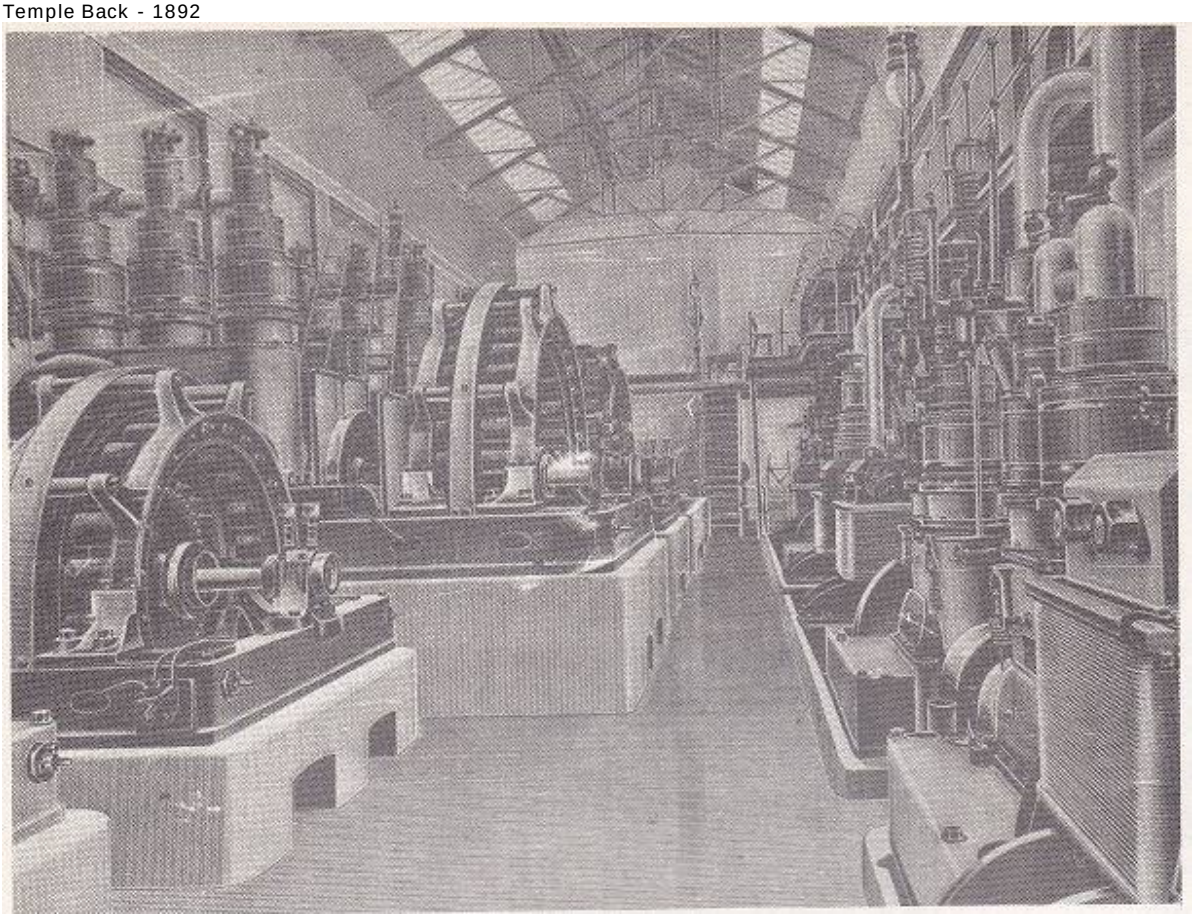
BRISTOL ELECTRICITY SUPPLY

by George Watkins

The successive stages in the evolution of electricity supply in the Bristol area comprise a story of rapid growth, most of which has occurred in ;the twentieth century. The first two sites are now significant industrial relics in the city, while the Portishead stations have been absorbed into the generating capacity of the C.E.G.B.

The Bristol electricity supply system largely represents the evolution of the power station. The city obtained a provisional lighting order in 1883, only a year after the Electric Lighting Act was passed, but wisely did not proceed to use this. The first public use of electric lighting was a small trial plant ordered by the council in 1881 with six arc lamps powered by a gas engine; this was not considered a success, but it served to arouse public interest in the subject. However, by 1890, the success of public supply of electricity was proved, and reliable plant available, and Messrs. Preece and Kapp as engineer and electrical consultants, were instructed to prepare a scheme, and a site at Temple Back near the point of maximum load, with good access to fuel and water, was chosen.

