STEER BY EVERSHED!

The story of Evershed & Vignoles Ltd

Synopsis

The aim of this synopsis is to outline the general approach and treatment. The research carried out so far has been primarily to define the nature of the story to be told, and to establish that material is available to cover the whole period.

The story is a fascinating one. It includes the inventiveness and entrepreneurial drive of the late Victorian electrical engineers; the creation of a new industry based on electrical test and measuring instruments; the introduction of various control techniques to the ships of the Royal Navy; and more recently the adoption of electronics for industrial control and instrumentation.

Evershed & Vignoles played a leading role in these and many other aspects of the electrical instrumentation business. Despite changes of ownership in recent years, there is a genuine continuity over virtually the whole period - in the people involved, in the association with the Royal Navy from 1893 to the present, in the occupation of the Acton Lane site for the past 80 years, and in several other respects.

As envisaged at present, the book is planned to comprise 10 chapters plus a short introduction. Each chapter will run to 2500 words on average, giving the book a total length of about 25,000 words. The chapters will be arranged as follows:

Introduction

This will be very brief (one or two pages), simply to establish why the book has been written.

Chapter 1. Early days (1885-1895)

The opening chapter will describe the formation of Goolden & Trotter in 1885, which became W.T. Goolden & Co in 1888 and Easton, Anderson & Goolden in 1892. The event of prime significance was the formation of the Instrument Department of the company by Sydney Evershed in 1886. He was later joined by Ernest Vignoles.

The background of electrical engineering in the 1880s will be sketched in, and reference will be made to some of the personalities involved -

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Ayrton, Perry, Cardew, etc. Evershed was a notable member of this group, and there will be a description of the work he carried out both before and after the formation of the Instrument Department in 1886.

The activities of the department will be traced over the following few years, and the story will lead up to the acquisition of the Instrument Department and the formation of Evershed & Vignoles Ltd in 1895.

Chapter 2. <u>The new company</u> (1895-1914)

This will trace the development of the company during the two decades from its formation to the start of the First World War. Brief reference will be made to the naval activities, but these will be dealt with in more detail in the following chapter. Chapter 2 will include the move to the Acton Lane site, and will concentrate mainly on the instrument side of the business, including the introduction of the Megger in 1904, the cell-tester (1901), the Dionic water tester (1910), Murday recording voltmeters and ammeters (1910), and the Ducter (1911).

Chapter 3. <u>The naval connection</u> (1893-1914)

The strong association with the Royal Navy, which began with the supply of the first Evershed helm indicators to HMS Howe and Narcissus in 1893, will be described against the background of the rapid expansion of the Navy under Sir John Fisher, and the changes taking place in ship design and gunnery. On the foundations of the helm indicator and the relationship it established between the company and the Navy, further products were introduced. These included Kilroy's stoking indicators (1902), Kilroy's turret danger signals (1907), and the Evershed orders telegraph.

By 1914, the company was able to claim that Evershed telegraphs had been supplied to 68 battleships of the Royal Navy, 9 battle cruisers, 39 cruisers, and 53 light cruisers.

Both Chapter 2 and Chapter 3 will include information about the people involved (Evershed, Vignoles, Kilroy, Adolph Vines, etc), and will describe the growth of the company's business overseas (a brochure on the Megger was published in German, optimistically, in June 1914).

Chapter 4. <u>Steer by Evershed</u> (1914-1918)

With the outbreak of war, the links between the Royal Navy and the company meant that it was immediately involved. More research is needed for this chapter, but a picture emerges of priority being given to military products rather than the instruments. Changes within the company caused by the employment of women, the higher cost of labour and materials, and the problems of running a company in wartime will be described. This chapter will include reference to the Battle of Jutland and the "Steer by Evershed" order (but see Note 3 below).

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Chapter 5. <u>A different world</u> (1919-1929)

As for the world at large, things would never be quite the same again for Evershed & Vignoles once the war was over. The pent-up demand for Meggers and other instruments kept the company busy, but there was a rapid contraction of the naval market as the sizes of the Royal Navy and other fleets were reduced following successive international treaties. The need for the stoking indicator also disappeared as oil replaced coal on board ship.

Nonetheless, the company remained active in naval matters, adding to existing instruments, with enemy bearing indicators, searchlight controls, torpedo controls, look-out telegraphs, etc. Instrument developments in this period included the introduction of the lightweight Meg in 1922, Needham's Pulsator system of speed control (1920), and Evershed's electrical speed indicator. The first fractional horse-power electric motor was introduced in 1927. Reference will also be made in this chapter to development of the Acton Lane site.

Sydney Evershed was now approaching 70, and although he was still active new personalities were emerging. Among these, G.B. Rolfe played an important technical role.

Chapter 6. <u>Hoping for peace, preparing for war</u> (1930-1939)

Despite the difficult economic conditions, developments continued on the instrument side in the early thirties with the design of the Wee Megger by G.B. Rolfe. A close relationship developed with GEC, which also marketed the Wee Megger on its own behalf. By the mid-thirties, the Admiralty was starting to increase naval procurement. The company responded to this challenge, and concentrated on anti-submarine developments and improvements to earlier products, such as the enemy bearing indicator. J.C. Needham is described as the "inventive genius" between 1928 and the outbreak of the Second World War. During this period the company also entered new markets with electrical control systems for public utilities.

Two breaks with the past came at the end of the decade. Sydney Evershed died in 1939, aged 82, and the same year saw the retirement of Adolph Vines, who had joined W.T. Goolden & Co in 1891, and had been a managing director of Evershed & Vignoles since 1909.

Chapter 7. <u>Under bombardment</u> (1939-1945)

This chapter will deal with the problems of the Second World War, when air raids disrupted production, the factory was damaged by incendiary bombs, and the size of the staff grew to meet the demands of the armed forces. Naval work became about 70% of the company's activities, but work was also undertaken for the RAF, and a lot of trim tab controls were made using the M-type motor system. This period expanded the product range considerably, and new technologies were developed which were to play an important part in post-war activities.

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Chapter 8. <u>New fields to conquer</u> (1945-1963)

Soon after the war was over, the company started to pioneer the application of electronics to industrial control. This led to the world's first fully-electronic process control system, at a BP refinery in Llandarcy. A leading role was played by W.T. Marchment, who had joined the company in 1932. Developments continued on instruments, naval systems, and FHP motors, and Evershed Power-Optics Ltd was formed as a subsidiary. Acquisitions included the Record Electrical Co (1955) and Tinsley Industrial Instruments.

