lump form in Ancient Egypt. In the 1907 book *Graphite: Its Properties, Occurrence, Refining and Uses*, Fritz Cirkel writes about it being used to paint on stone

→ *Even now, Cirkel's work on graphite is the most comprehensive and accurate despite being 100 years old. Though more easily read by a chemist than a reader interested in pencils, it covers every aspect of the mineral.*

vessels to be buried in ancient graves. Mines in Belgium and the Netherlands have been said to have existed prior to Borrowdale and to have exported graphite to Italy, where it was sold to artists as "Flemish Stone." As far back as the 1400s, graphite was allegedly being mined locally and used to make crucibles in Bavaria. Any number of these accounts may or may not be true, but the discovery of the Borrowdale mine, as it was called in Keswick, was by far the most credible and most widely known.

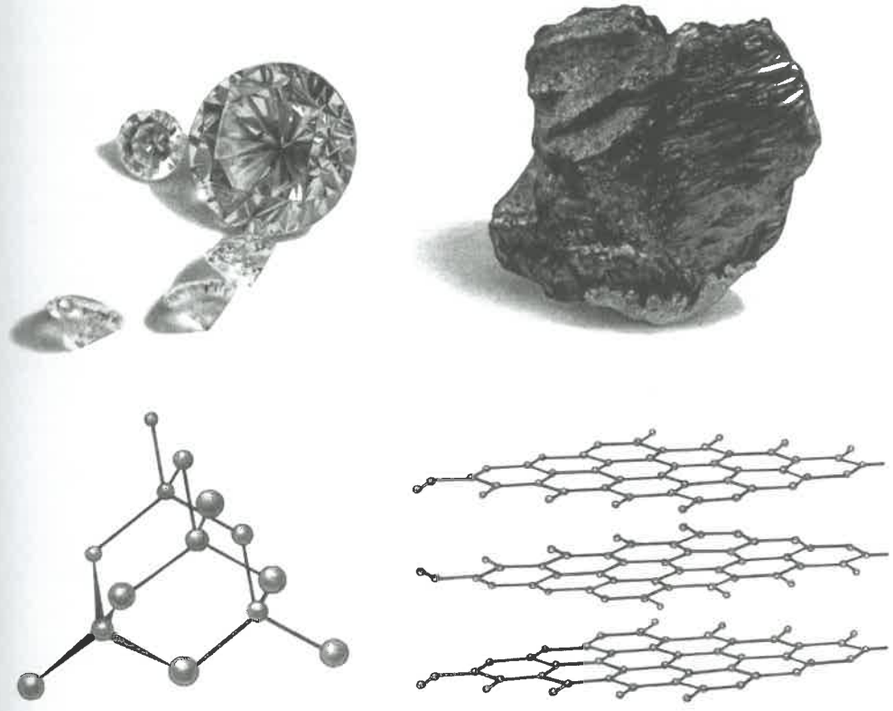
Before it was named graphite, the mineral was called many other things. Plumbago was the most common, as it means "that which acts like lead" in Latin. In Germany, it was often referred to as bismuth because of its seemingly metallic qualities. In Cumbria, the local name for the homegrown substance was wad, likely because it was found in wad-like chunks in the veins of the mine. In other places, it was simply called black lead. Interestingly, neither pencils nor graphite have ever contained actual lead in any capacity, except maybe for the brief use of lead paint. It was assumed that it was something of the sort merely because of its dark color and generic physical characteristics. For some reason, this assumption and label stuck and is often considered true to this day. You don't need to worry—your pencil won't kill you. The earliest graphite was found long before the science of chemistry was fully understood and new discoveries were classified based on the little information that could be observed and what was already known to exist.

The first major ground that was broken in the study of the chemistry of graphite happened around 1779, about two centuries after the founding of the Borrowdale mine by German-Swedish chemist and pharmacist Karl Wilhelm Scheele, who specialized in the study of acids. This interest in acids led him to find that graphite burns to carbonic acid in a current of oxygen, which led him to the very important inference that graphite is in fact made entirely of carbon. This notion was debated and widely doubted by other well-known chemists of the era, but was eventually recognized after graphite's resistance to other agents was more thoroughly tested. Mineralogist A.G. Werner further studied its properties towards the end of the eighteenth century and is credited with naming it graphite, from the Greek *graphein*, meaning "to write."

Carbon is an element mostly known for making up graphite and diamonds, whose structures are surprisingly similar except for a few details. Diamonds occur under high pressure and high temperature conditions while graphite could be considered their lower-maintenance sibling. Really though, it's rather simple. The crystal structure of graphite is hexagonal while the structure of diamonds is cubic. For decades it's even been possible to make diamonds from graphite—interesting, as graphite is entirely erasable and diamonds are virtually indestructible. Apart from that, graphite is a material all its own. It occurs in igneous rock (often limestone) or in meteorites and mostly in one of two forms: flake graphite or crystalline graphite. Flake graphite is most regularly used in pencils and for other things made with graphite. Crystalline, though rather common, is only actively mined in Sri Lanka. One of the more curious characteristics is that graphite is not a metal, though it appears to be so, and is also the only non-metal that is electrically conductive.

If you've ever wondered what a graphite mine looks like, you can visit the Graphitový Dul Český Krumlov in the Czech Republic or the Seathwaite Mines of the Borrowdale valley in England. The famous Borrowdale mine was closed for good in 1891, but not before a couple of centuries of heavy activity. In the immediate years following its discovery, the graphite was cut into pieces, wrapped in paper, string, or sheepskin, and sold to local farmers, who used it for marking livestock, and to artists, who used it to sketch out paintings. With encouragement from Queen Elizabeth as part of a new mining initiative, German miners came to the United Kingdom in the late 1700s and began doing serious mining work in Borrowdale. By the early seventeenth century, Borrowdale graphite was being exported all over Europe and was being sold regularly on the streets of London as an everyday product. Graphite had become popular as a writing material, especially for trades that involved keeping field books, and was favored by many innovators of the time. Around this time, other parts of the world had begun tapping into graphite mines of their own but quickly realized that Borrowdale graphite was uniquely pure compared to all the rest, which usually contained too much quartz and/or mica to be cut and used in chunks as Borrowdale graphite was.

The heyday of the Borrowdale mine is considered to have been the early 1600s, when the graphite was pure and plentiful and the demand was high. The mine was closed in 1678 because of the belief that it was totally used up. By 1710 it was opened up again and found to have been raided over the years by thieves hoping to capitalize on the mine's reputation. It's hard to imagine now since practically every inch of our earth has been scoured for all its available resources, but at the time there was nothing better than



The carbon atoms in graphite [RIGHT] are structured in sheet-like layers—very different to that of the material's almost indestructible relation, the diamond [LEFT]. The layers slide apart when they come into contact with other surfaces, leaving a mark.

In the early 1600s, graphite was wrapped in string and sold as a drawing material.