Temple Back - 1892



This print from *The Engineer* of 1894 shows the first Bristol public electricity supply plant as installed in 1893.

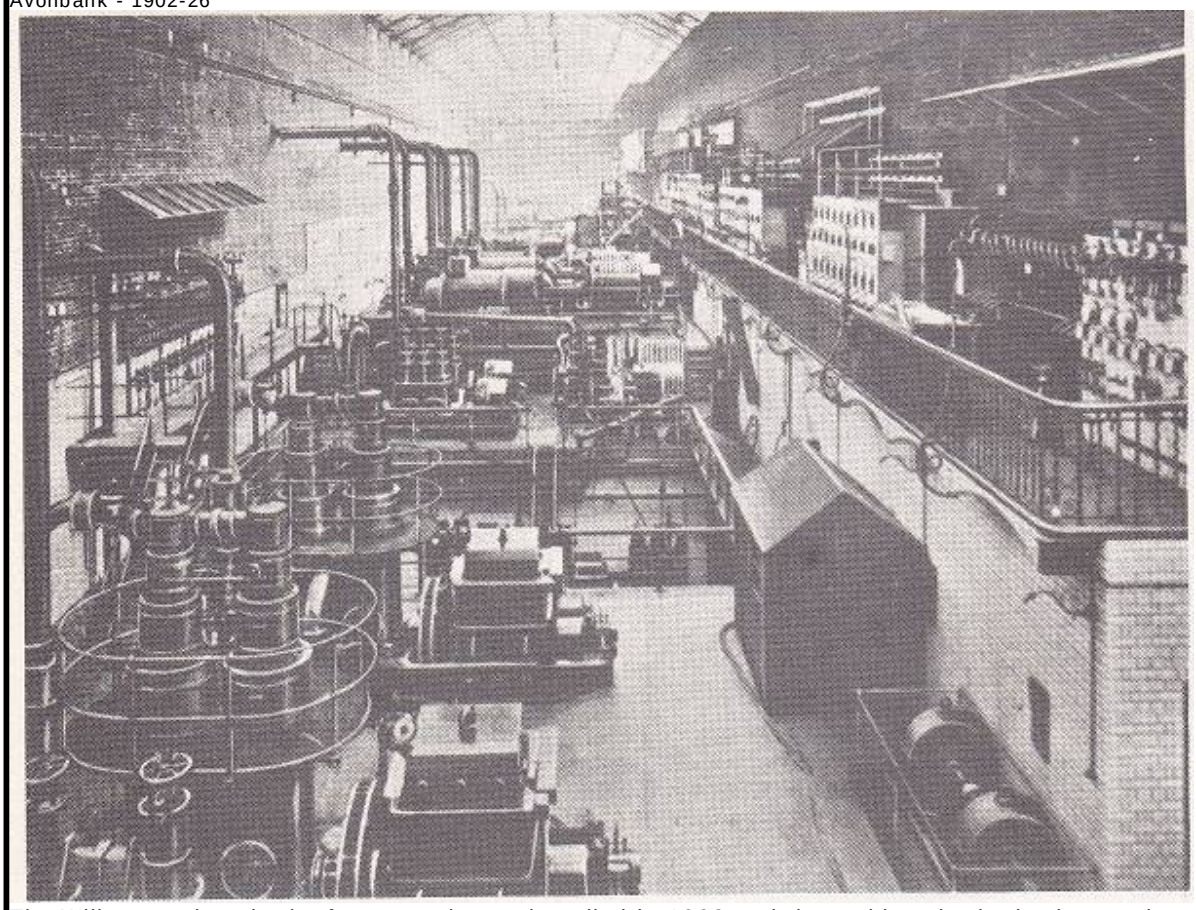
The scheme was estimated to cost £60,000 and provided for 100 arc lamps chiefly for street lighting, together with 120 consumers using 20,000 eight candle power lamps, the Whole requiring 20 miles of underground cables. The total capacity of the site was 2,500 kws, the initial plant of 796 kw comprising eight generating sets, with seven Lancashire boilers by Tinkers, working at 125 psi, fitted with Vicars mechanical stokers. The engine room was parallel to the street, with the cold water well at the right; i.e. in the centre of the proposed full layout. Condensing operation was provided for from the start, but with an atmospheric exhaust pipe beside the 180 ft. chimney which was one of the Twin Stacks so long a city landmark. The exhaust steam was taken by an underground ring main to the cold water well where a condenser with provision for two more was placed. The engines were all Willans compound type, with four alternators, two of 88 and two of 210 kw each, together with four small two-crank sets of 50 kw each; the latter placed on the street side supplying current for low loads, battery charging and station service. A gas engine for low loads was also proposed.

