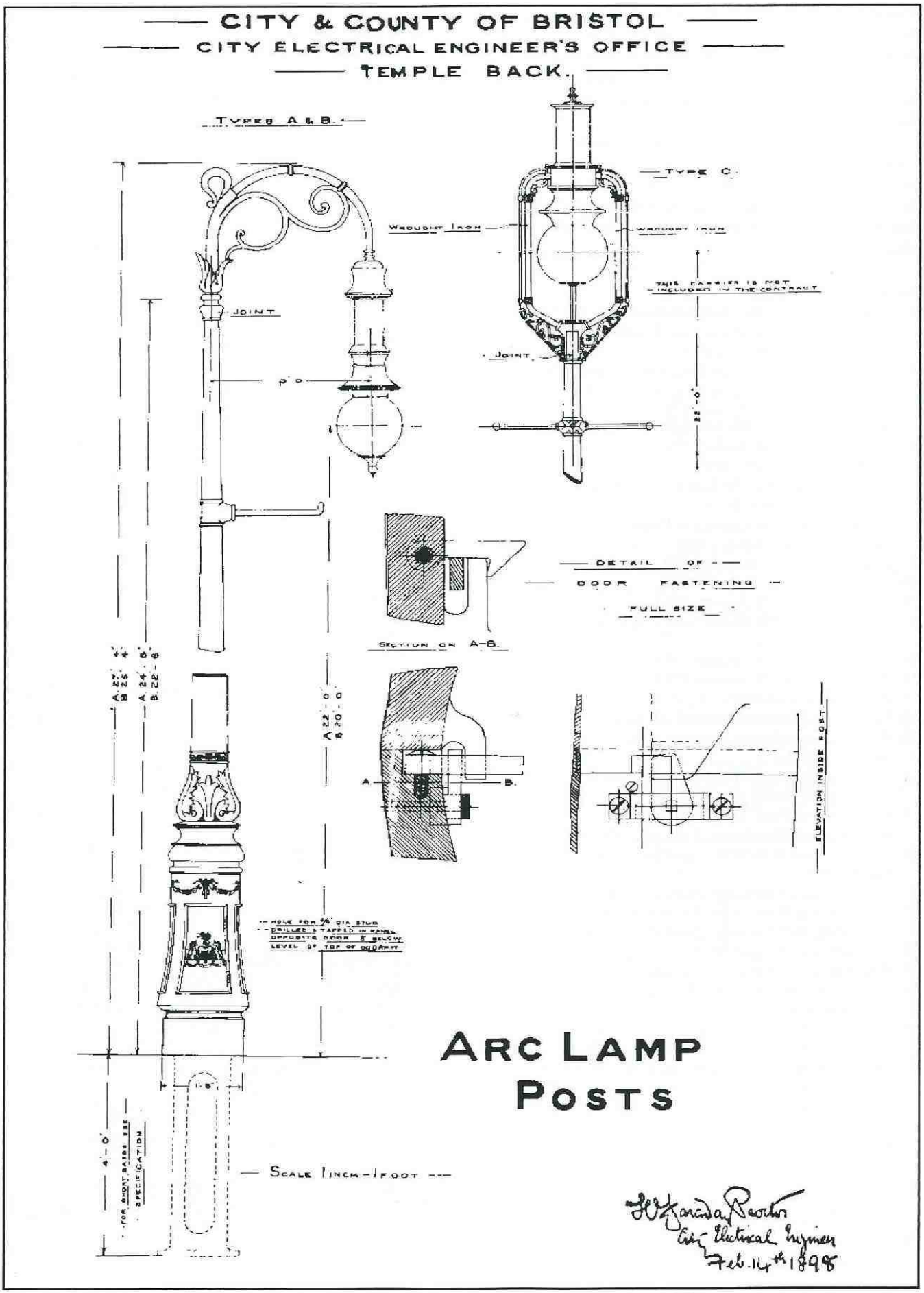


Drawing of arc lamp post, personally signed by Harold Faraday Proctor, 14 February 1898.

Electric Arc Lamps in Bristol

Peter Lamb

Old photographs of late-Victorian or early-Edwardian Bristol frequently have decorative street lights gracing the foregrounds. These lamp standards had long cylindrical shapes above the lamp, which distinguished them as being electric arc lamps. Inside were cylinders, known colloquially at the tum of the century as '*chimneys*', which housed the complex mechanisms regulating the carbon electrodes. Only two lamp standards of this distinctive design remain as street furniture on the Bristol streets, both at the Mall in Clifton village.