Borrowdale graphite and people went through great lengths to get their hands on it even though there was much more graphite to be found. Security measures were taken and once reopened, the mine continued to produce the product with lesser quality until it was permanently closed towards the end of the nineteenth century. The closing of Borrowdale wasn't necessarily because there was no graphite left to be mined, but rather because graphite had become more readily available and major advancements had been made that allowed inferior graphite to be processed into better quality without having to pay a premium for something chemically pure.

Nothing quite as perfect as Borrowdale graphite has been found to this day. Mines in Siberia and parts of Asia have come close, but apparently nothing was better than the original source. From what I gather there are no known pieces of original Borrowdale graphite left in the world. These days, most pencils are made from a combination of graphites from different places.

Should you wish to pursue "pencil tourism," Keswick is also home to the Cumberland Pencil Museum, which is full of artifacts and information about pencil making, particularly in the Lake District. Though the county of Cumbria once played host to an impressive number of pencil factories, only one remains.

→ *Derwent, formerly known as the Cumberland Pencil Company, still makes graphite pencils in the region, though only ones marketed as drawing pencils.*

Many different objects and industries have benefited from the discovery of graphite. Its simple structure, heat resistance, and conductivity have long been useful traits for a number of industries. It is said that graphite has been used for the manufacture of crucibles since the fifteenth century. A slightly more contemporary Joseph Dixon invested in a graphite mine in Ticonderoga, New York, from which he used the raw material for his crucible company in the 1800s. The density, stability, and resistance of the substance was ideal for making the molds, which also usually involved the use of clay and fine sand. It didn't hurt that graphite is a particularly slick and smooth mineral and can withstand temperatures of over 600 degrees Celsius (1,112 degrees Fahrenheit). This was especially useful in the making of bombs and cannonballs. Dixon also used it in powdered form to line molds in his foundry to make them more non-stick. Much of the credit for the creation of the American graphite industry is owed to Dixon and his Ticonderoga mine.

→ *You might recognize the names Ticonderoga and Dixon as the name of the pencil made by the very same company. More on that later.*

Because of the aforementioned slipperiness of natural graphite, it was and still is often used as a lubricant when in powdered form. It oxidizes slowly, is low friction, and most importantly is not affected by acids or gases. Here's a little tip: the next time you've got a sticky lock or any sort of jam, just crush the end of your pencil and either use it dry or mix it with oil.

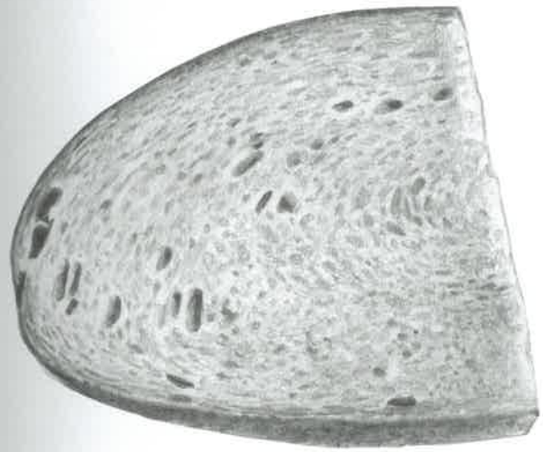
More recently, batteries are being developed for use in smartphones that are made of aluminum and graphite. They're meant to hold a charge longer, be less expensive than the current lithium-ion batteries, and also more environmentally friendly. On a less high-tech scale, graphite batteries can be made at home with aluminum foil, water, salt, vinegar, and a few tools.

One use I hadn't considered before doing research on this subject is graphite paint, which has been around since the late 1800s. Generally it's used as a protective coating, especially beneficial for iron structures. It's a terrific agent to protect against rust, and though it used to be made with linseed oil, it is now usually water-based. These days it's most common for painting the bottoms of lawn mowers because it keeps grass from sticking, keeps the machine rust-free, and is low friction so as to not cause mechanical problems.

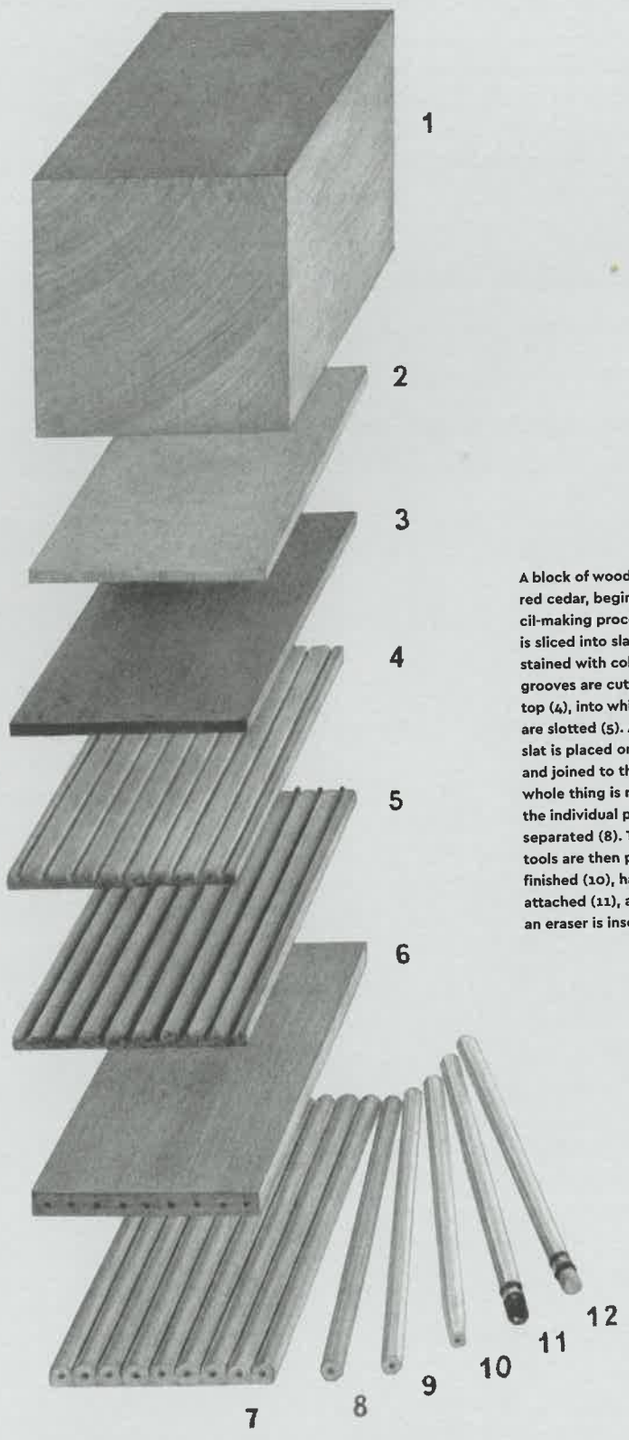
There are a few more unusual uses for graphite. Tennis rackets are often made entirely or partly out of the mineral because it's rigid but also very lightweight. For centuries graphite has also been used for medicinal purposes and is often considered an under-appreciated natural remedy. In the realm of homeopathy, it is said to help with cold sores, metabolic problems, eczema and other skin ailments, ulcers, hair loss, menopause, and mood swings among many others symptoms. It's either applied as a topical solution or mixed with water and ingested. If you've ever been told not to chew on your pencil because you might get lead poisoning, it's actually quite the opposite case, though I wouldn't go so far as to recommend it either.

