Marie-Anne Pierrette Paulze Lavoisier (chemist, translator, and illustrator)

(January 20,1758 -February 10, 1836)

I could not find any books written about Marie-Anne Paulze Lavoisier, the wife of the famous French chemist Antoine Lavoisier so I looked for books written about her husband. There you will find stories about how this amazing woman was her husband's collaborator, laboratory assistant, translator, and illustrator who drew most of the accompanying drawings in her husband's chemistry books. Thus, she is one of the most famous examples of a scientist who was not recognized for her work. She has been called the invisible assistant or the unsung hero of science. Her whole life was devoted to helping her husband in his laboratory and after her husband's death preserving his legacy and collecting all his laboratory notebooks and writing his memoir. She showed her love for Antoine Lavoisier by not changing her name to that of her second husband, Count von Rumfold. She preferred to be called Madam Lavoisier until her death. Roald Hoffmann, the 1981 Nobel Prize Winner in Chemistry, wrote that Madam Lavoisier not only deserved her own biography, but she also deserves an opera! I agree!

Her science journey began when Marie-Anne Pierrette Paulze was born in Montbrison, Loire, France on January 20, 1758. Her father, Jacques Paulze, worked primarily as a parliamentary lawyer and financier. Most of his income came from running the Ferme Générale, a tax farming group. The Ferme Générale

was a private consortium of financiers who paid the French monarchy for the privilege of collecting certain taxes and pocketing some of the money. These taxes included sales taxes on products such as salt and tobacco. Her mother, Claudine Thoynet Paulze, died in 1761 when Marie-Anne was only 3 years old. After her mother's death Marie-Anne was placed in a convent where she received formal education. She had two older brothers.

At the age of thirteen, a powerful relative wanted Marie-Anne to marry a middle-aged friend of his, 50-year-old Count d'Amerval. Her father was not keen on having his daughter marry someone who was almost 4 times older. He was in danger of losing his job at the Ferme Générale if his daughter did not agree to marrying Count d'Amerval. He found a solution in one of his colleagues at the Ferme Générale, Antoine Lavoisier. Lavoisier was 28 years old and very handsome. He was a lawyer and a chemist. He was a frequent visitor at the Paulze house, and he and Marie-Anne enjoyed playing board games. The only son of a lawyer and his wife who died when Antoine was only 5 years old, Antoine and his younger sister were raised by his maternal grandmother Madame Frere Punctis and his mother's sister Aunt Constance. Antoine and Marie-Anne agreed right away when Jacques Paulze suggested that they get married. Their wedding was held on December 16, 1771. It was a happy marriage and the start of a scientific collaboration that would last until Antoine's death on May 8, 1794.

MARRIAGE TO ANTOINE LAVOISIER

Antoine Lavoisier studied law to become a lawyer like his father, but his interest was in chemistry. He never practiced as a lawyer. He joined the Royal Academy of Sciences on May 18, 1768, after presenting a paper on the chemical and physical properties of gypsum (hydrated calcium sulfate) when he was just twenty-two years old. He also won a gold medal for the contest sponsored by the Royal Academy of Sciences, on the best

way to light the streets of Paris. In the same year, he joined the Ferme Générale to make good money and at the same time to help people as an honest tax collector. In 1767, while on a field trip with Jean Guettard collecting soil, mineral, and water samples, he saw the unhappy life of peasants living in the rural areas. He decided he will help these poor peasants by joining the Ferme Générale. This turned out to be a very good decision because he met his wife after joining the Ferme Générale.

After the wedding, Lavoisier continued working on chemistry with Marie-Anne as his assistant. When he first studied chemistry, most chemists thought that there were just four elements: earth, air, fire, and water. Everything else could be broken down into these substances. Antoine would work with all these "elements" and proved that that they were not elements at all. In all these experiments, Marie-Anne would be his able assistant, carefully taking notes and making sketches and carved engravings of the laboratory instruments used by Antoine and his colleagues. Marie-Anne began receiving artistic instruction from the painter Jacques-Louis David in late 1785 or early 1786. This training enabled her to not only document but also illustrate her husband's experiments. She even depicted herself as a participant in two drawings of her husband's experiments. Antoine's colleagues Jean Baptiste Michel Bucquet and Philippe Gingembre gave Marie formal training in the field of chemistry. She and Antoine spent most of their time together at the laboratory. They worked together as a team conducting research on many fronts. Marie-Anne was also a gracious host when scientists came to visit Antoine at their home. Some guests were very impressed on how she was able to serve tea and still converse about science with them.

Marie was fluent in French, English and Latin. She used this talent to translate scientific papers for her husband so he would know of scientific developments in Europe and beyond. In one of her famous translations, she translated Irish chemist Richard Kirwan's "*Essay on Phlogiston and the Constitution of Acids".* Marie-Anne not only translated but also critiqued the essay, adding footnotes as she went

along and pointing out errors in chemistry made throughout the paper. It was her translation that convinced Lavoisier that the phlogiston theory was incorrect. Chemists during the 1700s thought that fire could act like a chemical substance. A German chemist, George Stahl, called this substance phlogiston. No one had seen or measured phlogiston. But chemists believed that all things that burned contained phlogiston. Some substances were thought to be almost pure phlogiston because they burned easily and left nothing behind. Examples of these substances are oil and charcoal. Lavoisier suspected that oxygen not phlogiston was important in burning, calcining, and respiration. In 1783, Lavoisier attacked the phlogiston theory and called it an error fatal to chemistry.

Antoine Lavoisier wrote over fifty papers for the Academy of Sciences during his lifetime. But he did not work on science full time. He did experiments between six and eight o'clock in the morning and then he continued more in the night from seven to ten o'clock. Once a week he spends all day in the laboratory. So how was he able to write fifty papers for the Academy of Sciences? I suspect he had a lot of help from Marie-Anne. Perhaps he would start the experiment in the morning, and then his assistant Marie-Anne would take over and observe the experiment while he was gone. Antoine Lavoisier's main job was to work for the government. He worked for the Ferme Générale and traveled through France to see that taxes were collected fairly. Sometimes he was able to change tax rules that were not fair. As an example, he removed a tax that one province placed only on Jews. He wanted to make greater changes. He wanted the nobles to pay more and the poor people to pay less. However, the government and the Ferme Générale did not want to make these changes. They did accept one of his ideas, which was to build a wall around Paris to prevent people from sneaking goods into Paris without paying taxes. The government built the wall in 1783. Parisians hated the wall! They felt like prisoners in jail, and they suspected the wall was blocking fresh air and making them sick.

MOVING TO THE ARSENAL

In 1775, Lavoisier and three other men were tasked with making gunpowder for France. He and Marie-Anne moved to the Paris Arsenal where the city's gunpowder was stored. Antoine was given the post of Commissioner for the Royal Gunpowder and Saltpeter Administration. The couple were given a luxurious set of rooms there and they would live in them for seventeen years. In the attic at the arsenal, Antoine had set up a large and expensive laboratory where he and Marie-Anne received scientists from all over the world to witness their experiments. Each Saturday was devoted to science. Marie-Anne described Saturday as Antoine's "day of happiness".

Before 1775, gunpowder in France was made by a private company. It made very little gunpowder and did not do a good job of manufacturing it. France had to buy gunpowder from other countries and would sometimes lose battles because her soldiers did not have enough gunpowder. Lavoisier used his skills and knowledge of chemistry to change that.

Gunpowder was made from sulfur, charcoal, and niter (potassium nitrate). The niter came from saltpeter which formed on stones in damp places such as cellars and barns. Lavoisier heard that some countries made their own saltpeter. They filled ditches with manure, rotting plants, chalky soil or rocks, and a little water. The ditches were called niter beds. Lavoisier got France to start using niters beds. Because of these niter beds and other changes he made, France had all the gunpowder it needed within a few years. The quality of the gunpowder was of higher quality also! France even sold leftovers to the British colonies in North America. Lavoisier has commented that "North America owes its independence to the French gunpowder".

Lavoisier also helped French farmers. He bought a farm in 1778 to study farming methods. He knew that a successful farm needed both plants and animals. Manure from the animals made good fertilizer. The animals needed plants for food. He figured out a way so that the land was 5 times more productive as before.

Lavoisier also served on many committees in the Academy of Sciences. He could not have done all these activities and still worked on his experiments without the help of his wife Marie-Anne.

A REVOLUTION IN CHEMISTRY

In 1787, Lavoisier took on another challenge. He decided to create a new system of chemical names. Much of the language of chemistry came from ancient times. Chemists from long ago named some substances after gods. Some had strange and puzzling names like *flowers of zinc.* Lavoisier thought the old names were confusing and hard to remember. The name of the compound should give a chemist clues about how to make the compound and how it will react with others. This idea inspired his most famous book, *Elements of Chemistry.*

The *Elements of Chemistry* book followed a pattern designed to name plants and animals, invented by Carl Linneaus, a Swedish biologist. Lavoisier's system of chemical names works almost the same way. For example, one group of compounds is called acids. Acid is the family name, and the "species" comes from an element in the acid. Nitric acid for example contains nitrogen.

The book, though, contributes far more than the new naming system. It sums up all of Lavoisier's thoughts and discoveries about chemistry. He wanted students to use it to learn chemistry. One of the most important ideas in the book is that matter cannot be created or destroyed in chemical reactions.

The *Elements of Chemistry* book is divided into three parts. The first part describes Lavoisier's ideas about heat. The second part describes major chemical families, and the third part describes instruments used in chemistry and how they work.

Marie-Anne contributed 13 drawings to the *Elements of Chemistry* book. The drawings show all laboratory instrumentation and equipment used by the Lavoisiers in their experiments. Two drawings show her on the side taking notes. She kept records of the procedures followed, lending validity to the findings Lavoisier published.

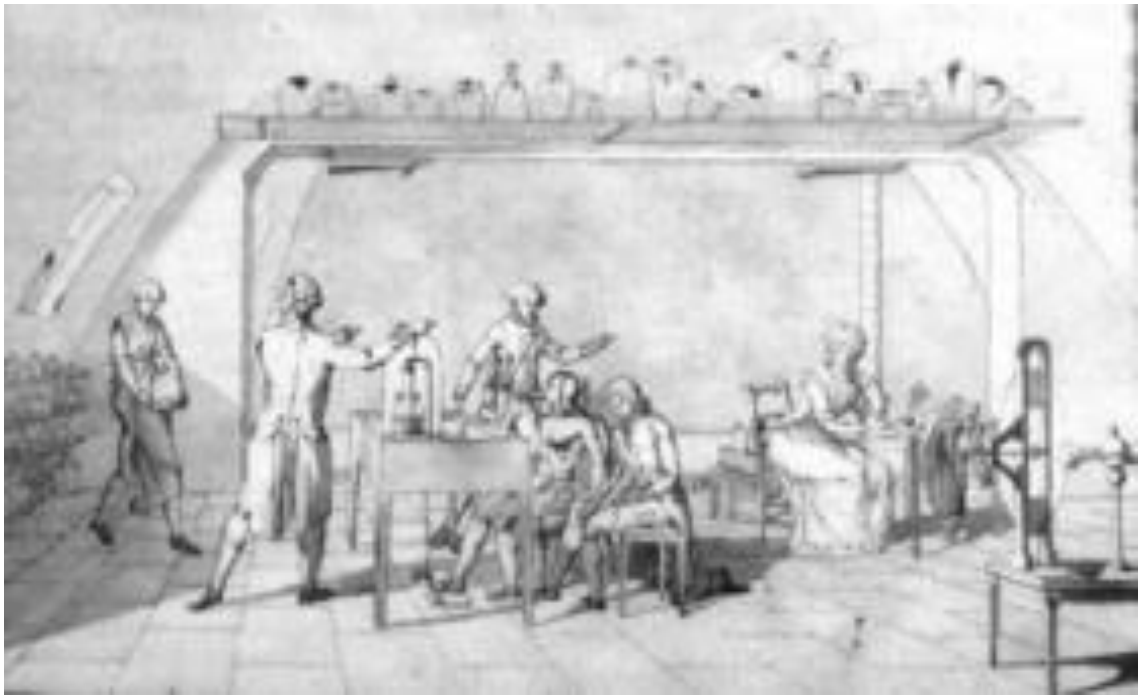
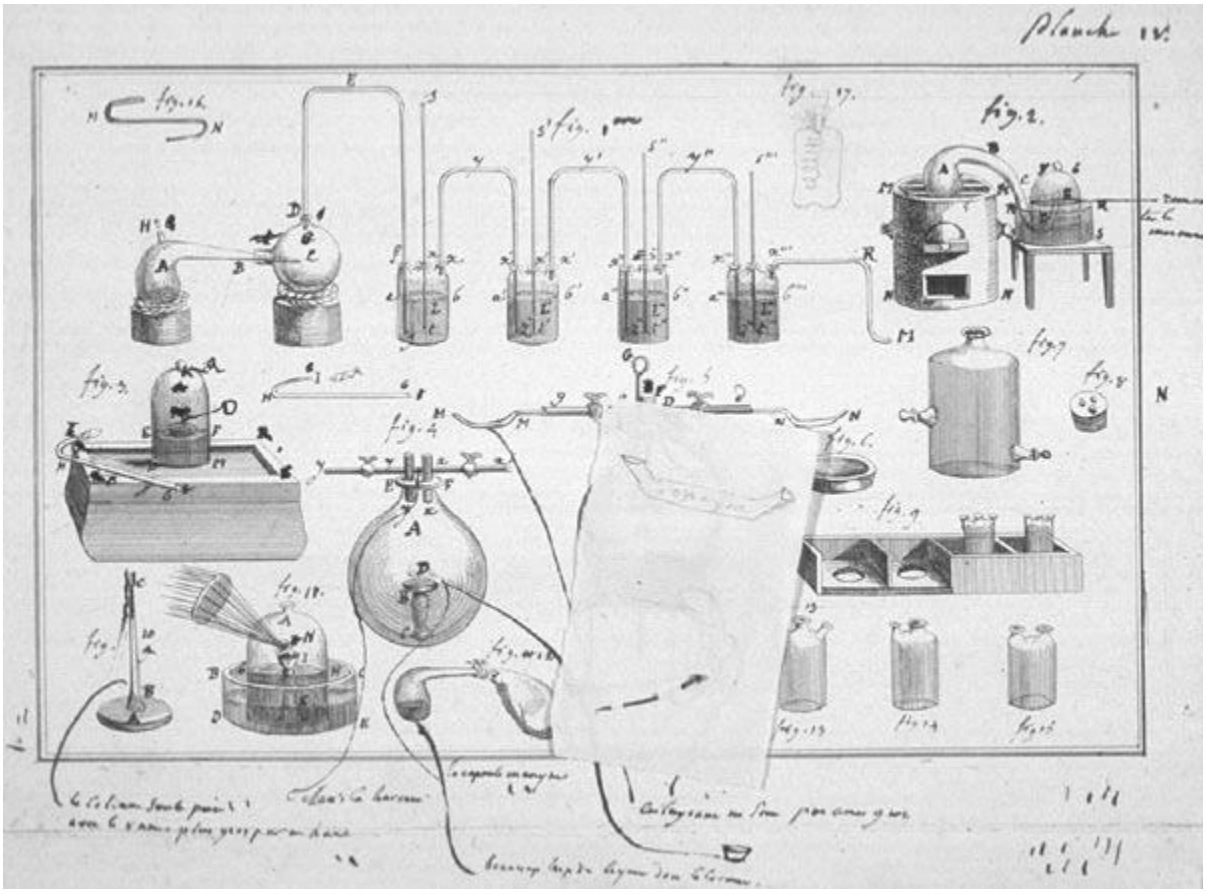


Figure 1 Marie-Anne taking notes

Figure 2 Marie-Anne taking notes

In one of her drawings, she even added a correction something like a modern Post-it ® note!



Two years after the publication of the *Elements of Chemistry* book, Lavoisier said that all the young chemists have accepted the new theory, and he felt that the revolution in chemistry was over.

ANOTHER KIND OF REVOLUTION

Meanwhile another kind of revolution was happening, a deadlier and more violent revolution. By 1788, France was financially broke and King Louis XVI was desperate! He called on the Estates-General to help him find new sources of wealth. The Estates-General had three parts. The First State was the French church. The Second Estate consisted of the nobles and the Third Estate was supposed to be everyone else. But most of the Third Estate came from the

middle class and no one really represented the poor. The Estates-General met on May 5, 1789, at the king's palace in Versailles. The king realized that most French people belonged to the Third Estate, so he let the Third Estate to have twice as many representatives as the other two. But then he decided each estate could only vote as a group. So, the first two estates could always outvote the Third Estate. The angry Third Estate members rebelled. On June 17, they changed their name to the National Assembly. They decided that they alone would make laws for France. When they heard that the king planned to send soldiers to the city, they formed a city government called a commune. They started to tear down the walls of Paris. Then on July 14, they took over the fortress called the Bastille. At the same time in the countryside, peasants attacked the castles of the nobles. Many nobles afraid for their lives left France. The French Revolution had begun! Some of the new leaders in France were not impressed with Lavoisier or his science. The National Assembly began to look at the Ferme Générale and accused it of keeping money that should have gone to the government.

In September 1792 France chose another lawmaking body called the National Convention. The convention made France a republic-where only representatives of the people would rule. Convention leaders wanted to wipe out all traces of the old ways. King Louis XVI was executed with the guillotine on January 23, 1793. The queen followed on October 16. Then Antoine Lavoisier and his father-in-law Jacques Paulze were arrested together with thirty-one other members of the Ferme Générale. Lavoisier and Jacques Paulze shared a large cell with a fireplace in prison. Lavoisier made plans to write an eight-volume book on chemistry. The book would also be a memoir and talk about his life. During his time in prison, he managed to write two volumes. Marie-Anne came to visit him in prison. She did her best to get her husband and father freed. She appealed to everyone she could reach. Alas it was of no use! Her father and husband were executed by guillotine on May 8, 1794.

LIFE AFTER ANTOINE LAVOISIER'S DEATH

Marie-Anne was left with nothing! The government seized her house, money, and goods. She was sent to prison for two months although there were no charges against her. When she was released, an old servant gave her a place to live.

The French people got sick of this reign of terror. So Maximilien Robespierre was overthrown in July 1794. He was also executed by guillotine.

In December 1794, Marie-Anne led the families of the tax farmers (former members of the Ferme Générale) to ask for some of their possessions returned. By the summer of 1795 she got back most of the family's money and Lavoisier's expensive laboratory instruments. A review of the Ferme Générale accounts showed that it was the government who owed the tax farm money and not the other way around. People called Marie-Anne "the widow of the unjustly condemned Lavoisier". It took a while to heal her broken heart but in 1805 she began to entertain scientists in her home again. The revolution was over, and France was run by a new leader named Napoleon.

One of the scientists who visited Marie-Anne was an American scientist and widower Benjamin Thompson who was famous for his work on heat. He also has a noble title, Count Rumford. Thompson was born in Woburn, Massachusetts in 1753 and was a veteran of the American Revolutionary War. Before becoming a merchant and a soldier, he had attended lectures by John Winthrop, a prominent mathematician, physicist, and astronomer at Harvard. In 1772 Thompson married a rich and well-connected widow, an heiress named Sarah Rolfe. Sarah's father was a minister, and her late husband left her property at Rumford, New Hampshire (now called Concord, New Hampshire). In 1785, he travelled to Bavaria to become *aide-de-camp* to the prince-elector, Charles Theodore. Prince-electors were members of the Electoral College of the Holy Roman Empire which elected the Holy Roman Emperor. In Bavaria, he reorganized the army and established workhouses for the poor. In 1789 he also created the *Englisher Garten*, a large public park in the center of Munich, Bavaria while continuing to work on his scientific experiments. In 1791, he was elevated to the Count of the Holy Roman Empire, taking the title of Reichsgraf von Rumford after the town of Rumford, New Hamsphire where he married his first wife. His experiments on gunnery and explosives led to an interest in heat. He devised a method for measuring the specific heat of a solid substance. Then he investigated

the insulation properties of various materials including fur, wool, and feathers. His most important scientific work took place in Munich, and focused on the nature of heat, which he said was not caloric but a form of motion. In 1798, he wrote "*An Inquiry Concerning the Source of the Heat Which is Excited by Friction"*.

Rumford was an active and prolific inventor, developing improvements for chimneys, fireplaces, and industrial furnaces, as well as inventing the double boiler, a kitchen range, and a coffee percolator. He invented a percolating coffee pot following his pioneering work with the Bavarian Army, where he improved the diet of the soldiers as well as their clothes.

He also worked in photometry, the measurement of light. He made a photometer and introduced the standard candle, the predecessor of the candela, as a unit of luminous intensity. His standard candle was made from sperm whale oil.

He was elected a Foreign Honorary Member of the American Academy of Arts and Sciences in 1789. With Sir Joseph Banks, he established the Royal Institution of Great Britain in 1799. His assistant, Michael Faraday, established the institution as a premier research laboratory. Thompson endowed the Rumford Medals of the Royal Society and the American Academy of Arts and sciences. He also endowed the Rumford Chair of Physics at Harvard University. In 1803, he was elected a foreign member of the Royal Swedish Academy of Sciences and as a member of the American Philosophical Society.

Rumford had several affairs with women but decided to marry the widow of the French chemist Antoine Lavoisier. One can only guess that Marie-Anne's intellect and beauty were very attractive to this scientist. He was probably hoping to make her a laboratory assistant just like she was with her first husband. Marie-Anne had many suitors also. The statesman Pierre-Samuel duPont de Nemours, a friend of Thomas Jefferson and namesake of the Dupont Company, courted her until she rejected him. She was obviously looking for a husband who was as smart as Antoine Lavoisier. And she found one in Benjamin Thompson! They got married on October 22, 1805. But this marriage was not a happy one. She insisted that she retain her first husband's last name demonstrating her undying devotion to Antoine Lavoisier. They divorced in 1809. Marie-Anne lived in Paris for many more years. She died on February 10, 1836.

HER LEGACY

Marie-Anne Lavoisier was Antoine Lavoisier's partner in the laboratory. She helped him with the experiments, took notes, and illustrated the equipment and instruments they used in the experiment. She was an integral part of the experiments and findings attributed to Antoine Lavoisier. Her knowledge of French, English, and Latin helped her translate scientific papers for her husband. She translated documents to French so her husband would know the latest scientific discoveries in Europe and beyond. Her translation of Richard Kirwan's "*Essay on Phlogiston and the Constitution of Acids"* is what finally convinced Lavoisier that phlogiston is not correct. Marie-Anne not only translated the essay but also critiqued the essay, adding footnotes as she went along and pointing out errors in the chemistry made throughout the paper.

Antoine Lavoisier built his reputation on identifying oxygen, but Marie-Anne was the English translator who negotiated with Joseph Priestley- Priestley had already discovered the same gas but had given it a different name.

Marie-Anne organized the publication of Lavoisier's final memoirs, *Mémoires de Chimie*, a compilation of his papers and those of his colleagues demonstrating the principles of the new chemistry. The first volume contained work on heat and the formation of liquids, while the second dealt with the ideas of combustion, air, calcination of metals, the action of acids, and the composition of water. Her efforts secured her husband's legacy in the field of chemistry.

Before her death, Marie-Anne was able to recover nearly all of Lavoisier's notebooks and chemical apparatuses, most of which survive in a collection at Cornell University.

There are three videos about Marie-Anne Lavoisier, one calling her the first female chemist and the other calling her unsung hero of science. Both are accurate descriptions, but I like the website where she is called the mother of modern chemistry: https://link.springer.com/article/10.1007/s00897980249a

A video calling Marie-Anne Lavoisier as the first female chemist:

https://www.youtube.com/watch?v=-uFZhbM4NnM

Video calling her the unsung hero of science:

https://www.youtube.com/watch?v=8jSaZzNvw-k

From alchemy to chemistry:

https://www.youtube.com/watch?v=9_-H7jxU77s

HER SCIENCE JOURNEY

1758 - Marie-Anne Pierrette Paulze was born in Montbrison, Loire, France

1771- Marie married Antoine Lavoisier and started working as his Laboratory assistant

1775 - Moved to Paris Arsenal

1783 - Translated Richard Kirwan's "*Essay on Phlogiston and the Constitution of Acids"* from English to French

1785 - Received artistic instruction from the painter Jacques-Louis David

1786 - Received formal chemistry instruction from Jean Baptiste Michel Bucquet and Philippe Gingembre

1787 - Illustrated 13 drawings for the *Elements of Chemistry* book

1789 - *Elements of Chemistry* book published

French Revolution began

1794 -Antoine Lavoisier was arrested, imprisoned, and executed by guillotine

Marie-Anne led families of the Ferme Générale to ask the authorities to return their possessions

1795 - Marie-Anne received most of her money and possessions back

1805 - Married Benjamin Thompson, Count Rumford, an American scientist

1809 - Divorced Count Rumford

1814 - Count Rumford died in Paris

1836 - Died at the age of 78 in Paris

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