Public lighting in Bristol prior to 1893 was by gas using a simple gas jet, which only provided a light of 15 candle-power. The gas mantle, at eight times brighter, had been invented prior to this time, but a commercially viable design did not become available until 1895.

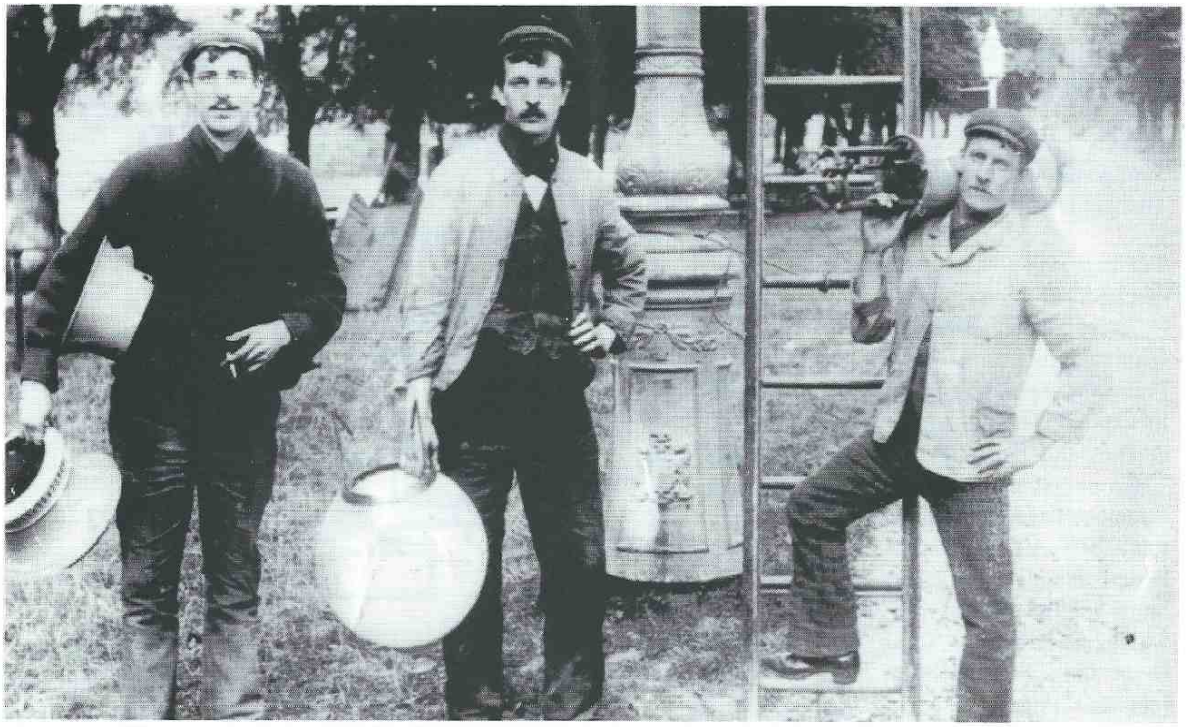
A public electricity supply commenced in August 1893 when Bristol's first generating station was commissioned at Temple Back. At that time, generation was solely for domestic and public lighting and there were two systems installed, alternating current(AC) and direct current(DC). The AC supplies were used primarily for the domestic supplies, distributing at high voltage and transforming down to 105/210volts at small substations. For lighting in domestic dwellings, incandescent filament lamps, with carbon coils as filaments, were used. Arc lamps were not used in the home, since they were too fierce and too smelly. The incandescent lamp, which had first appeared in the mid 1880s, had a luminosity of 15-100 candle-power being brighter than the gas jet. The great advantage of the arc lamp at 1500-2000cp was its extreme brightness at 100 times greater than the gas jet and also greater than the incandescent filament lamp. Therefore it may be appreciated why it was more suitable for street lighting.

The DC supply generated at Temple Back was at 600volts for public lighting using 96 arc lamps, initially connecting 12 per circuit in series, thus giving a voltage per lamp of 50volts. Over a decade later the voltage was changed to 500volts with 10 lamps per circuit.

The development of the arc lamp to 1893

Sir Humphrey Davey is credited with inventing the first arc lamp, when he demonstrated his invention at the Royal Institution in 1810. It was powered by batteries and used charcoal elements enclosed in a vacuum. The vacuum allowed a longer arc and a much higher voltage to be used. It was some years later (1844) that the principle was further developed by the Frenchman, J.B.L. Foucault. He used carbons from the retorts of a gasworks, which were more durable. Thomas Wright devised the first arc lamp, which involved adjustment of the carbons automatically as they burnt away and W.C.Staite used an electric current for the regulation of the carbons. Foucault responded in 1858 by producing his regulating lamp.