→ *Graphite, as used as a homeopathic treatment method, is often referred to as Graphites or often still as Plumbago.*

Though preferred in its natural form for most uses, especially for the making of pencils, graphite can rather easily be made synthetically as well. Whether you're marking your sheep, writing a novel, casting metals, or playing tennis, graphite is a mineral that is undoubtedly important. The Borrowdale mine may be closed forever, and greater advances in the study of carbon have been made, but graphite is still plentiful all over the Americas, Europe, Asia, and Africa, and likely will be for as far as we can see into the future.



Before erasers came bread. Instead of a rubber eraser, a slice of bread was used to eliminate unwanted marks.



A block of wood, usually red cedar, begins the pencil-making process (1). This is sliced into slats (2) and stained with color (3). Long grooves are cut into the top (4), into which the leads are slotted (5). An identical slat is placed on the top (6) and joined to the first. The whole thing is milled (7) and the individual pencils are separated (8). The analog tools are then painted (9), finished (10), have a ferrule attached (11), and finally an eraser is inserted (12).

How a Pencil Is *Made*...

Though the materials used are simple—wood, graphite, clay, and water—the pencil-making process is complex and it took centuries and countless individuals to figure it out.

The pencil as we know it is a seemingly simple thing. It looks like a stick of wood with lead down the center, with no other materials involved save for a few coats of paint and maybe an eraser. For most of my childhood, I believed that a hole is drilled through the wood and the graphite is then filled into the cavity. It made sense—why would you piece it together any other way if you can just fill it with molten pencil just like you would a jelly donut? Picture a factory full of tiny graphite-filled syringes carefully inserted into thousands of upright pencils.

Another uninformed theory is that the wood is cut, the hole down the middle is drilled, and the cured stick of graphite is subsequently just slid down inside it. This particular theory seems to be the most common, which I blame on those pencils made out of sticks that are often sold in natural history museum gift shops. Those are made precisely in the way conventional pencils are not: a branch is cut off of a tree, the hole is drilled through it, and a generic premade pencil core is inserted. Of course these are meant more as a novelty than a useful object—let's understand that they are not the same thing as what I'm talking about here.

The truth is that the making of a pencil is actually quite complicated. There are several very specific machines involved and materials that you probably wouldn't expect to be necessary. There's a famous essay called "I, Pencil" written in 1958 by economist Leonard E. Read in which the story of how a pencil is made is told from the perspective of a pencil itself, specifically the popular Eberhard Faber Mongol 482. At the beginning of this essay, the Mongol 482 shares that it is a mystery and that it feels taken for granted by those who use it. It even goes as far as to say that "not a single person on the face of the earth knows how to make me." The essay goes on to describe every single part of the process, from the harvesting of the wood to the growers of the castor beans from which the castor oil is extracted to make the lacquer. Perhaps it is true that there isn't a single person who could make a pencil

from start to finish (those repurposed branch pencils don't count)—at least "I, Pencil" certainly makes the reader believe that to be true. I like to think that if I had to make a pencil, and by that I mean making it my life's mission to make my own pencil, I could do it. After all, it would take decades just to grow the tree to harvest the wood from, so I'd have plenty of time to think about it.

The most important part of the pencil is what's inside, whether it be a mixture of pigments, charcoal, or graphite. You can't have a pencil without a core. Although there is one exception I can think of: the Dummy Pencil made by esteemed Portuguese pencil company Viarco. There is no graphite inside, it's just wood cut and painted as a pencil that is dipped in graphite on the end merely for appearances' sake. Truly though, it's a hilarious prank. The stump of a pencil tip skids awkwardly across the page and leaves only a faint gray mark. I wish I'd had one of these in grade school to offer when someone asked to borrow my pencil. Fake pencils aside, it took centuries to come up with an effective way to make a graphite core, and there's a reason why. Aside from graphite, there's a list of other ingredients and meticulous processes that go into making the inside of a pencil. If you've ever had a pencil that keeps breaking, it's probably because the core is either of inferior quality or it has shattered. Think of the wood of a pencil as bubble wrap for what's inside. It's fragile and worth handling delicately.

When making the core of a pencil you must first start with the obvious ingredient: natural graphite. Graphite can be found in a long list of different countries on just about every continent with varying characteristics depending on which mine it comes from. Most pencil makers use a mixture of graphite from different parts of the world to create an ideal texture. If you've ever seen a chunk of natural graphite it's easy to understand why it was once mistaken for lead. It's dark, rather lightweight, and incredibly shiny, especially when polished. Alone, most graphite tends to be crumby and sometimes too gritty when used for mark making.

The second most important ingredient in a graphite core is clay, which strengthens the graphite and adds character to the texture of the pencil. Most common is kaolin, which is a fine, white clay also used for colored pencil cores. Quite frankly, until recently I hadn't given much thought to precisely what type of clay is in a pencil. After doing some research and learning about the chemical composition, I ended up on a shopping website and learned more about kaolin and its uses from the reviews written by consumers. It turns out other common uses for kaolin include pest control and making homemade toothpaste, face masks, or quick clot bandages. Not only is it a very soft, remarkably absorbent material, but it is also apparently very versatile as a household substance.

Grind the graphite into a fine powder, add some powdered kaolin, and you're halfway to having a pencil core. Okay, maybe it's not quite that simple. Pencil hardness is determined by the ratio of clay to graphite—the more graphite there is, the softer the pencil. This means that it will be smoother, darker, more smudgy, and often shinier. The more clay is added, the harder, firmer, lighter, and finer it is. These two things can't hold each other together on their own, though—that's what the water and wax do. Wax is often used as a binder and an agent to make the pencil smoother to write with, as wax glides differently than dry minerals. If we're talking about more high-tech varieties, there's also polymer involved, which is often the case with pencils made in Japan. This makes the pencil more breakproof, smoother, and less messy. More traditional pencils feel remarkably different in comparison to pencils that utilize slick binders. They're often scratchier and run a little harder in comparison.

One thing that I often preach is that the pencil-grading scale is not universal. A German HB might feel harder than a Japanese HB. A Swiss HB might have better point retention than an American HB. An Indian HB might be lighter than a Portuguese HB. It just depends on where it comes from, who is making it, and what guidelines are being followed. That's one thing I love about pencils: they all have different defining characteristics and each one tells a different story about its origins.

→ Point retention is one of the staples of pencil jargon. It's used to describe how well a pencil holds its point before it needs to be sharpened again. Of course, this varies depending on the pencil you're using, the paper you're writing on, and how heavy-handed you are.