The scheme was very well designed, since each street was served by two power circuits, so that if one failed the street was not left unlighted, whilst it allowed alternate street lights to be switched off after midnight when lower illumination was acceptable. The initial engine room provided for the installation of two more large and two small units and by 1894 these were on order. The alternators all worked at 2,100 volts, at an unusual frequency of 93 cycles per second. The current fed through the switchboard to a network of mains which fed eleven substations. The additional engines were all Willans, and the generators and cables by Seimens and W.H. Allen and Brush for other plant, the West Country's contribution being switchboards, battery and station lighting, all of high repute.

Mr. Preece's original scheme was soon in operation, supply beginning with the 1893 Exhibition, and by 1894 large extensions were necessary and again in 1896, and in connection with the latter, the advanced practice of driving the auxiliaries electrically aroused considerable interest in the industry. Extension was again necessary in 1898, when the first water tube boilers were installed. More plant was added yearly, and in 1900 the supply of direct current for power purposes began. By now the Temple Back site was filled to capacity with sixteen Willans engined sets, twelve Lancashire and two Babcock water tube boilers, and with no possibility of extending the station at an economic cost, a new site capable of coping with the demand for many years to come had to be found. So the Avonbank

site in St. Philips was chosen, this having the advantages of a colliery on one side, a canal on another and a Great Western Railway branch line at the back.

Avonbank - 1902-26



The Willans engines in the foreground were installed in 1902 and the turbines in the background were added after 1904.

The site contained ten acres, and once excavation began in November 1900, progress was rapid, steam being first raised on the boilers in December 1901 and the station officially inaugurated in February 1902. Using 3 per cent of the space initially, the buildings, due to the remote site, were essentially functional in design. The main coal supply was from South Wales by steam colliers. The first instalment comprised four Babcock and Wilcox water tube boilers, each giving 14,000 lbs. of superheated steam at 200 psi. per hour, and fired by Meldrums Stokers, with a 90 ft. steel chimney and induced draft fans. Following the fine service of the Willans engines at Temple back, two three-crank triple expansion sets each of 1,000 hp. (745 kw - 2,000 volt - 93 cycles - 224 rpm) were installed, together with two small sets for house service. Culverts 3 ft. in diameter supplied cooling water for the condensers, the pumps electrically driven being 12 ft. below the engine room floor. The triple expansion engines and higher steam pressure indicate that they moved with the times, but wisely the original distribution system was retained, all of the current being sent to Temple Back for distribution, which continued as long as the private supply era, giving a minimum of alteration to the original area and supply. Yet, very early in the period of this the undertaking had good reason to doubt its wisdom, since at Christmas 1902, a serious fire at the switchboard at Temple Back caused an almost complete stoppage of supply from 5.30 p.m. on December 23rd when Christmas shopping was at its height. The importance attached to public lighting was shown by the assistance offered, since Messrs. Wills and Fry tendered the services of their staffs, and the Tramway Co. a supply of current, but with the help of men from the Sanitary Authority digging trenches for the new cable connections, it was less than eight hours before a partial lighting supply was restored, and in some twenty-four hours the whole supply was restored, albeit on a very Heath Robinson set-up.

