Lighting shop windows using gas light (around 1870).

1.1.4.1 Gas lighting

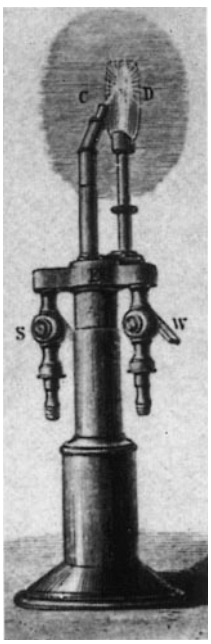
The first competitor to the Argand lamp was gas lighting. People had known of the existence of combustible gases since the 17th century, but gaseous substances were first systematically understood and produced within the framework of modern chemistry. A process for recovering lighting gas from mineral coal was developed in parallel to the Argand lamp experimentation.

Towards the end of the 18th century the efficiency of gas lighting was demonstrated in a series of pilot projects – a lecture hall in Löwen lit by Jan Pieter Minckellaers; a factory, a private home and even an automobile lit by the English engineer William Murdoch. This new light source achieved as yet unknown illuminance levels. It was, however, not yet possible to introduce this new form of lighting on a large scale due to the costs involved in the manufacture of the lighting gas and in removing the admittedly foul-smelling residues. A number of small devices were developed, so-called thermo-lamps, which made it possible to produce gas for lighting and heating in individual households. These devices did not prove to be as successful as hoped. Gas lighting only became an economic proposition with the coupling of coke recovery and gas production, then entire sections of towns could benefit from central gas supply. Street lighting was the first area to be connected to a central gas supply, followed gradually by public buildings and finally private households.

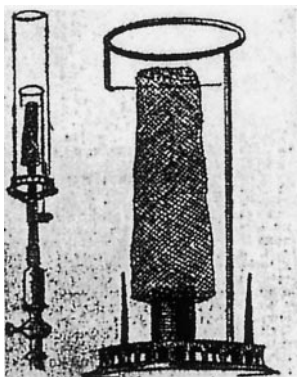
Carl Auer v. Welsbach.

As is the case with all other light sources a series of technical developments made gas lighting increasingly more efficient. Similar to the oil lamp a variety of different burners were developed whose increased flame sizes provided increased luminous intensity. The Argand principle involving the ring-shaped flame with its oxygen supply from both sides could also be applied in the case of gas lighting and in turn led to unsurpassed luminous efficacy.

The attempt to produce a surplus of oxygen in the gas mixture by continuing to develop the Argand burner produced a surprising result. As all the carbon contained in the gas was burned off to produce gaseous carbon dioxide, the glowing particles of carbon that incorporated the light produced by the flame were no longer evident; this gave rise to the extraordinarily hot, but barely glowing flame of the Bunsen burner. There was therefore a limit to the luminous intensity of self-luminous flames; for further increases in efficiency researchers had to fall back on other principles to produce light .



Drummond's limelight.

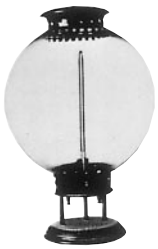


The incandescent mantle as invented by Auer v. Welsbach.

One possibility for producing highly efficient gas lighting was developed through the phenomenon of thermo-luminescence, the excitation of luminescent material by

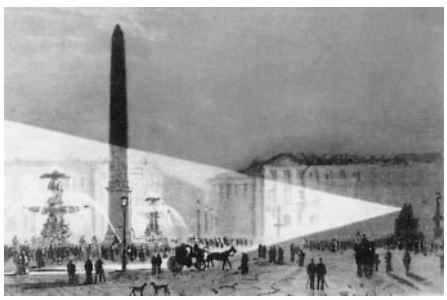
heating. In contrast to thermal radiation, luminous efficacy and colour appearance in this process were not solely dependent on the temperature, but also on the kind of material; more and whiter light was produced using temperature radiation methods.

The first light source to work according to this principle was Drummond's limelight, which was developed in 1826. This involved a piece of limestone being excited to a state of thermo-luminescence with the aid of an oxy-hydrogen burner. Limelight is admittedly very effective, but requires considerable manual control with the result that it was used almost exclusively for effect lighting in the theatre. It was only in 1890 that Austrian chemist Carl Auer von Welsbach came up with a far more practical method for utilising thermo-luminiscence. Auer von Welsbach steeped a cylinder made of cotton fabric in a solution containing rare earths – substances that, similar to limestone, emit a strong white light when heated. These incandescent mantles were applied to Bunsen burners. On first ignition the cotton fabric burned, leaving behind nothing but the rare earths – the incandescent mantle in effect. Through the combination of the extremely hot flame of the Bunsen burner and incandescent mantles comprising rare earths, the optimum was achieved in the field of gas lighting. Just as the Argand lamp continues to exist today in the form of the paraffin lamp, the incandescent or Welsbach mantle is still used for gas lighting, e.g. in camping lamps.



Jablotschkow's version of the arc lamp, exposed and with glass bulb.

Hugo Bremer's arc lamp. A simple spring mechanism automatically controls the distance between the four carbon electrodes set in the shape of a V.



Arc lighting at the Place de la Concorde.

1.1.4.2 Electrical light sources

Incandescent gas light was doomed to go the way of most lighting discoveries that were fated to be overtaken by new light sources just as they are nearing perfection. This also applies to the candle, which only received an optimised wick in 1824 to prevent it from smoking too much. Similarly, the Argand lamp was pipped at the post by the development of gas lighting, and for lighting using incandescent mantles, which in turn had to compete with the newly developed forms of electric light.

In contrast to the oil lamp and gas lighting, which both started life as weak light sources and were developed to become ever more efficient, the electric lamp embarked on its career in its brightest form. From the beginning of the 19th century it was a known fact that by creating voltage between two carbon electrodes an extremely bright arc could be produced. Similar to Drummond's limelight, continuous manual adjustment was required, making it difficult for this new light source to gain acceptance, added to the fact that arc lamps first had to be operated on batteries, which was a costly business.