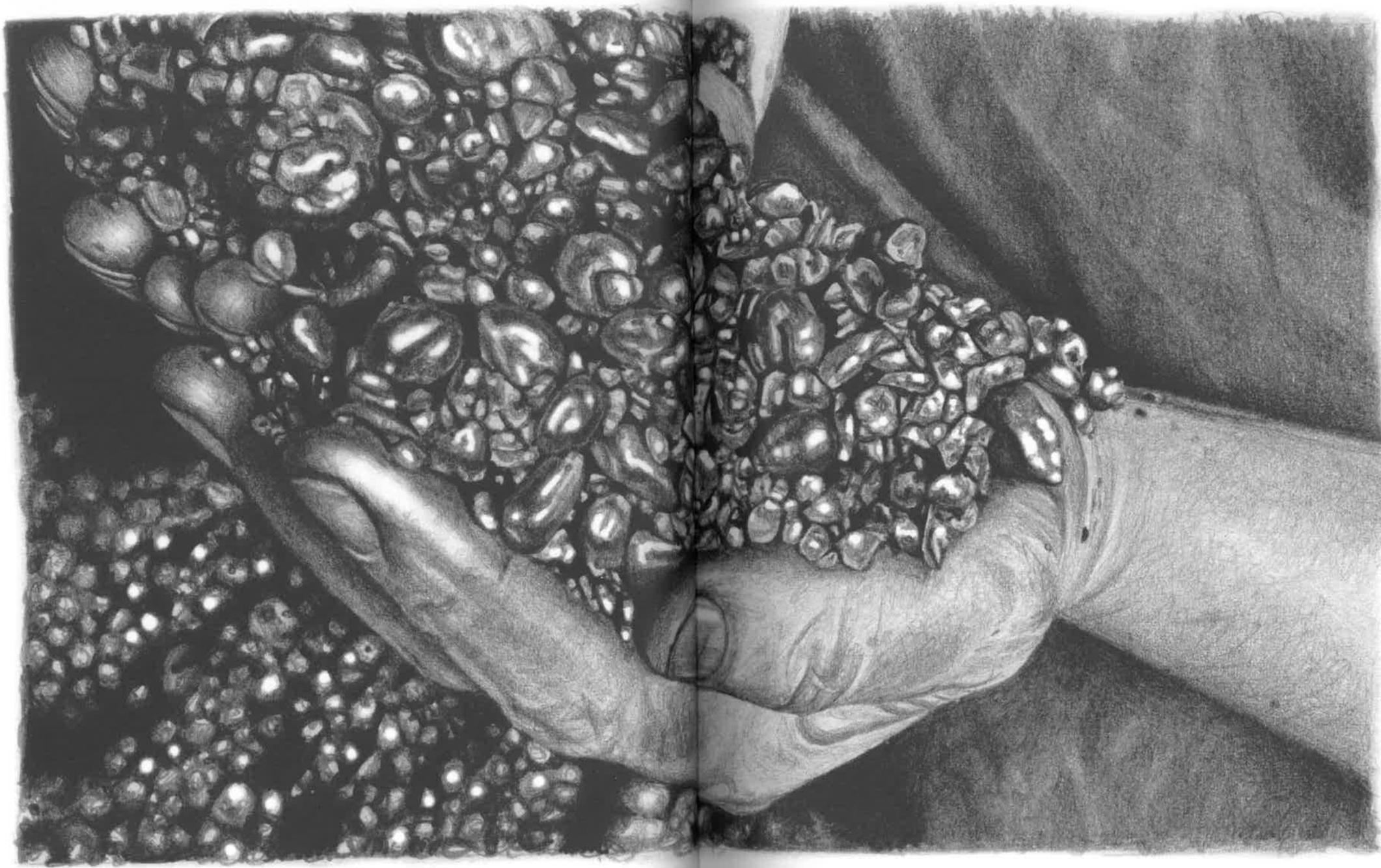
In a pencil factory, the ingredients for a given pencil core are all thoroughly combined through processes that vary slightly from factory to factory. When it's done it takes on a thick, doughy quality and is quickly put into a machine that presses it into a continuous strand that looks like a wet noodle. At this point, the pencil core is heated so it temporarily becomes malleable as it is fed into the cutter, which chops it to the correct length. Before the little graphite sticks cool down completely, they're put into crucibles in which they will bake at about 980 degrees Celsius (1,800 degrees Fahrenheit). It's a process that's not completely dissimilar to firing ceramics in a kiln. The whole point is that the process of heating and curing the mixture will harden it and make it stronger. Thank you, Mr. Conté, for your genius in figuring all of this out.

Graphite isn't the only common base for pencil cores. Pigment can also stand in its place for colored pencils, which are processed rather similarly. The difference with pigment is that depending on the hue, the physical consistency can vary drastically. It's difficult to make a really good colored pencil because it has to be lightfast, it has to feel consistent with the others in its range regardless of color, and it has to be as vibrant as possible. Colored pencil cores are traditionally made with wax or oil, but they can also be made with gum arabic, which makes them water-soluble. This allows the pencil to be used like watercolor paint. The core of a colored pencil endures an almost identical process as a graphite pencil, though they often have to set for a longer period of time as they are significantly more fragile.

→ Lightfastness describes how resistant a color is to fading. Most pencils have a star rating printed on them, 5 stars being the most lightfast and 1 star being the least.

The biggest pencil conundrum I deal with on a daily basis is that of lead breakage. If the pencil is fragile enough, all it takes is dropping it on the floor once to shatter the entire core. This is especially the case with colored pencils, charcoal, and softer graphite cores. Unfortunately, there's no official way to repair a broken pencil, though it has been recommended to me more than once to put a broken colored pencil in a microwave for long enough to fuse it back together. It won't melt into a gooey puddle of color but certainly the heat of a microwave would alter the pencil's carefully concocted formula. I'll admit that I've never tried this before, mostly because I don't own a microwave but also because it almost seems blasphemous. Instead, there are plenty of things you can do with a useless pencil. You can use it to stir your coffee, to rewind a cassette tape, to put your hair up, to reset your internet router … The possibilities are endless.

Once the graphite cores are finished and cured, they have to go into something. As we know well, they are most likely cased in wood. Despite all of the theories I had as a child, upon close inspection of a sharpened pencil it is pretty clear that it is made out of two pieces of wood. Have you ever seen a pencil that's been stepped on or run over by a car? You'll notice that it is split in two. Let's think of it as a graphite sandwich. The earliest pencils were made this way, but in a more primitive fashion by basically boxing in a rod of graphite with wood on each side. We can thank the Industrial Revolution for streamlining and perfecting the process as we know it now. We'll skip the chopping down the tree part and go straight to what the wood looks like when it makes it to the factory. If you run a



In its raw form, graphite is shiny, lightweight, and crumbly. To form a strong and textured pencil core, the material needs to be mixed with clay.

The red cedar, *Juniperus virginiana*, is ideal for pencil making as its wood is light and sharpener-friendly.