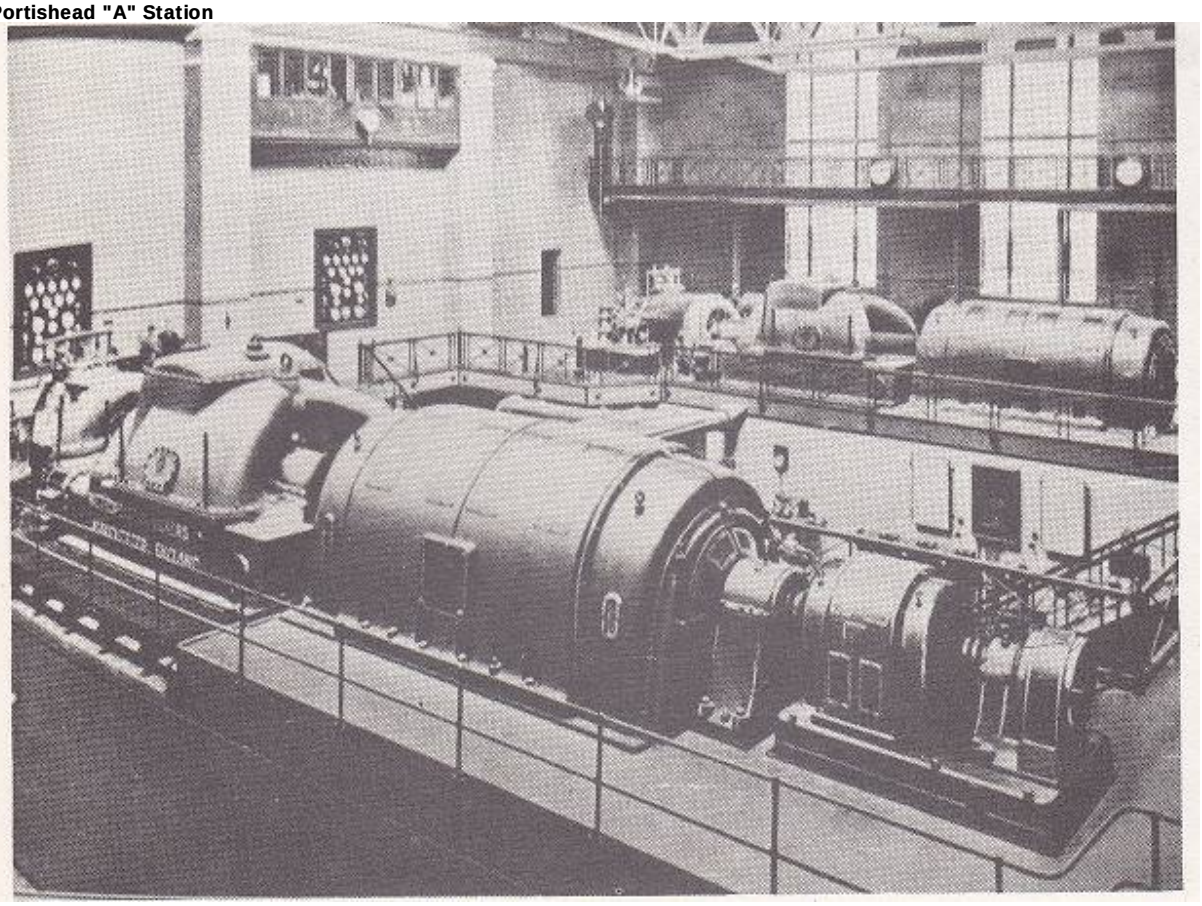
Progress was rapid, arc lights grouped as before in sets of twelve, together with direct current for power now extending beyond the city centre, and 1902 saw the addition of the greatest number of lamps, i.e. 21,799 in a single year. Electric radiators too were much used, but power showed the greatest increase, due no doubt to the low price, i.e. 1^{1}/2d per unit. After this rate was adopted in 1900, the motor load of 111 hp grew to 719 hp by February 1902, with the applications for a further 600 hp to be connected, the general rate being 3.3d per unit from midnight to one hour before sunset, and 5d for the rest, all being subject to discount. Growth was phenomenal, and plant had to match, growing to 5,700 hp by 1905, and 9,050 hp by 1907. The major supply now came from Avonbank where, with increasing turbine power, the coal per unit was now 6.8 lbs. against 11.0 for Temple Back, the generating cost being 1.88d per unit. Two more 3,000 kw sets had just been added when the' Institution of Mechanical Engineers visited the West in 1908, whilst by 1909 there were sixteen Babcock boilers evaporating 300,000 lbs. of water per hour, with eight turbines added to the original Willans sets.

Public lighting, now a prominent feature of the city, was applied to 16 miles of streets, whilst distribution was a study in economics, with 51 miles of extra high tension cables serving main distributing centres, the total mains now exceeding 330 miles, to convey the 10,000,000 units sold in 1909. Two more 3,000 kw sets followed in 1911, and by 1924 Avonbank received its last and largest set of 7,000 kw. The cables were now greatly overloaded, so the voltage in the extra high tension system was raised to 11,000 volts, which, doubling their capacity, required the provision of new transformers at the substations.

It was evident by 1925 that growth was overtaking any possible extensions at the Avonbank site, which had now had five extensions, whose efficiency is indicated by the reduction of fuel to 2.7 lbs. coal per unit and the cost to 1.07d per unit - whilst the 30,000,000 units sold in 1920 rose to 64,000,000 in 1927. The search for a new site needed as much foresight as in 1900, and led to the selection of Portishead.

The industry was now growing up, and in this connection another factor was involved. In the early stages of the industry, a chaotic collection of odd voltages and frequencies grew up, and in 1926 The Electricity Act was passed, by which the standard current became 3 phase 50 cycles which permitted the interlinking of undertakings into networks all over the country, supplied with low cost current from very large economically sited plants. This left the problem that local equipment at the old standards had to be converted, and national low cost loans were granted to local authorities to assist this. Bristol, with seventy two square miles and supplying over 300 square miles of the North Somerset authority's area, required loans of £326,000 between 1924 and 1928 for standardising, estimated to be one half of the total needed, whilst by 1928, over two-thirds of the plant generated standard current.

Portishead "A" Station



The first two generators dated 1926-28 with the condenser pump well between them.

The site of 23 acres, on which an initial capacity of 280,000 kw was planned, had good access for fuel and water, but the station was over 2,000 ft. from the Severn and the gently shelving banks meant that long culverts had to be driven under the foreshore to reach a point where silting would not be troublesome; the high tidal range i.e. 51 ft. also added to the problems. Four brick-lined culverts, each 7 ft. 6 ins. diameter were therefore driven from a level of over 80 ft. below the turbine room, for the supply and return of the cooling water. Costing £193,000 this was very sound as they still serve, despite the possibility of silting in estuary waters, and the tidal range led to special condensing design features which, proving satisfactory, have been adopted for the later station.

This plant indicates the growth of unit sizes. Thus the largest set at Avonbank was the 7,000 kw of 1924, whereas the "A" plant was initiated with two Metropolitan Vickers 20,000 kw two-cylinder sets with stainless steel blades, and fan cooled generators. A non-condensing house service set was provided to make the station self-starting. Five Vickers steel-cased water tube boilers working evaporating 80,000 lbs. per hour at 300 psi, superheated at 750°F with steel chimneys 102 ft. high and chain grate stokers were fitted with space for another. The current, transformed to 33,000 volts, was sent to Avonbank, where a new transformer and switch house fed it to the local network. The plan shows how duplicate layouts could be added with little difficulty, as each turbine and its boilers were in line. To secure the best use of the syphon action of the tides, the condensers were placed 40 ft. below the turbines, to which they are connected by trunks 11 ft. in diameter, whilst the circulating pumps are placed 30 ft. below the turbine floor, but their driving motors are in the turbine basement, some 70 ft. above, driving by vertical shafts. Portishead thus became the most important unit in the South-West Grid System, planned to be completed by 1942-3, the second two units, of 50,000 kw each, going into action in 1930.

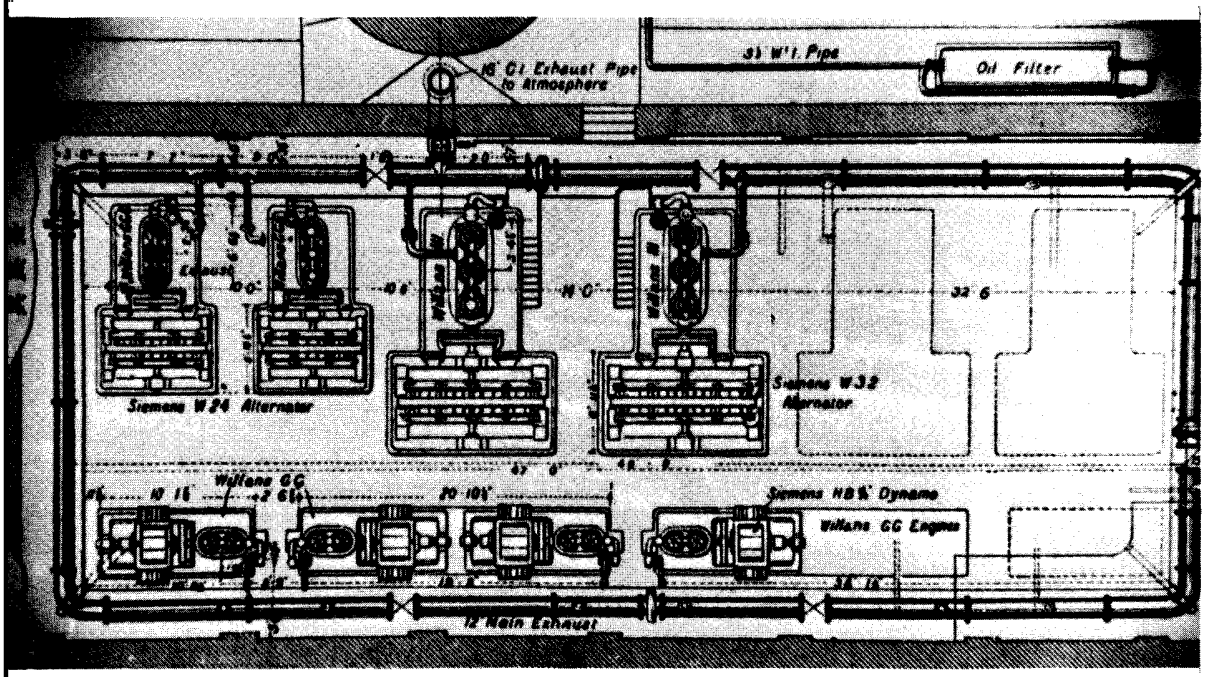
Portishead "B" Station

When the industry was nationalised in 1947, the concentration policy was intensified, and the increased demand and run-down condition of the older plants required the rapid increase of generating capacity. The construction of the "B" station was therefore authorised in May 1949 which, with six sets each of 60,000 kw, was planned to be completed in 1959. Progress was rapid, as begun in 1951, although full access to the site was not obtained until 1955, the second of the 60,000 kw sets was commissioned in June 1956. Due to the narrowness of the site, the building is 700 ft. long by 190 ft. wide, twelve
boilers of the Mitchell radiant heated type, each to evaporate 300,000 lbs. per hour at 900 psi and 900°F were planned, with water-cooled furnaces, eight to be fired by pulverised coal, and four by oil. The fuel store at the boiler house carries 36,000 tons of coal, whilst the emergency stock is 105,000 tons. The turbines are two cylinder 3,000 rpm type as at "A", but the high pressure and temperature give great economy, requiring 8.52 lbs. steam, or under 1 lb. of coal per kw hour. The condenser system, too, is similar to "A", but the culverts, in this case concrete lined and nearer the Severn, are only 600 yards. long. Valves are provided to allow the flow direction to be reversed

to clear silt. The pump pits are 79 ft. deep with four Drysdales pumps, each of 25,100 gallons per minute capacity, at the bottom with the driving motors 75 ft. above them. In keeping with modern practice, the generators are hydrogen-cooled, auxiliaries electrically operated, but with steam stand-bys on essential services, but since there is power permanently available on the site, no station auxiliary generator is provided.

With the "B" stage completed, the story of the Bristol supply may be said to end, as the later nuclear powered stations are more national than local, but Portishead will long function as a generating station, a tribute to the engineer and all who assisted in the scheme.

It is of interest that having fathered the Bristol undertaking from the start, Mr. Faraday Proctor saw the last stage of its development in action prior to his retirement in 1930, whilst his prescient sitings are commemorated by the use now of Temple Back as a store unit, and the Avonbank site is now a large administrative as well as a current distributing centre.



Temple Back. Plan of the first power station as in 1893, with provision for extension in the first stage. There was a second stage extension to the right beyond the condenser well. The first of the twin stacks is at top centre, and the exhaust steam ring main is shown going round the plant delivering to the condensers (right) or to atmospheric exhaust beside the chimney.