In 1876 Paul Jablochkoff, a Russian living in Paris, produced what was considered at the time to be a big breakthrough, selling 4,000 within a few years. His device was known as the '*electric candle*', since it involved two parallel carbon rods in an upright position separated from



Photograph of street lighting 'trimmers' changing carbons on the Downs c1910.
(South Western Electricity Historical Society Archive)

each other by a layer of Plaster of Paris. As the carbons were consumed, the positive rod was eaten away at twice the speed of the negative rod, so alternating current was preferred to equalise the erosion. In other later arc lamps the positive carbon rod was made twice the size of the negative rod.

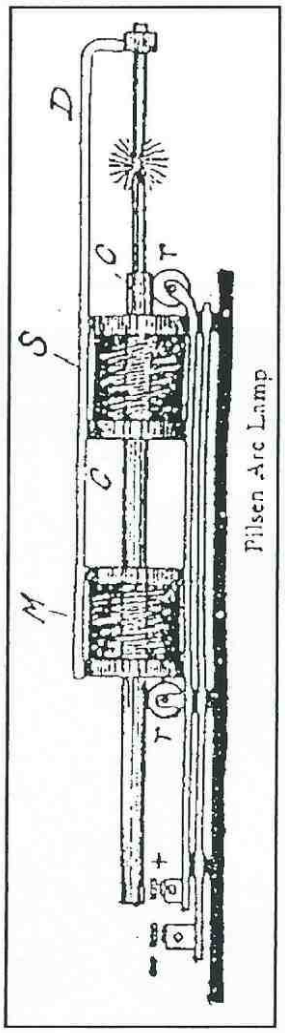
Jablochkofi's invention was soon overtaken by lamps with more sophisticated regulating devices and there were many to choose from by 1893. Arc lamps were devised to work on both DC and AC, but a brighter light was achieved on a DC system. Also some lamps were open and some were enclosed. There were advantages and disadvantages with enclosing the arc in a vacuum or inert gas. The carbon rods did not burn away so quickly when enclosed, but soiled the glass enclosure, thus requiring regular albeit different maintenance. This was partially overcome by using carbons with a purer content i.e. less metal oxides included. Not only was there a wide choice of manufacturers, but also a wide choice of regulating devices, which can be condensed into the following five varieties:-

i) Clockwork mechanism
ii) Basic electrical, involving two solenoids
iii) Two solenoids with a clutch
iv) Two solenoids with a brake wheel
v) Electric motor operated

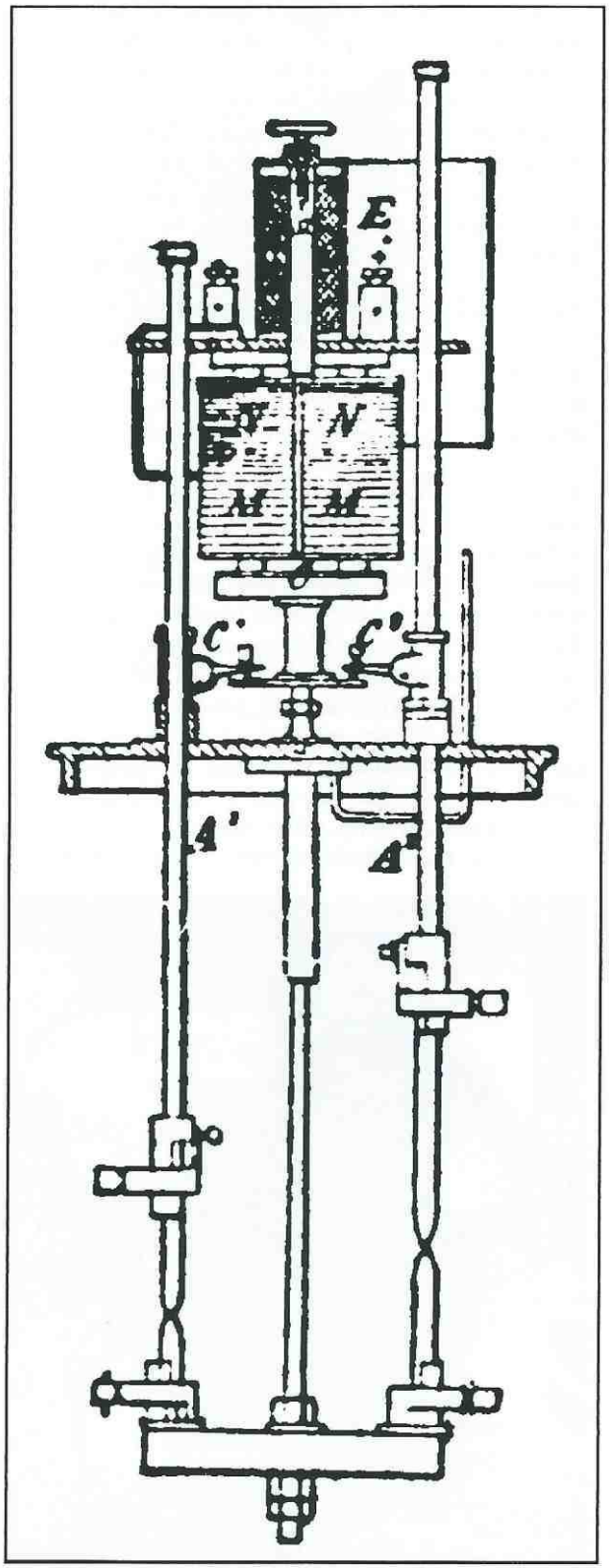
Arc lighting in Bristol

Bristol Corporation Electricity Department chose the Brockie-Pell open type lamp with two pairs of carbons from advice given to them by their consultant, William Preece (later Sir William), Chief Electrical Engineer to the Post Office, and their newly appointed (in l892) Electrical Engineer, Harold Faraday Proctor, a relative through his mother's side of Michael Faraday.

The Brockie-Pell lamps are described in some technical literature as being of the type with two solenoids and a brake wheel. Professor Silvanus P. Thompson describes the Brockie-Pell Lamp as having a see-saw leverage system. First of all, it is necessary to explain the basic principle of most arc lamp regulating devices, which involved two solenoids, since the majority of regulated lamps consisted of these basic parts. The basic principle of this lamp was for the main coil M acting on a bi-conical core C to pull one carbon apart from the fixed one, thus striking the arc. When a current is drawn through the shunt coil S, it pulls the carbon rod in the opposite direction, until a balance is achieved. As the carbons burn away they are automatically moved closer together maintaining a specific gap.



Pilsen two solenoid arc lamp. (Kennedy, R., *Electrical Installations*, 1915)



Patent No.4504 by J. Brockie, London. *Electric Arc Lamps*, 15 October 1881.
(South Western Electricity Historical Society Archive)

The type of Brockie-Pell arc lamp used in Bristol is not clear. A patent design was filed in October 1881 by J. Brockie using two pairs of carbons and this is shown in the diagram which shows the complex mechanisms involved. It is not intended to describe in extreme detail the workings of this arc lamp, suffice it to say that they were designed to achieve two objects:

i) To feed the carbons very gradually as they are eaten away, maintaining a constant gap and voltage across the arc.
ii) To change over the one pair of carbons, when one pair had been eaten away.

By 1911 there were 695 arc lamps connected to the Temple Back DC system involving five different types of arc lamp and three different manufacturers. All the arc lamps had two pairs of carbons with added mechanisms as above, which changed over the carbons to a second pair of carbons. One pair of carbons only lasted 6-8 hours and one pair would barely last one night before requiring the replacement of the carbon '*pencils*' as they were known locally. The men who changed the carbons were known as '*trimmers*', a relic from the days of trimming oil lamp wicks passed on to the gas men trimming gas mantles and thence to electricity workers!

The lamps on the system in 1911 were:

185 Brockie-Pell	10 ampere open type with 2 pairs of carbons
364 Oliver	5 ampere open type with 2 pairs of carbons
116 Oliver Oriflamme	10 ampere enclosed
16 Oliver Oriflamme	7 ampere enclosed
14 Excello Flame by Union Co.	open type

The flame arc lamps achieved a greater brightness by the introduction of other chemicals such as salts of calcium, barium and strontium into the carbon rods. Some of the flame type arc lamps, involved even more complex mechanisms, such that they had a magazine containing six pairs of carbons and thus extended their lighting time from 12 hours to 36 hours.

Although exploring these lamps in books can be a fascinating activity, it would be even more fascinating to explore one in '*the flesh*'. The author would be pleased to know of any existing arc lights, other than those in the London Science Museum.

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Assistance is acknowledged also of David Gledhill of SIAS, Taunton.