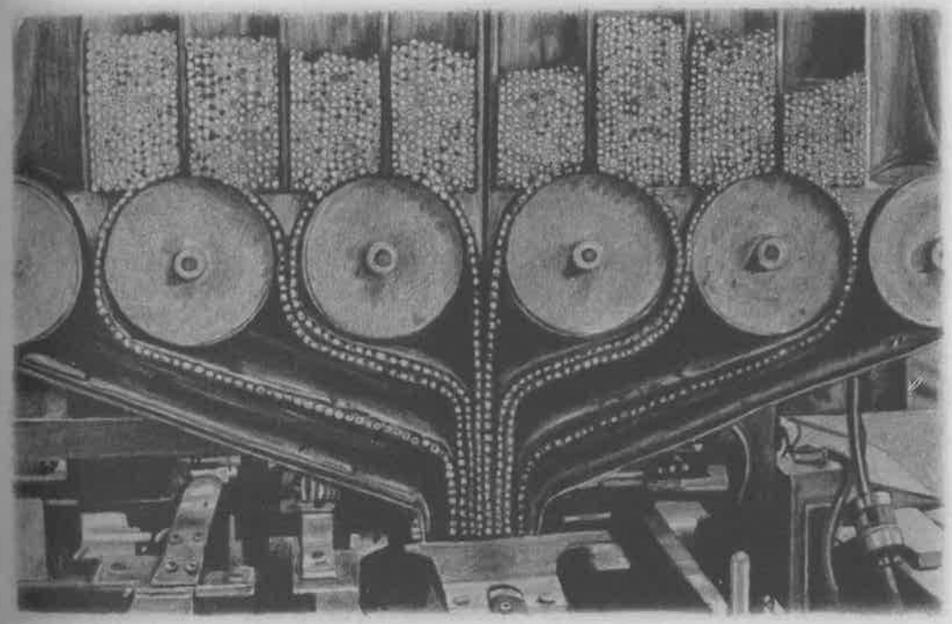
pencil factory, chances are you order pencil-specific slats from a supplier who has pre-cut them to be the right size, which is more-or-less standardized. In the early years of pencil manufacturing, eastern red cedar was the norm but most commonly these days they're usually made from incense cedar sourced from California or Oregon. Cedar tends to be the wood of choice because it's lightweight and therefore easy to sharpen and has a tight wood grain that isn't too dense but also isn't too splintery. It certainly doesn't hurt that its natural fragrance is warm, earthy, and a little bit spicy. Though most quality pencils are made from incense cedar, there are a few alternatives. Linden, poplar, and vatta are also common but quite different to cedar. They're often a bit lighter in weight and more likely to splinter. Most of the time, pencils are made out of a non-cedar wood to cut costs or simply because an alternative wood is indigenous to the pencil's origin location, as is the case for pencils made in India. Sometimes pencils are made out of more exotic wood, like the Caran d'Ache Swiss Wood, which is made from beechwood from the Jura forest. It's noticeably heavier than cedar, much darker in color, and very strongly smells like brown sugar. Other rare woods have been used for pencil making in the past, not always for general use as a pencil but often because they make beautiful collectors' objects. Regardless of the type of wood, the process always starts with a slat.

Those slats are cut along with the grain of the wood to be about 18 centimeters (7 inches) long with varying width depending on the type of pencil being made. Pencils come in a few different sizes, namely standard diameter, mini-jumbo, and jumbo. Mini-jumbo logically is the size between standard and jumbo and is probably the least common. Usually jumbo pencils are marketed towards children as they're meant to be easier for tiny hands to hold but quite honestly, they're generally more comfortable for anyone to hold especially for long periods of time. Occasionally you'll find smaller than standard pencils, especially Bridge pencils, which are made for scoring the card game of the same name. All things considered, though, the average pencil has a diameter of about 6 millimeters (15/64 inches) and is made eight to a slat.

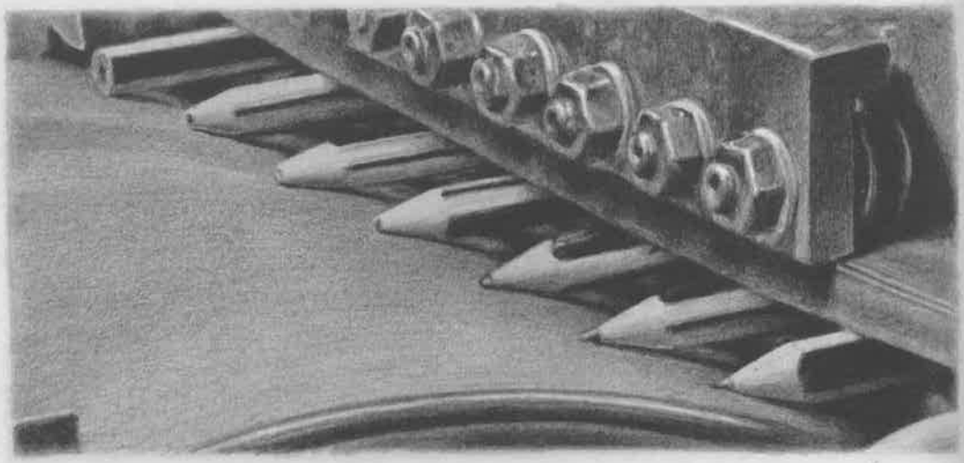
Once the slats are cut, they go through a machine that carves grooves down them lengthwise, one for each pencil-to-be. This is where it starts to get a little bit tricky. The sticks of graphite or whatever is going inside the pencil has to fit into the groove so perfectly that the margin of error for a high-quality pencil is about 0.01 millimeters. Have you ever had a pencil that has an annoying sliver of wood that runs up the point on one side after sharpening? That is because the grooves weren't cut precisely enough and the pencil isn't well centered. Once those grooves are cut, the most visually satisfying part of the process occurs: the slats go through a machine that carefully squirts just the tiniest bit of glue into the freshly cut grooves. Just enough to hold the core in place but not so much that it compromises the physical integrity of the pencil. From there, the cores are carefully put in place and another identical slat with identical grooves is laid on top and pressed together.

Once that's done and the pencil cores are comfortably settled into the wood, the slats are put into a press where they'll stay for a few hours to ensure that they can endure any amount of use in the future. From there they go through yet another machine that will cut them one side at a time into the shape they'll end up being, usually hexagonal, round, or triangular. And there you have it! A pile of slightly rough-looking, freshly cut pencils. Before they get coated in paint or whichever finish they're meant to have, they'll be sanded down so they aren't at all splintery, should you want to use them unpainted.

When visiting a pencil factory, the one thing I found most mesmerizing was the painting process. This might have been because the repetitive motion of seeing naked pencils dipped in



A 1950s colored-pencil packing machine in the Faber factory.

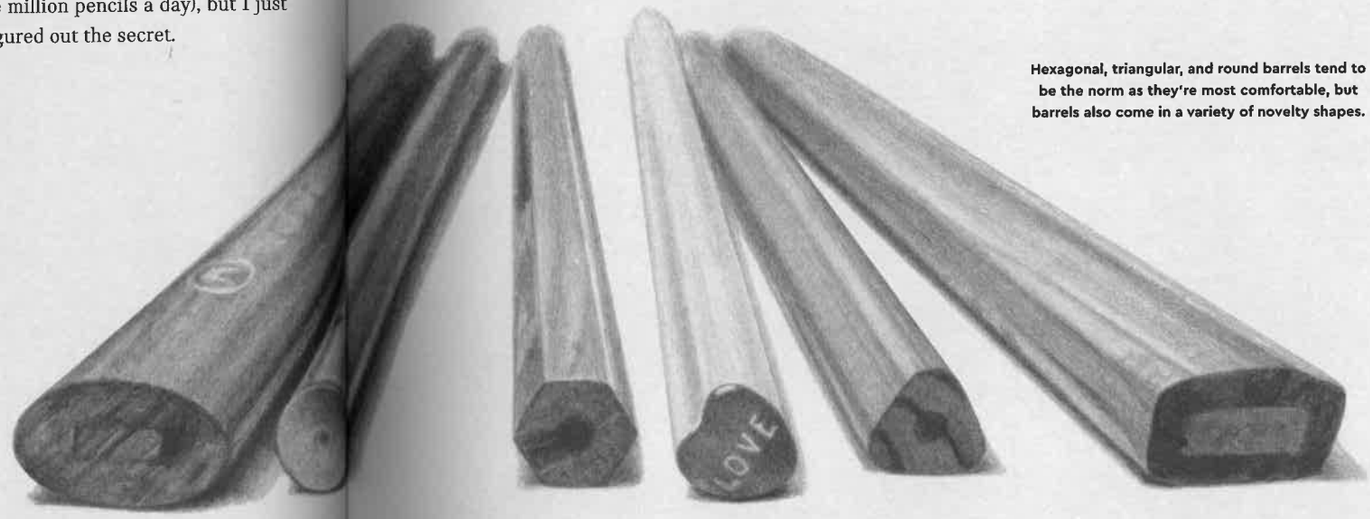


Pencils are sharpened to a point in the factory by being rolled over a rough surface.

layers and layers of colorful paint seriously satisfied my slightly OCD tendencies or maybe it was because the smell of the paint was particularly intoxicating. Not all pencils are painted. Some are left "naked", as I like to label them, though they do usually get some sort of clear coat to prevent splinters. Those that are painted, however, endure a long process where they are funneled through identical painting machines anywhere from four to 14 times. Yes, that's a lot of paint. Have you ever noticed how Japanese pencils are usually super glossy and a tiny bit bigger than most others? It's because of all that paint. The paint not only decorates the pencil, but it also holds the whole thing together and almost acts as a back-up sealant for the pencil sandwich. In lieu of paint, there are some other creative alternatives, like the scented pencils made by Viarco in Portugal. These are simple, round, barreled cedar pencils that are soaked in fragrance, making them smell like common plants found in the backyards and gardens of Portugal (fig, peony, orange blossom, lily of the valley, and jasmine). They're shockingly fragrant and mingle nicely with pencils of a more regular variety in a pencil cup. An example of a particularly interesting paint job comes from Hindustan Pencils in India. My favorite model is hand-marbled so each pencil has a different colorway and pattern. As a marbled paper hobbyist, I've tried to figure out exactly how this is done (especially by a company that makes nine million pencils a day), but I just haven't quite figured out the secret.

Next comes the question of what goes on the end of the pencil. Some very brazen pencils will just go on the way they are with their interior exposed. Others will go through one of many other processes. In Europe and Asia especially, it is common practice to "tip" a pencil. By that I mean that the pencil is carefully (very, very carefully) dipped in a vat of paint so it just barely kisses the surface. Some even have tiny designs painted on the end. In general, the more decorative the end cap, the higher quality the pencil probably is. A more common practice is attaching a ferrule and eraser onto the end of the pencil. A ferrule is the metal piece at the end of the pencil that holds the eraser onto the body. There is really only one successful example of a pencil that has an eraser attached without a ferrule of some sort; it was designed by Eiichi Kato in Japan and simply looks like a very minimalist rubber end cap. Apart from that exception, a pencil with an eraser always needs a ferrule. Some ferrules are prettier than others and some are representative of a specific type of pencil, but in general, especially in the twenty-first century, they all look very similar. The part where the ferrule and eraser are both attached has always been a mystery to me. Is the ferrule attached first or is the eraser glued and then the ferrule slid over it? Or maybe they're assembled together? I've never witnessed this particular action in real life so I wasn't ever sure. I remember being in grade school and chewing the ferrule on the pencil until it was misshapen and simply fell off the pencil. From there it appeared that the eraser would have had to have been put in first, because the ferrule is squeezed onto the pencil and thus there would be more room for error when sliding it on the pencil. I never bothered to research this because it seemed like superfluous information. It wasn't until I started selling pencils that I started to notice the occasional faulty example, where there's a thin curtain of eraser that hangs over the top of the ferrule. In the most anti-climatic way, my question was answered. First goes the ferrule and then the eraser.

After all of the fuss and detail with the paint and the ends of the pencils, there are still a couple of optional things that need to happen before the pencil is ready to leave the factory. The first is branding. Almost any pencil you come across will have some sort of text on it. Whether



Hexagonal, triangular, and round barrels tend to be the norm as they're most comfortable, but barrels also come in a variety of novelty shapes.

it be a brand name or an advertisement for something else, you are likely to find it laden with text. There are a couple of ways to do this, but for the most part, text is added to a pencil with hot foil. It's a simple stamping process where a plate cast with text is heated up and pushed into the sheet of foil that lies against the surface of the pencil. The text is transferred through the sheet of foil and there you have it: a branded pencil. Some pencils have barcodes and lots of text, whereas some are just stamped on one side. Japanese pencils are famously elaborate and one unique feature is that they almost always have the intended purpose of the pencil written in English on the opposite side of the brand. For example, it'll say "For Master Writing," "For Academic Writing," "For Special Drawing and Retouching," or "For High-Precision Drafting." The designated uses are almost always more specific than they need to be, but that's part of the charm of an over-the-top Japanese writing instrument.

Disclaimer: I'm not a huge fan of visible branding on consumer products. I would never buy a handbag covered in a monogrammed print. Nor would I wear a T-shirt with a brand name across it. It's mostly just a pet peeve, but I also believe that the things I wear, carry with me, or use shouldn't speak for me. With pencils it's a little bit different. Often the only thing that clearly distinguishes one pencil from another to the untrained eye is the branding, and since the surface area of the pencil is so small it can be a crucial factor to its design.

By now the pencil is just about ready to head out into the world. Sometimes it is pre-sharpened to a slightly dull point for immediate use, which is usually done with a belt sanding apparatus. Other times it needs a couple of finishing touches to its design. The one thing that it has to go through without question is quality control. Is the paint finish even? Is the text stamped correctly? Is the pencil core perfectly centered in the wood barrel? Are there any obvious cosmetic flaws? Once all of these questions are addressed, the pencil is carefully put into whatever type of packaging it's destined to live in and is shipped out to a shop where you or I will purchase it and put it through rigorous use.

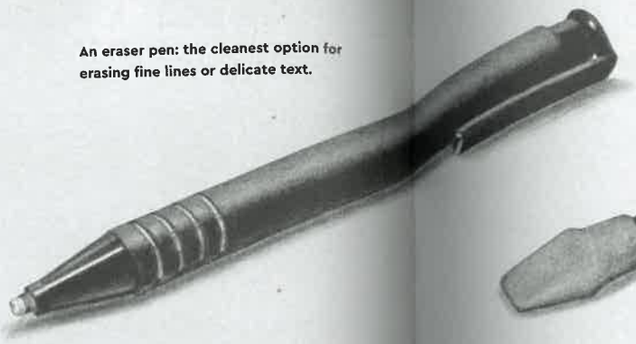
Even as a pencil-obsessive, I'd never thought much about the exact nuances of how pencils are made until I stepped into an actual factory. Sure, I knew extensive amounts of information about each component involved, but to see the physical process of assembling the whole object is a completely different thing. The machines move so seamlessly and every step appears so natural that it's hard to imagine it ever being done any other way. It makes sense that the first pencils were made by cabinet makers. Even with modern machinery there is an incredible amount of craft and skill that goes into making each individual pencil. Part of the charm of the pencil as an object is that it's such a compact, tidy little thing that is capable of so much creativity. The same goes for a pencil factory itself. The raw materials start as organic globs of matter and stacks of simple wood slats. The floor is coated in a thin but slippery layer of graphite dust and the machines are whirling as faulty sticks of lead are being thrown on the floor into a humorously disorderly pile of reject pencils. It's like being in Willy Wonka's chocolate factory where everything is so tactile and engaging to the senses. It's hard to believe that such a streamlined thing is made by such a messy and organic process. By the end, there's no more graphite on the floor and flawlessly formed pencils are being perfected like they're the most important objects in the world. It's hard not to reach out and touch it all. That's okay though, because the actual pencil at the end of the conveyor belt is still the best part.

The average pencil diameter is around 6 mm (15/64 inch), though this varies between countries. Mini-jumbo pencils are 8 mm (5/16 inch), and jumbos are 10 mm (25/64 inch).

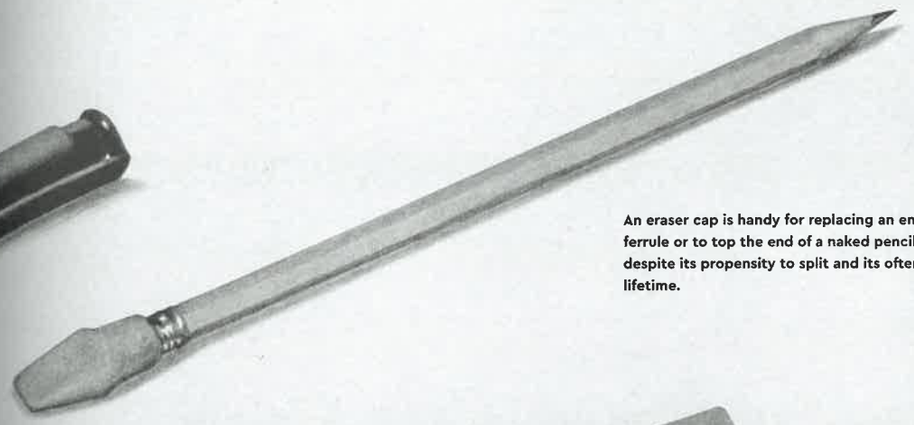
Before erasers, people used an unlikely tool to rub out their mistakes: breadcrumbs. Thankfully, in 1770, an "elastic gum" that could do the job much better was discovered.

On *Erasing*

One of the most beautiful and unique things about the pencil is that you can erase it. Yet the pencil existed for quite some time before the eraser as we know it came to be. In the earliest days of the pencil, breadcrumbs were used to smudge away the marks because the abrasion worked to gently scratch away the graphite. It wasn't until 1770 when a man by the name of Joseph Priestley found that a new substance usually referred to as "elastic gum" was effective in rubbing out pencil marks, hence the name "rubber," which is still used in place of "eraser" in the United Kingdom, Australia, New Zealand, and South Africa. Before Priestley's realization, rubber was a fairly new discovery that didn't yet have a practical application. It is found naturally by cutting the bark of the *Hevea brasiliensis* tree. When cut, the bark of the tree leaks a milky liquid that is then

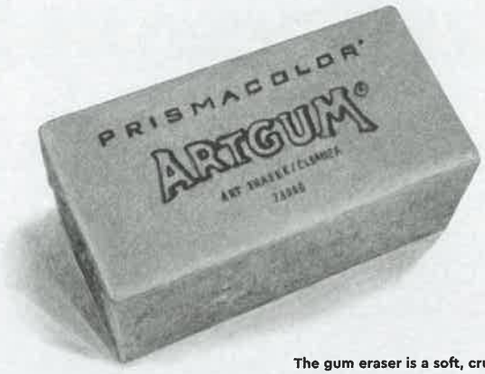


An eraser pen: the cleanest option for erasing fine lines or delicate text.



An eraser cap is handy for replacing an empty ferrule or to top the end of a naked pencil, despite its propensity to split and its often-short lifetime.

The plastic, or vinyl, eraser works on anything from graphite to ink. Dust-free residue rubs together to make the waste less messy.



The gum eraser is a soft, crumbly thing that won't easily tear paper. It's normally brown, semi-transparent, and made of rubber.

An artist's friend, the kneaded rubber eraser removes mediums from pencils and pastels to charcoal and chalk, and only needs some gentle kneading to clean it.

An icon from the end of #2 pencils, the distinctive Pink Pearl was first made by Eberhard Faber. Its distinctive color comes from the rosy tones of pumice.

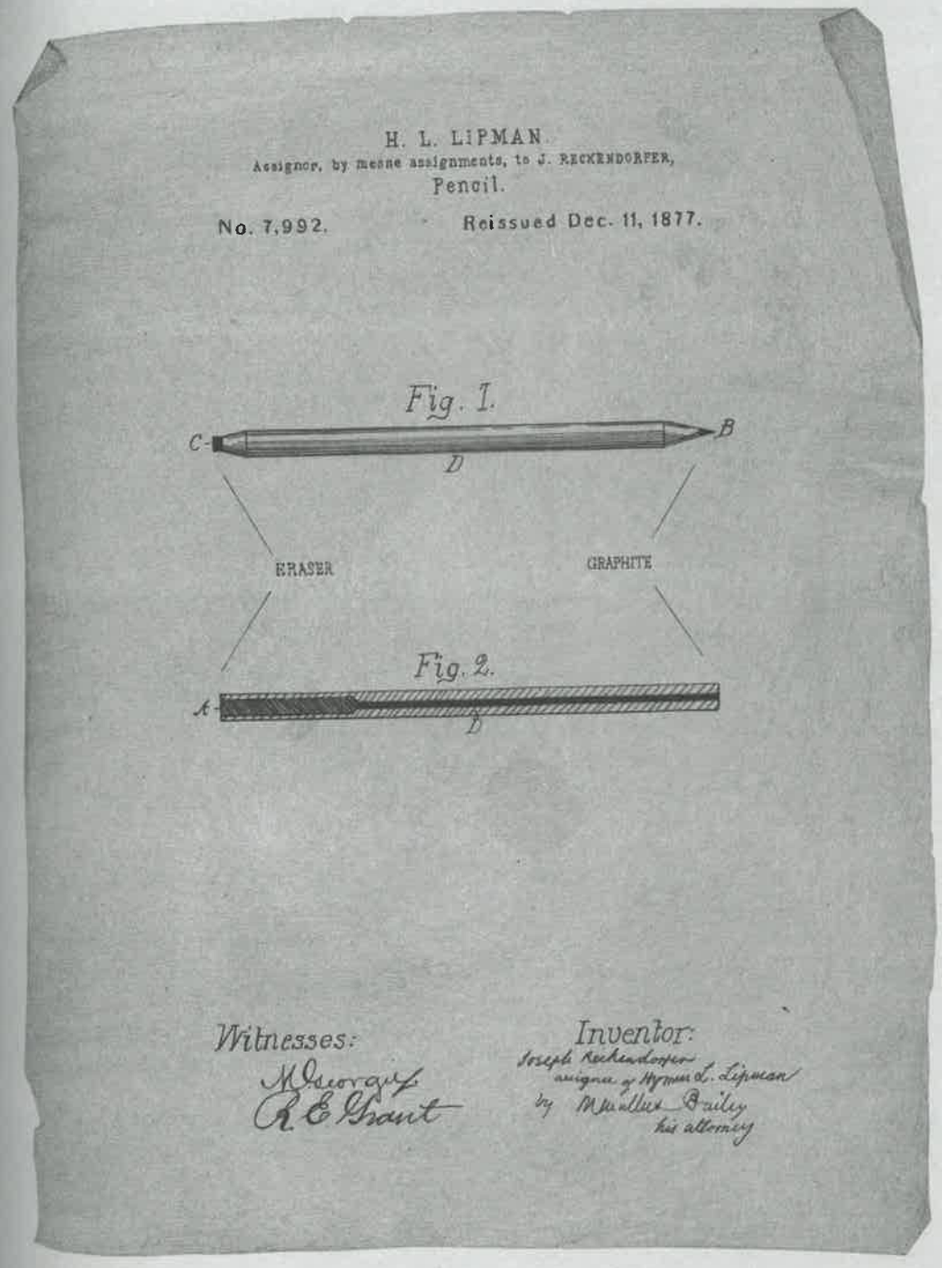
hardened into the solid form we most commonly know it as.

Engineer Edward Nairne is credited for being the first to create and sell cubes of rubber marketed specifically for pencil erasing, which he sold out of his shop in London. After the eraser caught on as a commercial product, most manufacturers began mixing rubber with Italian pumice—and the modern eraser was born. The slight abrasion of the pumice and the heat caused by the friction of rubbing makes the eraser slightly sticky and able to pick up the graphite particles. For about a hundred years the eraser was purely a pencil accessory, until American stationer Hymen Lipman patented a pencil with an eraser attached to the end, and in 1858 the whole pencil game changed. In fact, March 30th, the day the patent was issued, is still considered to be National Pencil Day in the United States. The eraser wasn't held onto the end with a ferrule as we're used to, but rather cased into the pencil on the opposite side of the graphite core so the user could cut away the wood to expose and use it. Four years later, entrepreneur Joseph Reckendorfer purchased the patent for $100,000 with the intent of making improvements on the design. It wasn't until the middle of the twentieth century that the idea of having an eraser on the end of the pencil caught on. Until then, the eraser-clad pencil was considered a luxury as it was significantly more expensive to produce than a pencil without one. On a worldwide scale, a separate eraser has always been preferable because the amount of eraser that can go on the end of the pencil is often not enough for an avid user. Despite this fact, the advent of the attached eraser was crucial to the popularity of the eraser as an essential pencil accessory in the nineteenth century.

Erasers have played many different roles since then. One of the most iconic is the typewriter eraser. Mostly common in the middle of the twentieth century, the typewriter eraser was made to be hard and especially gritty so as to remove typewriter ink. It existed in two forms, one as a flat, round disk with a nylon brush affixed to it and the other as a pencil with an eraser core instead of a graphite one and a nylon brush instead of an eraser on the end. The brushes played a key role as they were used to brush away eraser and paper dust to avoid jamming the typewriter. Though these types of eraser are completely defunct now, a large-scale version lives permanently in the National Gallery of Art Sculpture Garden in Washington, D.C., in the form of a rather famous sculpture by contemporary artists Claes Oldenburg and Coosje van Bruggen. Since the typewriter eraser, the tool has existed in the form of a cap that fits on the end of a pencil, a stick that goes into a retractable holder, a glob that is kneadable like clay, and many others. My favorite eraser memory involves an electric erasing machine that my mother kept on her drafting table in our dining room when I was a child. It plugged into the wall and was a handheld device with a stick of eraser in the inside that vibrated when turned on. Of course I used it more as a toy than a tool, but the purpose was to erase effectively, easily, and with little harm to the paper. Though I don't think wall-plug electric erasers exist anymore, battery powered ones are still popular for precision erasing.

In this day and age, the erasers found in offices and art supply stores are usually made from plasticized vinyl, which is even more effective and considerably less messy than rubber. Actual rubber erasers are few and far between, though Koh-i-Noor still makes many different types in the Czech Republic. Classics like the Pink Pearl are instead made with synthetic rubber, as are most school-quality erasers. Though the eraser has come a long way since 1770, it still plays a vital role in our use of the pencil and the freedom we get from using it. At the end of the day, it's all erasable.

→ *The color pink is synonymous with erasers because the pumice used, which comes from volcanic rock, gives it a pinkish hue. Eberhard Faber named their iconic eraser the Pink Pearl because of the natural coloring.*


H. L. LIPMAN.
Assignor, by mesne assignments, to J. RECKENDORFER,
Pencil.
No. 7,992. Reissued Dec. 11, 1877.
Fig. 1.
C
B
D
ERASER
GRAPHITE
Fig. 2.
A
D
Witnesses:
M Georger
R E Grant
Inventor:
Joseph Reckendorfer
assignee of Hymen L. Lipman
by M Muller Bailey
his attorney

An 1877 reissue of Hymen Lipman's patent for securing an eraser onto the end of a pencil. The idea was to have a huge impact on U.S. pencils in particular.