By the early sixties the company was firmly established in process control, as well as the traditional activities, but the long timescales of industrial contracts and the increasing competition from well-funded American groups put Evershed & Vignoles under financial pressure.

Chapter 9. <u>Times of change</u> (1963-1971)

Up to now the company had remained privately owned, but during this period it changed hands three times in eight years. The first new owner was British-American Tobacco, which affected mainly the management side. Two years later, in April 1965, BAT sold the company to George Kent Ltd. This had far greater effects, with extensive rationalisations and transfers of parts of the Evershed business. Kent became involved with changes of its own when it acquired Cambridge Instrument Co with the active encouragement of the Industrial Reorganisation Corporation. New management took over, and in 1971 Kent sold Evershed & Vignoles to Thorn, though some parts of the company were retained.

Chapter 10. <u>Under new management</u> (1971 - present)

This final chapter will summarise the changes which Thorn made, with the instrument side being transferred to Dover and certain activities of Thorn joining Evershed at Chiswick. There will be a description of the company as it is today, with references to the current product range and recent developments, and a brief look at the future as seen by the present management.

NOTES

(1) <u>Sources</u>. There appear to be sources of information on the company over most of the period. The early years are well documented, and material I have studied so far takes things up to the early twenties. More research is needed to cover the First World War. From the early twenties to the present the sources are obviously varied, but there is no doubt that they will yield the material required.

Mr Murray Vines will be an excellent source of personal recollections, and also has considerable quantities of documents. Other past and

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present members of the company will also be interviewed. Published sources include the electrical, electronic and engineering press; bound volumes of the leading journals are held by the IEE Library, and are readily accessible.

(2) Illustrations. The company has many volumes of photographs dating from the 1900s to the 1950s. Among these are a few much earlier and some later. While many are straightforward product photographs, several show applications and installations. There are also works shots, early groups, photographs of individuals, etc. There is a particularly good run of internal works photos of 1931.

A plan of the Acton Lane site, showing development at different periods, would also be of interest (more than one plan might be necessary).

(3) "Steer by Evershed". It has not yet been possible to establish the source of this phrase, said to be current in the Royal Navy and used at the Battle of Jutland. However, only a few naval sources have been consulted so far. It is perhaps worth mentioning, however, that Mr Murray Vines said he had not heard the expression. He referred to the phrase "Switch on the Evershed", apparently used in association with the enemy bearing indicator.

Roger Woolnough
February 18, 1983

First draft

STEER BY EVERSHED!

The story of Evershed & Vignoles Ltd

by Roger Woolnough

INTRODUCTORY NOTE

This manuscript is a first draft. It is virtually complete, with the exception of Chapter 4 (First World War), which is still being researched. However, some of the chapters will be expanded with additional material, and this is indicated at various points in the text. Some details, such as dates, have to be corroborated.

Any comments, additional information or suggestions of further sources will be gladly received.

Roger Woolnough

December 14, 1983

CHAPTER ONE

Early days: 1884-1895

In the last two decades of the 19th century the great discoveries in electricity and magnetism which had been made in earlier years began to be applied in a practical way. The incandescent lamp brought electric lighting to homes, offices and public buildings. The dynamo evolved from a laboratory demonstration to an industrial product. Power stations were built by newly-formed electricity supply companies.

Supporting such developments were several other activities of which the general public was less aware, but without which the rapid growth in the use of electricity could not have taken place. One of these concerned the science of measurement, which was about to form the basis of a new branch of engineering - the instrument industry.

Practical discoveries in electrical measurement date at least from the 18th century, but during the next 100 years new instrument designs came in rapid succession: voltmeters, bridges, potentiometers, galvanometers. Despite this proliferation, however, when electric current became available in bulk an important facility was lacking. Accurate direct-reading instruments were not available.

This need was soon met. Established instrument designers like Kelvin and Nalder produced some of the answers, but a new crop of inventors - often engineers rather than scientists - also appeared. They included

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William Edward Ayrton, John Perry, and Philip Cardew - names which will recur later in this story. And gaining increasing notice was a young man called Sydney Evershed.

But if these inventions were to meet the urgent needs of the time, the instruments had to be made in considerable and growing quantities. The nascent instrument industry faced both a challenge and an opportunity.

One of the new electrical manufacturing companies was Edmunds & Goolden, founded by Henry Edmunds and Walter Goolden in 1884. Henry Edmunds was a pioneer in applying both arc and incandescent lighting, and had worked closely with Captain John Fisher, RN (later famous as Admiral "Jackie" Fisher, First Sea Lord) in persuading the Admiralty to make the first installation of electric lighting on a British battleship: HMS Inflexible in 1881. As a company, Edmunds & Goolden had a brief life, but this association with the Royal Navy was to play a highly significant part in the story of its eventual successor, Evershed & Vignoles - an association which continues to this day.

Edmunds & Goolden was just one of many ventures in which Henry Edmunds was involved. He was only 30 years old at this time, but had made a mark as an inventor with a device called the phonoscope, an instrument which showed the vibrations of sound in rays of light. He also invented the aquaphone, an apparatus for signalling under water. Edmunds seems to have had a knack of being in the right place at the right time. He brought the first phonograph to Britain, and later is said to have introduced the Hon C.S. Rolls to Henry Royce.

For Edmunds & Goolden, a factory was established in Halifax (Henry Edmunds' place of birth) with the idea of making dynamos for lighting

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the local cloth factories, dye works, and shops. The company also made arc lamps, and even generated its own power, supplying electric light to two of the largest shops in Halifax. Goolden stayed in London, managing the finances and trying to raise orders. Once again the Royal Navy proved to be an important customer, for in later years it was recalled that Goolden had broken records "in carrying out some of the stiff conditions of Admiralty dynamo specifications". The business was scarcely established, however, when Edmunds left in the latter part of 1884 to pursue other interests. Goolden had to find a new partner.

Walter Goolden hardly seems the type of the late Victorian entrepreneur. Born in 1848, he was educated at Magdalen College, Oxford, became science scholar of Merton College in 1867, and then took a First Class in Natural Science in 1871. Most of his early career was in education. He was assistant examiner in natural philosophy to the Science & Art Department, South Kensington, from 1871, and in 1876 became a master at Tonbridge School, where he was remembered for his mathematical skills, his love of astronomy, and a fine tenor voice.

There is no indication of what prompted Goolden, by this time 36 years old, to leave education for the uncharted world of commerce: perhaps, like so many others, he was just caught up in the excitement of electrical science, of which his knowledge was said to be "singularly exact and clear, but totally unpedantic".

His obituarist in the Journal of the Institution of Electrical Engineers - Goolden died comparatively young in 1902 - wrote that as a successful business man, Goolden "was handicapped by want of commercial training, and by the perfection of his honesty, and there are some who would have counted

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the transparent frankness and warmheartedness of his nature as a disadvantage". The writer admitted that one weakness was that Goolden "could hardly believe that those with whom he had dealings were not all as upright and of as good faith as himself".

Even allowing for the fulsomeness of obituary writers in those days, it is easy to agree with this particular memorialist that Walter Goolden was "the antithesis of the pushing business man".

Nonetheless, it was largely the efforts of Goolden which kept the young company in being, and gave it the continuity it needed. His second partner was Alexander Pelham Trotter, and in 1885 the firm became Goolden & Trotter. Trotter left after about three years, and later became well known as electrical adviser to the Board of Trade. In 1888 the company was renamed again, this time simply W.T. Goolden & Co. Walter Goolden found yet another partner, Llewelyn B. Atkinson, who had joined the company as a pupil at Halifax in 1884, and then been employed as an engineer.

By this time the steps had been taken which within a few years were to lead to a totally new business in the shape of Evershed & Vignoles Ltd. It was in 1886 that Goolden decided to establish an Instrument Department, taking a licence to manufacture the hot-wire voltmeter invented in 1883 by Philip Cardew, a major in the Royal Engineers. The most important of Goolden's decisions, however, was to engage Sydney Evershed as manager of the new Instrument Department.

Evershed was a very different type from Goolden. He was an engineer, although his family history reveals no other engineers. He was born in Surrey in 1857, member of a family whose roots have been traced back to

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John Evershedd, who died in 1565. Sydney was the third of eight children, and although two did not reach adulthood it was, on the whole, a long-lived family. Sydney himself died two days after his 82nd birthday, and one brother lived to 92.

Unlike Goolden, Sydney Evershed had no background of university education or academic attainments. He was educated privately, and his entry in The Blue Book, the electrical industry's standard reference work, reads defiantly: "Has never passed an examination, nor even attempted to do so. He gained no prizes at school, and has never held a scholarship."

This lack of formal education was largely a matter of necessity. Sydney's father was a tanner, but the tannery fell on hard times, and Sydney had to stay at home to help his father manufacture a special tanning oil.

Goolden possibly felt that any shortcomings in higher education were irrelevant for the manager of an Instrument Department. What he was getting in Evershed, by now 28 years old, was an eminently practical man with a growing reputation as an electrical inventor and with some real down-to-earth experience in manufacturing.

The young Evershed had first been apprenticed in 1876 to a London optician, but his health failed at the end of the first year, and he spent the next seven years "in a manufactory then just started near Guildford". It hardly sounds like a rest cure, but Evershed obviously flourished. By 1879 he was manager, and designed and built all the new machinery and plant which was needed to develop the business. He was becoming increasingly interested in electricity, studying the subject in his spare time and carrying out various experiments. One of his Blue Book entries

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mentions "a lengthy series of observations on atmospheric electricity" and "research on the potential difference due to contact".

By 1884 he had decided to concentrate entirely on electrical work, and resigned his position as manager. At the end of that year he joined the instrument department of the Hammond Electric Light Co, but that firm went into liquidation soon afterwards. For most of the following year, Evershed worked on his own developing measuring instruments, until he applied for the post of manager with Goolden in 1886.

Evershed's standing in the electrical world at this time can be gauged from his application for associate membership of the Society of Telegraph Engineers & Electricians (later the Institution of Electrical Engineers): "Mr Evershed has had considerable experience in designing and making electrical measuring instruments and galvanometers for very accurate physiological work. He is the inventor of the instruments known under his name and is in addition a very good technical electrician." He was recommended for associate membership of the Society on March 11, 1886.

In joining Goolden & Trotter he also brought a most valuable property, a new design for a measuring instrument. The Cardew voltmeter, for which Goolden had secured manufacturing rights, was based on the "hot wire" principle. This was exactly what its name suggests. The ends of a fine iridio-platinum wire were fixed to terminal blocks, and looped behind an indicating dial with a series of springs and pulleys. An increase in current caused the wire's temperature to rise and its length to increase, and this caused a pointer to move across a scale which was calibrated in volts.

Evershed's measuring instrument worked on a completely different

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principle, in which a soft iron armature was attracted between two soft iron poles. Current in the coil would magnetise the two pieces of iron, and cause a pivoted iron rod to drive a pointer. The shape of the scale required could be obtained by varying the shape of the poles.

These two instruments were the only products of the Instrument Department in the early years. The Cardew voltmeter was widely employed in power stations, and was also used by the Royal Navy. Evershed's design was very successful, and large numbers were sold to the General Electric Co and others. Adolph Vines, who joined the department in 1891 and later became a managing director of Evershed & Vignoles, claimed that the Weston Co of the USA copied the design; "and," he wrote in 1944, "are using it to this day".

When the Instrument Department was formed in 1886 the main factory of Goolden & Trotter was still in Halifax, so London premises were taken at Kings Head Court, Westminster. The address may suggest a touch of grandeur, but there was nothing grand in fact. The instrument factory was in a loft, and Ernest Vignoles recalled later: "The court was full of slum dwellings, and the impression I got from several visits to it was that it was mostly inhabited by costermongers and an unnaturally dry and blackened goose."

Ernest Blacker Vignoles is, of course, the other leading figure in this story. He was born in 1865, so was eight years younger than Evershed, and came from a family of engineers. His grandfather, Charles Vignoles, was a pioneer of railway engineering, and inventor of the Vignoles rail. Ernest Vignoles was educated at Malvern College and the Central Technical College in South Kensington, where he studied under Ayrton, and he joined

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W.T. Goolden & Co in 1889. He started as a pupil, and recalled later that "after a short period of service in the Dynamo Works, (I) definitely joined the Instrument Branch early in 1890".

The wording suggests that Vignoles had been hankering after the instrument activities for some time, and there seems no doubt that the possibility of working with Evershed was one of the attractions. During the early nineties, the two men co-operated on a series of investigations of the magnetic phenomena produced in the cores of transformers. A series of articles on the results was published in The Electrician, which was being edited by Alex Trotter.

Just at the time that Ernest Vignoles joined Gooldens in 1889, the firm was in the throes of an important move to new premises. The dynamo factory in Halifax was closed, and this activity moved with the instrument department to Westbourne Park, a few miles west of central London. It was a decided gain in status.

A firm called Clayton & Co had premises in Woodfield Road, a turning off Harrow Road. Although only two storeys high, these had an appearance of some magnificence, with a stone-faced lower storey, classical pillars, and an elaborate iron railing. At each side of the imposing entrance stood two small figures of Atlas, each carrying a globe, and Claytons called the building Atlas Works, Woodfield Road.

Gooldens now occupied part of this building, and although the official address was No 1 Woodfield Road, it adopted the description Woodfield Works, Harrow Road. The instrument factory, which had employed only six men when Evershed joined it, now occupied areas on the ground and first floors, along with a separate calibrating room, test room, galvo room,

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experimental room, and (a period touch) an accumulator shed.

The adjoining building, known as the Globe Shop, was occupied by the dynamo side of the business, which had also expanded into coal-cutting machinery. The offices, which fronted Woodfield Road, were common to both sides of the business. It is suggestive of the role which Sydney Evershed had assumed in the company that he was one of only four people with offices of their own, the others being the two partners, Goolden and Atkinson, and a man called Townsend, who ran an installation department for the company.

Despite the impressive new surroundings, things did not prosper with W.T. Goolden & Co, and in 1892 it merged with another firm, Easton & Anderson, to become Easton, Anderson & Goolden Ltd. Apparently this had little effect, for Adolph Vines recalled in later years that "up to 1894 the business was carried on without much expansion", while Ernest Vignoles recorded that between 1890 and 1895 "progress, if any, was extremely slow".

Yet it was during these years that Evershed and his colleagues were laying the foundations for much expansion in the future. The voltmeters and ammeters which had formed the first products of the Instrument Department were all designed for panel mounting, such as on the switchboards of generating stations, but it was becoming clear that there was a growing need for portable electrical measuring instruments. Soon after becoming manager of the Instrument Department in 1886, Evershed realised that to test the safety of electrical house wiring it was necessary to measure the insulation at a pressure equal to the supply voltage.

By using a magneto generator in conjunction with a modification of Ayrton and Perry's ohmmeter, Evershed was able to achieve his purpose. The company tried out the principle successfully on its own installation

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work, and after further development the instrument - the ohmmeter in one box and the generator in another - was patented and placed on the market in 1889. This was the start of a business in insulation testing which was to become one of the mainstays of Evershed & Vignoles after the invention of the Megger some 15 years later.

Not all of Evershed's inventions were a success. In 1892 he took out a patent for a light ship telegraph based on an inductive principle. A cable was laid from the shore on the bottom of the sea to form a loop round the light ship, and interrupted current was passed through it when a key was pressed. The receiver was formed by a telephone connected to a coil on board ship.

"A trial set was fitted to the Goodwin Light Ship but failed to act," Adolph Vines recorded, "due to absorption of magnetic waves by the sea water and iron covering of the ship."

At about the same time, however, Evershed was working on another development which was to provide a major part of the company's business within a few years. This was the helm indicator (later called the rudder indicator), which Evershed developed in conjunction with A.E. Richards of the Corps of Royal Naval Constructors. It was to become standard equipment for ships of the Royal Navy and many foreign navies. This invention, and what resulted from it, will be described in a later chapter.

While much of this work held promise for the future, at the end of 1894 the prospects were not good for Easton, Anderson & Goolden. The company was in increasing financial difficulties, and had transferred all the dynamo work to the Easton & Anderson works in Erith, Kent, leaving only the instrument business at Woodfield Works. The company decided

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that selling this business offered a way out of its problems, and suggested that Sydney Evershed and Ernest Vignoles should take it over.

The fact that Vignoles was included in the approach says much for the standing he had achieved in only a few years. Perhaps Walter Goolden had discerned that the two men were complementary, and had the potential to form an effective partnership. Certainly it seems unlikely that the transfer of the instrument business would have taken place if it had not been for Ernest Vignoles. Evershed's forte showed itself at the experimental bench; Vignoles, though not yet 30, demonstrated that he had become a skilled man of affairs. He mounted what would these days be described as a management buy-out.

It was mainly Vignoles who rallied friends and relations to put up the money. It was Vignoles who persuaded his former mentor and leading figure in electrical measurement, Professor W.E. Ayrton, FRS, to take an interest. It was during this hectic period, one feels, that Vignoles - so recently a pupil and assistant to Evershed - laid the foundations of the partnership that was to take Evershed & Vignoles Ltd to success in the years ahead.

"Though we had little money at command we were ambitious," Ernest Vignoles wrote in later years, "and believed in our power to develop the business on right lines and avoid the losses our predecessors had incurred; so we persuaded friends to help us with money... We managed to scrape together £7,500; and an agreement having been completed for the sale of the business for £7,000, a Limited Liability Company was registered, under the title Evershed & Vignoles, Limited, on the 5th February, 1895. On the 1st of July of that year the new company definitely took possession of the Works."

It was the beginning of great things.

CHAPTER TWO

The new company: 1895-1914

Having purchased from Messrs. Easton, Anderson & Goolden Ltd. the Instrument Business founded by Messrs. Goolden & Trotter in 1886, we shall endeavour to maintain the reputation established by our predecessors by making careful design and workmanship of the highest class essential features of every instrument, from the cheapest gauge to the most costly standard which we produce.

The whole of the Evershed Patents having passed into our hands, we shall continue to make the various instruments associated with that name, including the Richards-Evershed system of Electrical Ship's Telegraphs now being introduced into the Navy, and we have therefore retained the services of the whole of the Technical Staff, who have had many years' experience of this work.

No change is contemplated in the general scope of the business, but we shall as occasion offers take up the manufacture of such electrical and kindred apparatus as may meet the special requirements of the Engineering Industry.

This was the letter which the new company sent to customers in July 1895. Although Evershed & Vignoles Ltd had been registered in the previous February, the transfer of the business was not finally completed until

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July 29, 1895, but the new management had not waited on events. The first board meeting was held on February 12. Professor Ayrton, who was principal of the City & Guilds Technical Institute, became chairman, with Sydney Evershed and Ernest Vignoles as managing directors "for at least five years". Another director was Horace M. Gregory, a mechanical engineer who had held no previous positions with the company, but was to remain on the board until the thirties. Adolph Vines was made factory manager.

When the company had been registered in February the subscribers, with one share each, were named as Ernest Vignoles, the Reverend C.J. Vignoles, Adolph Vines, Frank Evershed, and John Evershed. The latter were brothers of Sydney, who rather surprisingly was not a subscriber himself.

The new board was faced with considerable problems. Sales in 1895 totalled £5,418, and the 43 employees were paid £2,353, made up by £1,667 for wages and £686 for salaries. It is easy to see what Vines meant by "not much expansion". Two years earlier, in 1893, sales had been slightly higher at around £5,600, and the wages bill for 31 men and boys had been £1,700.

Today, after some 90 years of inflation, it is difficult to grasp the finances of a small company in the last years of the Victorian era. What seems trivial to us was of great moment to management and employees alike. The skilled instrument makers at Evershed & Vignoles were on an hourly rate of 9d (3.75p), while piece work earnings averaged 11½d (about 4.7p). These were good wages by the standards of the time. In 1889, for example, London dock workers went on strike for 6d an hour (2.5p), and the dockers had no security of employment. The wages of skilled men did not come easily, however. The boys at Evershed & Vignoles started at 1¾d an hour - less than 0.75p.

If the amounts seem small to us, Mr Micawber's famous dictum still held good. In 1895, the new management at least came out on the right side, with a profit of £107. But if the ambitions referred to by Ernest Vignoles were to be fulfilled, something clearly had to be done.

The problems were not only those of stagnation. Working capital was small, and there was a limited range of products. On the other hand, the company had a well-equipped factory and plenty of ideas, and before long it was to enjoy those strokes of good fortune which every young enterprise needs in order to survive.

As the letter to customers quoted at the beginning of this chapter makes clear, the original instrument business had already expanded into the manufacture of helm indicators for the Royal Navy. This became a significant part of the company's activities from 1896 onwards, when the Admiralty adopted the Richards-Evershed system as the standard pattern. The development of this side of the company, and the addition of other naval equipment, will be discussed in the next chapter.

Instruments still formed the major interest of the company, and for the next few years this meant primarily the soft iron ammeters and voltmeters, with growing business in the combined ohmmeter/generator for insulation testing. The soft iron instrument was the design which Evershed had introduced in 1886, but the company had made a number of improvements over the years. It had designed different types to widen the market appeal, but the principle remained the same - current value was indicated by the magnetisation of pieces of soft iron by a coil placed round them.

In 1888, however, a rival technique had appeared in the form of the moving coil system developed by Dr Edward Weston in the United States, and the success of his direct-reading portable ammeter led to the adoption of this principle by other manufacturers for various purposes, including switchboard instruments. In these designs the moving iron (such as that used in Evershed's ammeter) was replaced by a moving coil. This was suspended on jewelled bearings in an air gap of a few millimetres between a cylindrical core of soft iron and the curved pole pieces of a permanent magnet. It soon gained a reputation for accuracy.

Evershed & Vignoles did not start making moving coil ammeters and voltmeters until 1899, and even then one feels that at first the company's heart was not in it. A catalogue of 1901 promoting soft iron instruments comments, somewhat defensively: "Although the rise into favour of the moving coil principle has tended to throw soft iron instruments somewhat unduly into the background, there remain many cases in which the latter type should be preferred."

The company was proud of its ammeters and voltmeters, and even when it introduced an intermediate range, "for switchboard work of the very highest quality where great accuracy is not required", it could not resist taking a sideswipe at its competition. "With regard to this question of accuracy," the sales literature said, "we note that some makers of cheap ammeters and voltmeters guarantee their instruments to read within one per cent. An instrument by such a maker which recently came into our hands, with seals untouched, varied by 17 per cent, according to the direction of the current, while a Volt Gauge of similar range, taken at random from our stock, had a mean error of 0.3 per cent, and a maximum error of 1 in 80."

Nonetheless, history was on the side of the moving coil principle.

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In 1895, Evershed & Vignoles made 461 soft iron ammeters and voltmeters, reaching a peak of 588 in 1898 and falling to 252 in 1902. The number of moving coil ammeters and voltmeters made by the company in 1899, the first year of their manufacture, totalled 249, but by 1902 output had risen to 861.

The lower cost gauges based on the soft iron principle survived rather better. From their introduction in 1897, when Evershed & Vignoles made 279, production increased to 1,169 in 1902.

By this date, the company was well established financially. Sales had grown steadily to reach £25,094, and the 1902 profits of £5,856 were greater than the first year's turnover, only eight years before. Although gauges - the panel-mounting ammeters and voltmeters for switchboard use - were still the largest part of the instrument business, the ohmmeter/generator (known as Evershed's Testing Set) was making increasing contributions.

From small beginnings, output of the testing set rose to over 500 by 1902. Even the following year, when production of the other main products fell sharply and there was a severe general drop in sales, output of the testing set went up. This was an encouraging augury, for the company was soon to introduce the Megger, which was to confirm the unique position of Evershed & Vignoles in the field of insulation testing.

The company was less successful in trying to broaden its range in other ways. Recording instruments, in which measurements were drawn as a graph on a moving strip of paper, were to become an important activity in later years, but the first entry was disappointing. In 1895 an agreement was reached with a Major Holden to manufacture his hot-wire recording instruments, but only a handful were made. Nor did Sydney

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Evershed have much success with a meter patent which he took out in 1897, which employed magnetic suspension of the armature. "A lot of money was spent on this meter," Adolph Vines wrote later, "but only a few were sold, it proving too expensive for commercial use."

Vines, who joined the company in 1891 and retired from it in 1939, fortunately recorded some of his early memories, and gives an often amusing insight into life in the company in the late nineties and early 1900s.

"In October 1898," he wrote, "G.J. Lemmons joined the test room staff. His chief characteristic was his capacity for writing voluminous notes and keeping records. He left in 1899 to go to the Boer War, returning in January 1901 when he was made sales manager. He left in October 1902. After a period with the Home and Colonial Stores, where he tried to teach the butchers to use a slide rule, his uncle bought him a directorship in Everett Edgcumbe Ltd."

One feels that Mr Vines and Mr Lemmons did not really hit it off.

By 1899, the new company had progressed to the point where it had to find new premises if it was to continue expanding. Additional buildings had already helped to ease the pressure at Woodfield Works, but transfer to another location became essential when the Paddington Board of Guardians bought the works, and it proved impossible to negotiate an extension of the lease. In June 1899, the company purchased Acton Green Lodge for £4,400 with a view to having a new factory built on the site. The move to Acton Lane was made in June 1903, and Evershed & Vignoles has been there ever since.

The new location, about three miles west of Westbourne Park, was

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described a few years later as "a pleasant residential district, bordering the open spaces of Acton Green". The company kept the house already on the site, known as Ivy Lodge, and this became offices. Behind the house extensive workshops were built, while other buildings were erected alongside. This was long before electronics came to measurement, and the biggest investment was in the machine shop. It was arranged on flow-line principles, with tools capable of handling a variety of metals, as well as ebonite, vulcanised fibre, and mica. Elsewhere were the coil-winding shop and a carpentry department, where the polished wooden instrument cases were made.

In 1907 the magazine Electrical Engineering published a detailed description of the Acton Lane Works, following a tour "under the able guidance of Mr Vignoles". Particular attention was given to manufacture of the Megger, and this section of the report concluded: "The more delicate parts combine the fineness of clockwork with the robustness needed in a machine that has to rough it in all climates, to stand travel, weather, and ignorant handling, and the whole have to be made on the interchangeable principle, by processes as nearly as possible automatic, for commercial reasons. There are, however, few completely automatic tools in the shop, most being of the semi-automatic type, and therefore applicable to the variety of work which passes through."

Variety, indeed, was now the order of the day at Evershed & Vignoles. Not only was the naval side of the business being expanded, several new instruments were being added to the switchboard range and the original insulation tester.

The success of Evershed's testing set had helped to open up an

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entirely new market area, that of portable instrumentation. In October 1902, the company announced another development of this kind, the cell-testing voltmeter. This was another invention by Evershed, although in this case he had been assisted by a member of the experimental department called Cox.

This moving-coil instrument, designed to test accumulators, must have been revolutionary in its day, for it could be held in the palm of the hand. Contact was made by a hooked probe described as a "barb", which was fixed on a spike attached to the case of the instrument, but insulated from it. In his other hand, the user held another barbed spike, joined to the case by a short length of cable, and the charge of the cell under test could be read on a meter by contacting the cell's terminals. There were two versions, the cost of the simplest being £4.10s (£4.50), later reduced to £2.10s (£2.50), while the leather case was an optional extra at 15s (75p).

The cell tester became one of the established products of the company, and was still being made in the 1940s, though with a Bakelite case, instead of aluminium. Cox, however, its co-inventor, did not stay with the firm. In his own time he had developed an electrostatic ohmmeter, which he offered to the management. The two sides were unable to agree terms, and in 1903 Cox joined another instrument company, Nalder Bros & Thompson, which adopted the design and put an ohmmeter on the market.

By this time, Sydney Evershed was deeply involved in developing the instrument with which he will always be associated - the Megger. As we have seen, Evershed had recognised the importance of insulation testing as far back as 1889, and the testing set which he designed had been a steady

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seller ever since. The Megger (a name coined by Vignoles, who thus added a new word to the English language) was the latest version of the testing set, and for the first time it combined the ohmmeter and generator in one box.

The thing that most people remember about the Megger is the handle of the generator, which had to be turned to produce a voltage, but in fact this part of the instrument was virtually the same as had been supplied with the most recent models of the testing set. The ohmmeter, however, was entirely new. It was a moving-coil instrument with a current-coil moving in a powerful magnetic field, and an astatic pressure coil controlled by the same field. It had a greatly extended range reaching 2,000 megohms, compared with a maximum of only 50 megohms in the original testing sets.

Several problems had been overcome to enable the ohmmeter and generator to be contained in the same box. The ohmmeter was compensated for stray magnetic fields, and there was a special guard system to eliminate errors due to surface leakage when very high resistances were under test. A constant voltage was obtained from the generator, regardless of the speed at which the handle was turned.

All in all, the Megger responded to the growing need for an instrument which could be used by the semi-skilled, and was a classic example of fitness for purpose. Simplicity of operation was the predominant feature.

"To test the insulation of a circuit," said an early Megger sales leaflet, "it is only necessary to set the Megger down on a fairly level base, connect the circuit wires to the line and earth terminals and give the winch handle half-a-dozen rapid turns. The Ohmmeter is dead beat and

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the index promptly comes to rest and points to the insulation resistance in four or five seconds from the start. That is all the user has to do... There are no switches, no plugs, no adjustments, no key to be tapped, no galvonometer to watch, no rheostat to adjust. There is no multiplying by ten or by a hundred: the scale is always read direct without any calculation whatever, and the Ohmmeter index points to where the value of the insulation resistance is plainly written in so many hundred thousand ohms or so many megohms."

There were low-range and high-range Meggers, the price going up with the measuring capability. The cheapest instrument, with a range of 0-10 megohms, cost £18.10s (£18.50), followed by the 0-20 megohms Megger at £20 and the 0-100 megohms model at £25. There were two versions in the high range, the first able to measure 5-1000 megohms and costing £32, and the other with a range of 10-2000 megohms at £37.

The descendants of that original instrument are still produced under the same name today (although, following reorganisation in the instrument industry, they are now made by a former associate company of Evershed & Vignoles Ltd).

The Megger soon became world famous, and the company wasted no time in developing an export business. In 1909 there were three "colonial" agents, in Toronto, Bombay and Melbourne, and foreign agents in Paris, Stockholm, Copenhagen, Smyrna, Buenos Aires and Yokohama. In 1910 James G. Biddle of Philadelphia started selling Meggers and other instruments in the USA.

By this time a family of instruments deriving from the Megger had been introduced. The first was the Bridge-Megger, which appeared in 1906,

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and combined the functions of a Megger with those of a Wheatstone bridge. Evershed then invented the Ducter, which applied the same principles to the measurement of low resistances.

"The task which Mr Evershed set himself," went a 1911 sales letter for the Ducter, signed by Ernest Vignoles, "was to provide a portable instrument which would measure anything from an ohm to a few microhms, and do it in less than a minute from start to finish."

Existing methods of low-resistance measurement were cumbersome and time-consuming, and Evershed hit on a solution to this problem during the development of the Bridge-Megger, while investigating the resistance of the switch contacts and connections in the resistance box. The Ducter combined in one box the functions of an ammeter, a potential galvanometer and a slide rule, and gave a direct reading of the resistance under test. The working principle was similar to an ohmmeter, and the instrument was described as a "potential ohmmeter".

Unlike the Megger, the Ducter did not have a hand generator, but used four secondary cells contained in a wooden case. One of the striking things about the company during this period, though, was the way in which it applied its repertoire of techniques to a variety of end uses. Something of an oddity, from a slightly earlier period, was Evershed's patent automatic exploder for high-tension fuses, which was intended for use in mines and quarries. Although not a measuring instrument, it used the same type of hand dynamo as the testing set and the Megger, and built its appeal on similar principles of ease-of-use and infallibility. A sales leaflet of 1903 said: "If there is a misfire do not waste time fiddling with the Exploder: if you can make the hammer sound, you and the Exploder

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have done all that a man and a machine can do. The defect is in the fuses."

Evershed's inventiveness continued to provide the company with a steady stream of new products, but others made contributions from time to time. We have already seen how Evershed worked with A.E. Richards on the helm indicator, and other engineers who played a part on the naval side of the business will be discussed in the next chapter.

Despite the unhappy experience of Cox and his electrostatic ohmmeter, ideas from outsiders were also adopted for instrument designs, and following the practice of the time the inventors' names were associated publicly with the resulting products. In this way, by the later 1900s we start to find references to the Digby and Biggs Dionic water tester and Murday's recording instruments.

The Dionic water tester was a departure for the company. Once again it adopted the ohmmeter and hand generator, but these were now applied to testing for impurities in water, a process which until now had normally relied on chemical methods. With their instrument, Digby and Biggs introduced the electrical measurement of conductivity. The water to be tested was placed in a glass U-tube, with electrodes a standard distance apart. A current was passed through the water from the hand generator, and the ohmmeter read the conductivity by direct deflection on a scale. The method was easy to use and highly accurate.

After the disappointing results with the Holden hot-wire recording instruments in the 1890s, the company had been on the look-out for a suitable design. It found it in the recorders patented by Murday, which entered manufacture towards the end of 1909. These recorders used a continuous roll of paper which lasted more than a month, but their chief feature - said to distinguish them from all other recorders of comparable price - was the form of the Murday pen. This resulted in a chart having rectangular co-ordinates, making it easy to read. The pen could also be "removed in a second, cleaned in a few moments, and replaced without the slightest difficulty".

The mechanism of the Murday recorder was simple, so prices were kept low: from £12 to £18.15s (£18.75) for ammeters, and from £13 to £16.10s (£16.50) for voltmeters.

By the period leading up to the First World War, the instrument range of Evershed & Vignoles was far wider than when the company had been formed less than 20 years earlier. Testing sets for insulation and conductor resistance formed a major part of the range, with the Meggers, Bridge-Megger, and Ducter. Other portable instruments included moving-coil voltmeters and ammeters; combined moving-coil ammeter/voltmeters; the cell tester; moving-iron ammeters and voltmeters, and combined instruments using the moving-iron principle; and ammeters, voltmeters and wattmeters of the dynamometer type. There was also the Dionic water tester.

Switchboard instruments comprised similar ranges of ammeters and voltmeters, again of moving-coil and moving-iron designs, which could be supplied in both indicating and recording versions. Another range of industrial instruments was for the measurement and recording of heat, and was marketed under the name Foster's Practical Pyrometers.

Impressive though this was, it represented only one half of the company. We must now retrace our steps to the beginning, and see what progress had been made in the equally important naval activities.

CHAPTER THREE

The naval connection: 1893-1914

When Sydney Evershed started to co-operate with A.E. Richards on the helm indicator in the early nineties, both men must have been well aware that an immense new market was opening up. Even so, they could hardly have imagined the scale of the opportunities which were to blossom during the next 20 years as a result of the naval rivalries among the great European powers.

Kaiser Wilhelm II came to the throne of Prussia in 1888 on the death of his father, and his ambitions to create a great pan-Germanic sea power soon became evident. The British government wasted no time in responding, and in March 1889 introduced a Naval Defence Act which surpassed anything seen previously. Over the next five years, no fewer than 70 ships were to be built at a total cost of £21.5 million; they included 10 battleships and 42 cruisers. This was to be only the start of the great naval building programmes of the late Victorian and Edwardian period.

Basically, what Evershed and Richards invented was a system of electrical signalling for use on board ship, and although the application was quite different, there was a close technical link with the company's measuring instruments. The first use of the signalling system was in the helm indicator, but in subsequent years there were to be several related applications.

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The system worked on the ohmmeter principle. A soft iron needle was pivoted freely at the centre of two coils whose axes lay at right angles to one another. The position taken up by the needle depended on the ratio of the currents which were passed through the two ohmmeter coils. By sliding a contact on a resistance, the ratio of these currents could be altered.

In the helm indicator, the angular motion of the rudder caused a contactor to slide on a sub-divided resistance contained in a case. This formed the transmitter, and it was connected by three wires to the indicator, which was mounted in front of the helmsman. The indicator consisted of a dial and pointer, which showed dead ahead, seven positions to port, and seven to starboard. Like the transmitter, the indicator contained ratio coils and a needle, the movement of which corresponded to the position of the contactor in the transmitter. This was used to direct the pointer on the dial in front of the helmsman.

Technically, the Richards-Evershed system had several advantages over mechanical methods of helm indication. Any change in the electrical pressure had no effect on the ratio of the currents, since both relied on the volts applied to the circuits. The instruments could therefore be run from the ship's lighting circuit.

The unique feature of the Richards-Evershed signalling system was that it was impossible for the indicator to get out of step with the transmitter. The company believed it was this fact above all which led to its being adopted so widely. A further advantage was that a large number of signals could be transmitted with only three wires, which simplified the connections and reduced the cost of fitting on board ship.

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The Admiralty learned about this development in 1893, and immediately recognised the advantages of the system over the mechanical steering telegraphs which had been used up to this time. It was arranged that the helm indicator should be fitted on HMS Howe and Narcissus, and it was so successful that further lengthy trials were carried out. In the early part of 1896 the system was fitted to HMS Royal Sovereign, the first of a new class of battleship built under the Naval Defence Act. The Admiralty then decided to adopt the Richards-Evershed helm indicator as the standard pattern for the Royal Navy. Orders for 11 ships and enquiries for five more were received in 1897, and during the next four years 21 were fitted.

As with the instrument side of the business, Adolph Vines was able to recall in later life one of the incidents of this period. He wrote that when the trials on HMS Narcissus were started, the helm indicator refused to work. Richards went down from London, and was relieved to find that the only fault was that the switch supplying the system with current had not been turned on.

Once the company had established the principles of electrical signalling on board ship, and demonstrated its competence to the Admiralty, other naval applications began to follow. It was a small step to adapt the technique to two-way communication by adding an additional wire. This was applied to steering telegraphs, so that orders could be sent to various steering stations, and also to engine-room telegraphs, anchor telegraphs, and docking telegraphs. Although the apparatus was similar to the helm indicators, in these cases the transmitters were operated by hand, and usually mounted on deck pedestals.

The arrival of W.D. Kilroy led to further developments. Kilroy had

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approached Evershed & Vignoles in 1899 with the design of a speed indicator, suggesting the company might wish to manufacture it. The proposal was adopted, and the invention assigned to the company in July 1900. Kilroy then joined the staff to work in the drawing office, and began development of what was to become known as Kilroy's Stoking Indicator, and was to prove a major asset for the company.

This invention related to the firing of the furnaces in a ship's boiler room. These were the days when coal was the principal fuel, and it was well known that if a ship's boiler furnaces were given fresh charges of coal at a uniform rate, the result would be a maximum of fuel efficiency and a minimum of smoke. This was of great significance to the Navy, for by firing the boilers at a uniform rate a battleship could extend its steaming distance by about 15% from the same amount of fuel.

Although Kilroy was an employee, he must have had considerable personal standing, as any mention of the stoking indicator was always prefixed with his name, and the same practice was followed with his later inventions. Company literature gave Kilroy the same "billing" as Evershed himself.

The stoking indicator was introduced in 1903, and the first ships to be fitted were HMS <u>Hague</u> and <u>Sutley</u>. The principle of the system was that the boiler furnace doors in the ship were given numbers (the company recommended brass, as painted numbers soon became dirty). These numbers were signalled in rotation at regular intervals by a stoking indicator which was fitted in each stokehold, and a loud gong would ring to call attention to each change of signal.

The engineering officer could control the time between the signals by setting another apparatus, the regulator, which was placed in one of

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the engine rooms. This regulator, or timing apparatus, incorporated a switch mechanism, and this would operate at the chosen intervals to close electrical circuits, and actuate the stokehold indicators. Electricity for working the regulator and the indicators was derived from the ship's lighting circuit.

The switch mechanism was designed in such a way that the stokehold indicators could not all ring at the same time, and things were arranged so that the minimum number of furnace doors would be open at one time. Even so, the life of the stokers must have been gruelling. A description of Kilroy's stoking indicators included this piece of advice:

"As a rough guide for determining the quantity of coal needed at each firing, the following may be taken as a typical case: Assuming that each boiler is to be worked at an output of 450 h.p. and that the coal consumption is 2 lbs. per 1 h.p. hour, then the coal burnt per boiler will be 900 lbs. per hour; and (taking the weight of a shovelful of coal as 10 lbs.), this is 90 shovelfuls in 60 minutes for each boiler. If eight minutes has been decided upon as the Firing Interval, the number of shovelfuls required for firing to each boiler during that interval is therefore

$$\frac{90 \times 8}{60} = 12$$

"If each boiler has 4 furnace doors this will mean 3 shovelfuls in each furnace door every time its corresponding number appears on the Indicator."

Whatever the wielders of shovels may have thought about the perpetual sound of the gongs, the stoking indicator was a great success. By 1907,

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only four years after it was introduced, indicators had been supplied to the Royal Navy, or were on order, for 31 battleships (including the Dreadnought) and 35 cruisers. The system was also in use by the navies of Japan, Austria, Russia and the United States, bringing the total to over 70.

By 1912, stoking indicators had been fitted to, or ordered for, 47 battleships and 42 cruisers of the Royal Navy. Italy and Chile had been added to the list of foreign navies, and the latest Cunard and White Star liners had also been fitted with the system. By 1915 the total of warships was over 150, besides vessels of the mercantile marine.

Meanwhile, the company had developed other applications of its electric telegraph systems for use above deck. One of these was the fire-control apparatus, which transmitted orders from the conning tower or other controlling position to the guns. The signals could include such orders as "combined fire" or "independent fire", the range in yards, and the left or right deflection. The numbers for the ranges and deflection were indicated on dials, viewed through windows, and the other orders were also given on dials or drums. This was the origin of the enemy bearing indicator which was to come into wide use during the First World War and later.

In the article about the Acton Lane Works published early in 1907 by Electrical Engineering, the principle of the fire-control apparatus was described as follows: "Each dial or drum requires a separate wire and a separate transmitting switch. These switches are geared together so as to give one transmitting handle for 'Orders', one for 'Range' (controlling five figures), and one for 'Deflection' (giving two figures and direction left or right simultaneously).

"These switches simply move a contact over a sub-divided resistance which is permanently coupled across the mains. The wire from this contact passes into the receiver, through a small bipolar motor, and thence to a contact on a similar subdivided resistance to that at the transmitting end, also coupled permanently across the mains. Any motion of the motor moves this contact, which is suitably geared to it. The whole system is now like a Wheatstone Bridge - the mains being the battery, the subdivided resistances the four arms, and the galvanometer circuit the circuit passing through the motor. If the balance be disturbed by altering the position of the transmitter switch, there are volts on the motor, which runs the receiver switch round till balance is restored, and gives the required indication of its position by dials or drums suitably geared to it."

Kilroy did not rest with the stoking indicator. He developed two other systems for shipboard use which responded to the problems being created as more and more armament was added to modern warship design.

The 70 ships authorised by the Naval Defence Act of 1889 were not complete when in 1893 the Admiralty asked for more, and the building of seven additional battleships was approved. This led to the Majestic class, the first of which was turned out by Portsmouth Dockyard in the astonishingly short time of 22 months. Between 1895 and 1904, 30 battleships were completed.

The year 1904 was significant for two events in naval history: the Battle of Toushima in the Russo-Japanese War, and in Britain the appointment of Sir John Fisher as First Sea Lord. Toushima revised naval thinking throughout the world, because the Japanese had opened fire at a range of

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7,000 yards, yet had annihilated the Russian fleet. All experts agreed that naval actions of the future would be fought at long range, but fire control was still in a primitive state. The only way to improve the hit-rate was to fire more shells.

The Royal Navy's response was HMS Dreadnought, a fast ship with five twin 12-inch gun turrets which was to be the first of a new generation of battleships. Whatever his faults may have been, