Chapter Three

BITUMEN AND CABLES

Callender and Sons - V .B. Cables - "C.C.C.C." – Asdic –
H.V. Cables - The Grid System - O.T.D. – Testing Techniques

ALTHOUGH THE next logical step covers the arrival of Callender's at the site in 1931, the authors feel it is necessary to go back in time to the beginnings of the old Callender Company and trace through the developments in the cable world as they affected the Company. In this way, the reader will appreciate more fully the role initially played by the research side before it reached its present home at Wood Lane.

Callender and Sons, as the Company was originally known, had its origin in 1877, being formed by William Ormiston Callender and two of his sons, Thomas and William, with the original object of importing and refining Trinidad Lake bitumen for road-making and building purposes. About this time the family took up residence in Shepherds Bush in a house called "Oaklands", which was situated on the corner of

Ormiston House

Uxbridge Road and Ormiston Grove, not a "stone's throw" from the fields which would eventually become the site of the Wood Lane Research Laboratories. The house, now called "Ormiston House", still stands, albeit in a dilapidated condition. It was recently learned (via Hammersmith Central Library), that around the time that the Callender family moved in, other residential development was going on in the area', and sewers were being laid along the aforementioned Grove, which evidently then had no name. W. O. Callender requested that the road be called "Callender Grove", but this was rejected by the Council. They did, however, adopt his "second choice" and thus Ormiston Grove came into existence.

It was not long before Mr. Tom Callender was at work on the Continent, visiting many different places, and at one time spending nearly a year in Rumania when the entire city of Jassy was re-paved. Another journey, this time to St. Petersburg in 1880, was instrumental in concentrating his interest on electrical work.

During his stay in the Russian capital a visit was made to the Opera House. A great impression was made on his mind owing to a part of the illumination being provided by an immense number of Jablochkoff candles, an electrical innovation that was to be seen at Covent Garden Opera House three years later when Callender's installed the necessary underground mains.

On his return from Russia Mr. Tom. Callender travelled much throughout the Continent of Europe and later one of his journeys was to the U .S.A. The outward passage was made in the Cunard s.s. "Scythia", which was lighted by paraffin lamps, while the homeward journey was made in the Cunard s.s. "Servia" (then on her maiden voyage), the first large liner to be equipped with an effective electrical installation. Mr. Tom Callender was very interested in this development and upon his return pressed his firm to devote all possible attention to electrical matters.

W. O. Callender had earlier conceived the idea that the bitumen he imported ought to be a suitable material for insulating electrical conductors (9, 10), At that time electrical engineers, mainly concerned with the electric telegraph, were seeking an economic and efficient substitute for rubber and gutta-percha (both of which had a limited life) and such materials as oil and wax, resin and asphalt, jute, hemp and cotton were all tried singl.y and in combination. Young William Call ender , the chemist of the family, was given the task of developing the proposed material, Le. bitumen (9).

Callender's had a landing stage and 41 acres of land at Erith, on the River Thames, where shipments of bitumen were unloaded and where the refining was carried out; and here, in a hut on the marshes, William Callender pursued his experiments.

Since fluxing the bitumen did not seem to him a very promising line of approach, his attention switched to a material known as "Elastikon", described as a waste product of a certain Liverpool firm (probably cotton-seed oil pitch). It was found that there was a possibility of combining bitumen and "Elastikon" to form a product capable of being vulcanized. During 1881 a series of tests were carried out at Erith in conjunction with Sir William Kennard, and as a result of experimental work patents 4408-9 were granted to W. O. Callender on 11th October 1881, covering "improvements in the manufacture of telegraph conductors and materials for covering and insulating wire or other conductors used for telegraphic, electric or other similar purposes". These related to insulating compositions made from bitumen, oil residues and waxes (8-10),

The Callender Bitumen Telegraph and Waterproof Company was formed on the 12th April 1882, to exploit the development of the material as a dielectric (8). Callender's had arrived in the cable industry.

Cable laying at Hanley, Stoke-on-Trent, 1893

Thomas Callender, the Manager of the new Company, pursued with enthusiasm the development of his brother's invention, and in a very short time vulcanized bitumen (“V.B.”) cables were being Installed in a number of localities, both in London and in the provinces (9). By 1896 the original Callender Company had so extended its business that it became necessary to enlarge and re-organize it, and in that year, on the 24th July, Callender's Cable and Construction Company formed, with a capital of £100,000. Mr. Tom Callender was appointed Managing Director*.

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Mr. James Callender, the third of the brothers, had early been associated with the Company at Erith Works. But ill health made it desirable for him to travel to Australia, where he remained for 14 years and greatly benefited from the change in climate. He played a considerable part in the country’s electrical progress was one of the founders and one of the first presidents of the Australian Institute of Electrical Engineers. On his return to England, in 1898, he took charge contract work for the Company.

It is worth noting here that the British Insulated Wire Company of Prescot was also formed during this period (in 1891) and it was here that the first paper insulated cables were made in this country.

The Directors and Management at Erith Works. 1896
Back, L to r.: Theodor Petesen, Major W. Y. MacKenzie, CoL G. A. E11iot
Front, L to r.: Sir Tom Callender, S. C. Lambert, Percy Walker, W. O. Callender, Henry Drake, D. P. McEuen.

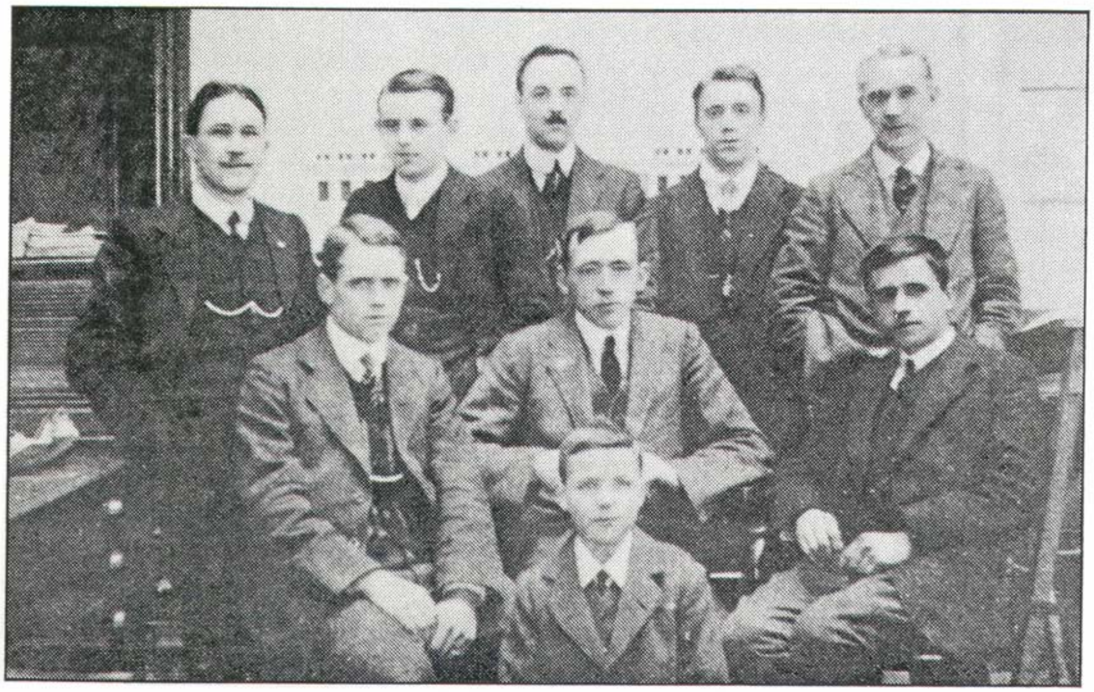
In 1903 the Company was so well established that it was capable absorbing the Anchor Cable Company Limited of Leigh, Lancashire. Mr. James Callender, in addition to his other duties, took over the Technical Management of Archor Works, and devoted a great deal of his time to the conversion of the factory from paper insulated to rubber insulated cables.

This same year (1903) saw the retirement from active directorship of Mr. W. O. Cal1ender, the founder of the business. Five years later he died, at the age of 81.

In 1904, Sir J. Fortescue Flannery, Bart, D. L., M. Inst. C.E., was appointed Chairman of the Board of Directors, an appointment he held for many years.

In 1914 came the First World War. It is common knowledge now, how the technical resources of the country were squandered, misapplied and often ignored in the early stages of the war (11).

The professional soldier, by his very training, was reluctant to admit that civilian engineers had anything of value to contribute. But gradually a change of heart became apparent, and in 1915 Charles Merz of the electrical firm of Merz and McLellan, of Newcastle, was appointed “Director of Experiment and Research” at the Admiralty. He immediately proposed the formation of specialist teams, composed basically of a scientist, an engineer and a Services representative, to solve the various problems presented by the war. The engineer member of one such team, formed in 1917 to combat the submarine menace then assuming alarming proportions, was one P. V. Hunter, then in the employment of Merz and McLellan, where he had rapidly risen to a responsible position. The work of this team culminated in the successful development of the now famous “Asdic” equipment for submarine detection and, later, Hunter's major contribution to its effective introduction was recognized by the award of the C.B.E.



Electrical Dept., Men and McLellan, 1912
P. V. Hunter seated, centre

In June 1918, Thomas Cal1ender was honoured by a Knighthood (8) and this well deserved recognition gave the greatest pleasure to his many friends, including the Company's large staff in all parts of the world. No one can have failed to notice how continuous travel played a large part in Sir Tom's life and it was no mere coincidence that after his visits to many parts of the globe business developments occurred which resulted in Callender's supplying cables and auxiliary equipment “all over the world”.

Unfortunately, the happiness surrounding the bestowal of his Knighthood was marred by the death of his brother James, in October of the same year, which followed so soon after the successful completion of Picardy Works at Erith, the design and construction of which, for the manufacture of special trench cable, had been James Callender's sole responsibility.

The conclusion of the war gave vent to a flood of orders for power cables and plant, sources of supply of which had been stretched to the limit during hostilities, and Callender's found itself nearly overwhelmed (11). Seeking a Chief Engineer of ability, Sir Tom Callender approached P. V. Hunter whose acquaintance he had made earlier. They had met first in 1911, during the development of the Merz-Hunter split conductor system of automatic protection, the experimental lengths of cable for which were made at Erith Works, and again in 1917, in connection with the supply of bitumen for the "Asdic" equipment. P. V .H., looking for a new world to conquer, decided at once to join Sir Tom and on 1st June 1919, began his association with Callender's which was to last until his death 37 years later.

Hunter's objective after joining the Company was to build up a first rate engineering team, consisting of specialists in their particular fields, to which he could delegate a very 'high degree of responsibility and which would provide the background of expert knowledge and information required by the production engineers. This objective was not fully realised until some years later when difficulties encountered with 33 and 66 kV high voltage cables were to increase the emphasis on a more fundamental approach to cable problems and were to result in the emergence of a research department.

It is perhaps fitting at this point to clarify the picture with respect to power cables in the period under review, i.e. in the 1920's. Prior to 1926 the supply of electricity was mainly local (12). Power stations were usually situated in the towns and cities they served, and distribution was largely by underground cables. Distances were relatively short and voltages in excess of 22 kV were seldom used before 1920.

Reliable paper insulated cables of the belted type were used for operation at 22 kV, with a maximum radial stress of approximately 20 kV/ern. The insulation thickness was largely determined by mechanical considerations and the potentialities and limitations of this type of insulation were not fully explored.

However, the growing demand for electrical power necessitated the use of higher voltages and by 1923 over 125 miles of 33 kV cable were installed by Cal1ender's in this country (the first lengths were laid in Manchester about 1920-22).

It became necessary to utilise paper insulation as efficiently as possible to keep the cost of the cable to a minimum. Belted cables were made for 33 kV, using a higher maximum radial stress than previously, a value of 26 kV /cm being typical. However, although a few solid type 33 kV belted cables were still in operation at least until the late 1950's, the design was not wholly satisfactory and failures occurred in service. The problem was not solved until core screening, on the basis of the Hochstadter patent of 1914, was introduced (see Chapter Four).

The establishment of the Grid system meant that transmission became mainly via overhead lines at 132 kV with secondary voltages of 66 kV and 33 kV, but some underground cables were required, for example in urban centres, and their design and manufacture for voltages in excess of 33 kV presented a fresh set of problems to the cable industry. However, with the increased experience of screened cores, cables for use at higher operating voltages were developed. Single core 66 kV cables were made and installed in appreciable lengths from 1929 onwards. Some troubles were experienced, but with improvements in materials and manufacturing processes it was found that solid type could be used for 66 kV.

Coupled with these developments in power cable manufacture were the problems associated with testing the quality of such cables. Within the Company the development of suitable testing techniques was the problem of the Outside Testing Department (O.T.D) which was located at No. 1 Ormond Yard (close to the Great Ormond Street Hospital for Children). O.T.D. was an "off-shoot" of the Contracts Department at Erith and, under the leadership of Mr. 1. Urmston, was directly responsible to the Contracts Manager (initially Mr. Skacey, later Mr. C. J. Green). The Contracts Manager was responsible for work involved in outside construction, overhead lines and installation of cables, whilst Mr. Urmston was under him in charge of telephone cable installation and the O.T.D.

The work of the Outside Testing Department in the period around 1919-20 was mainly centred on the testing of telephone cables. During installation the various cable lengths forming part of the telephone line are "balanced", that is to say the characteristics of the various lengths are matched by jointing in such a manner that the best possible capacitance balance between circuits, or to earth, is obtained and cross-talk is eliminated.

One of the better known personalities who was associated with this type of work was Mr. A. S. Butler, who later played a role in the move to Wood Lane.

As stated earlier, O. T.D. was mainly concerned with telephone work in those early twenties, but testing of high voltage cables was also carried out. As these cables developed to higher voltages, so the testing equipment had to be improved accordingly.

Prior to 1916 a few tests (13) had been made in this country using high voltage direct current, the most interesting being those on the Metropolitan Electric Company's 100,000 volt dc transmission cables at its Ironbridge Sub-station. A special form of influence machine working under 200 lb/in^2 air pressure was built for these tests, and actually a voltage of 150,000 was obtained on the cable for a short time before the machine broke down. Later a Snook mechanical rectifier was tried, but this also failed.

Other than these unique types of test, the quality of cables was judged chiefly on the results of ac breakdown tests and measurement of dielectric losses by electrostatic wattmeters.

In 1916 a very instructive paper (14) on dc testing of underground cables was read before the I. E. E. In it was described the "Delon" mechanical rectifier for producing high voltage direct current up to 130 kV and as a result of the paper a lengthy discussion arose over the advantages and disadvantages of testing with rectified, or what is more usually termed direct, current. The "Delon" mechanical rectifier soon came into common use for testing supertension cables after laying.

Callender's had one located at Ormond Yard. However, it did not last very long, as a few years later the General Electric Company of America introduced the "Kenetron" valve - a two-electrode thermionic valve capable of withstanding a peak voltage between electrodes of 110 kV. Again, Callender's bought and made use of this latest development and soon the "Delon" rectifier was no longer used.

Before the introduction of the Kenetron valve direct current testing was mostly confined to 22 kV and 33 kV cables, as in these cases it was impracticable to make ac tests owing to the size of the testing transformer required to give the necessary charging kV A.

With the introduction of the valve testing sets, the testing of 11 kV and 6.6 kV cables with direct current was favoured. This was partly due to engineers realising that the dc was as effective as the ac test for proving cables and joints after laying, and also to the quickness with which the dc test could be arranged and carried out. A further advantage of dc testing was that owing to the small power required a portable petrol driven generator plant could be used for supplying the energy to the testing set. This was particularly important on rural systems comprising sections of cable and overhead line. It naturally followed in these cases that overhead lines were tested with direct current as well as the cable sections and the dc test was found to be just as effective as the ac test in detecting faulty insulators and in locating overhanging tree branches.

One of the arguments used against dc testing was that in the event of a breakdown the fault resistance would be too high for a location to be made by the ordinary loop test. Actually, it was often possible to burn out the fault sufficiently for a good location test to be made, but in 1924 Mr. Urmston successfully tried locating a high resistance fault with the Murray loop test, using a high voltage dc testing set as the source of supply to the bridge.

This test was on one of the Charing Cross E.S. Company's 10,000 V mains from Ludgate Circus, and it took only seven hours with a test voltage of about 20 kV before the location was made. It was quickly realised that a great step forward had been made in the art of fault location.

By 1937 the H.T. Slide Wire Bridge had become an essential part of high voltage dc testing equipment, and locations could be made rapidly and accurately. By then there had also been the development of the Westinghouse Metal Rectifier for high voltage testing and the Gooding Flash-Meter for the location of intermittent flashing faults.

As will be realised from the above, Callender's played a leading role in the development of testing techniques. It was about the period of Urmston's work with the Murray loop test that the first graduates were brought into the Company at Ormond Yard.