Light Bulb

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A HISTORY OF INTELLECTUAL PROPERTY IN 50 OBJECTS

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MANKIND HAS BEEN using artificial light for millennia. Starting with campfires and torches in ancient times, lighting improved slowly but incrementally with the introduction of candles, oil lamps, kerosene lamps, and gas lighting.

Artificial lighting was lifted to another dimension by the invention of the electric light bulb, which effectively extended day into night at the switch of a button. However, electric light not merely prolonged the usable hours in a day: by illuminating homes, schools, factories, offices, shop windows, theaters, street corners and parks, it also improved conditions for learning and reading, furthered economic and commercial progress, created opportunities for leisure and night life, and brought about a sense of safety. It transformed the world.

Of course, electric light required a network of wires and power generators to bring electricity to the people, and this spurred the development of the electric power industry. As Thomas Edison explained in the *New York Sun* of 16 September 1878: "The same wire that brings the light will also bring power and heat." The widespread use of electric light facilitated the invention of various electric home appliances and industrial equipment. Without electric lighting, everyday life would look completely different and contemporary concepts like the "24-hour economy," or even the "city that never sleeps," could not exist. And the story of the electric light bulb is one that relies on patent law, (outrageous) exercise of monopoly control, and a hefty serving of marketing brilliance.

Like many other famous inventions, the light bulb was not the result of a spark of genius of a sole inventor. While Thomas Edison or Joseph Swan are often credited as "the" inventors of the light bulb, the truth is that the concept of incandescent light existed long before they entered the scene. In 1802, Humphry Davy and Vasily Petrov simultaneously invented the arc lamp, by lighting an electric arc between carbon electrodes. Because arc lamps were too bright for indoor use and suitable only for large spaces, other 19th-century scientists experimented with a range of electrically heated wires or rods inside semi-vacuum glass tubes, trying out various combinations of iridium, platinum, carbon, and other materials. However, none of these early experimental bulbs were commercially attractive—they were too costly to produce, or they burnt out too quickly. This was where Edison, Swan, and their teams of inventors stepped in.

In 1878, Swan was the first to create a light bulb consisting of an enclosed vacuum glass tube, platinum wiring, and a filament of carbonized cotton. It gave off light but was short-lived. Having a low-resistance filament, it moreover required larger conductors to supply the necessary electric current, making it ill-suited for commercial application. Meanwhile, in the United States, Edison had developed an incandescent lamp based on similar principles to Swan's, but which used a high-resistance carbon filament. This increased the durability of the lamp, as it required a lower current for the filament to glow. On 22 October 1879, Edison successfully demonstrated a lamp that burned 13.5 hours at his home laboratory in Menlo Park, NJ, and, in 1880, he created a light

bulb with an improved filament of carbonized bamboo that lasted over 1,200 hours.

Swan did not seek patent protection for the light bulb he created, as he assumed that its technical details were public knowledge and lacked patentable innovations. However, Edison sought and eventually obtained patents in the United States, Britain, and elsewhere on his invention of the 1879 carbon-filament lamp and its subsequent improvements. In his zeal for patenting, he was not alone: already by 1878, Sawyer and Man had obtained patents on a filament improvement process called "flashing," and in the 1880s Swan obtained a series of patents for a method to avoid bulb-blackening, a process to produce "parchmentized" cotton filaments, and a process to create high-resistance cellulose filaments. Not only were many inventors working on incandescent lighting at the same time, but they also all realized the significance of the patent system to secure and maintain their position in the newly emerging lamp market.

Patent holders enjoy strong commercial advantages, of course, since their patents can be used to prevent competitors from entering new markets. Unsurprisingly, the early days of the incandescent lamp industry witnessed fierce patent wars. The most contested patent was undoubtedly Edison's basic patent on the 1879 light bulb: it was central because of its broad scope, and so its validity was widely questioned by competitors who maintained that Edison's invention was not genuinely new, and was, instead, based on existing knowledge and prior art.

The battles over this and other patents played out differently in different territories. In Britain, for example, a near-monopoly on electric lamps was established after Edison and Swan joined forces in the Ediswan Company in 1883. This merger was mutually beneficial, as Edison's broadly formulated patent on the 1879 light bulb made Swan's business vulnerable, while Edison was uncertain about his patent being upheld in court if Swan could establish priority of invention. Ediswan's rich patent portfolio—which also included Sawyer and Man's flashing patent and lamp patents purchased from others—formed the basis for systematic litigation against competitors. After winning a series of patent infringement cases against rival manufacturers in the mid-1880s, Ediswan's near-monopoly in the British incandescent lamp industry was firmly secured. Oddly, Swan was asked to testify as an expert witness in those cases as to the validity of Edison's basic patent. His business interests forced him to agree that Edison was the rightful owner of the patent, and so Swan downplayed his own contribution to the invention of the light bulb. This act of willful self-erasure doubtlessly contributed to the myth that Edison was the sole inventor of the light bulb.

Outside Britain, the lamp industries in other territories were more competitive. This was particularly so in continental Europe, where unfettered competition reigned, especially from foreign lamp producers whose economic sustainability greatly depended on export markets. Despite the existence of patents—including Edison's basic patent held by local subsidiaries such as AEG in Germany and the Compagnie Générale des Lampes Incandescentes in France—competition in Europe could roam freely, as French and German courts rendered the validity of some key lamp patents uncertain, while light bulbs could be manufactured without restrictions in the Netherlands and Switzerland, which had no patent protection at the time. This also explains the establishment in the Netherlands of the Philips company in 1891, which later grew out to be one of the largest lamp producers in Europe, next to AEG and Siemens-Halske.

Likewise, while the early US lamp industry faced little foreign competition due to high import taxes, domestic competition was intense. In the United States in the 1880s numerous lamp manufacturers existed, and despite litigation over various lamp patents, few of them took out licenses: they either ignored the patents, or designed around them. Ultimately, in the early 1890s US courts upheld the validity of Edison's basic patent; but by then it was too late to confer monopoly powers on the Edison General Electric Company. Still, General Electric led the US lamp industry with a 50 percent market share

throughout the 1890s—partly caused by the success of Edison's bamboo filament lamp, but also because fierce competition had, by then, driven many competing lamp manufacturers out of business.

Consistent with the economic literature on monopolies, the dominant market position of a few large companies caused drawbacks for consumers. During the period of Ediswan's near-monopoly in Britain, innovations in filament development halted, and lamps cost almost three times the price charged in Europe. Only after Edison's basic patent expired in 1893 was the British market flooded with foreign lamps, often of a better quality and costing less than Ediswan's lamps. But the monopoly was not all bad: the public benefited from the monopoly rents extracted from the sale of lamps, as part of these profits were reinvested in the development of the electricity network. This brought advantages to all, rich and poor. Edison's famous quote in the *New York Herald* of 4 January 1880 captures some of this: "After the electric light goes into general use, none but the extravagant will burn tallow candles."

However, monopoly powers derived from lamp patents impeded the public interest more seriously in the first half of the 20th century, when carbon-filament lamps were replaced by metal-filament lamps which significantly improved the lifetime and intensity of light bulbs. The basic patents on these new lamps were owned by a few large companies, which repeatedly strengthened their patent portfolios by amassing improvement patents through corporate invention, mergers and takeovers, and the purchase of patent portfolios. The incumbents controlled domestic competition, and had the power to speed up or delay introduction of new innovations, depending on their commercial interests.

In the United States, the market was controlled largely by General Electric, which owned most metal-filament patents. General Electric was able to fix prices and set strict production quotas for licensees. Although in 1911 a federal antitrust case was successfully brought against General Electric, it did not seriously affect the company's patent domination and its market-restricting licensing practices in the US market.

In other territories, lamp producers established market control through collaboration, by establishing national cartels—such as the British Carbon Lamp Association—or by using patent pools to jointly regulate competition, quality, and prices in the metal-filament lamp industry. Examples of these pools include the UK Tungsten Lamp Association founded in 1912; and the German *Patentgemeinschaft* established in 1911 by AEG, Siemens-Halske and the Deutsche Gasglühlicht AG, which sought to control competition on the European mainland. After World War I, as the balance of power in the European lamp industry changed, the three German firms merged into the Osram company to secure their position.

Around this time, the world's leading lamp producers also began to organize themselves internationally. While in continental Europe, regional markets were allocated and prices and production quotas were fixed through international lamp cartels such as the Internationale Glühlampen Preisvereinigung, transatlantic trade was controlled by cross-licensing contracts between General Electric and leading European lamp producers, which agreed to exchange technological advances but not to invade each other's markets. In 1924, lamp producers in continental Europe, the United Kingdom, and Japan set up the Phoebus cartel, which regulated prices, quality, and sales quotas; facilitated the exchange of patents and knowhow; and introduced technological standardization in the lamp industry. Meanwhile, General Electric continued its patent licensing and exclusive sales territory agreements with lamp producers around the world, while securing its interests in the Phoebus cartel through foreign subsidiaries.

The outbreak of World War II rendered the cartel ineffective. Moreover, postwar antitrust actions filed against lamp producers, mostly in the United States, soon banned the industry practices of international cartelization, exclusive patent licensing, price fixing, and market division. Cooperation and knowledge exchange between lamp producers continued, but this was now based on the principle of

formal nonexclusivity. However, while competition increased, large pre-war companies like Osram, Philips, and General Electric continued to dominate the postwar global lighting market.

Today, in many countries worldwide, incandescent light bulbs are gradually being phased-out in favor of more energy-efficient lighting like halogen, CFL, and LED lamps. Yet, the history of the light bulb remains and holds important lessons for current and future generations. From questions of inventorship and patent grants for incremental innovations built on existing ideas, to patent wars that established early market positions, collaborative strategies of pooling patents to eliminate competition, and exclusive sales territory and cartel agreements to divide markets, the chain of events in the history of the light bulb is characteristic of how industries emerging around new paradigm technologies behave. Utilizing the commercial power of intellectual property was central to the history of the light bulb, and studying this history helps us to better understand how these cycles might repeat themselves in the future. ◆

Further Reading

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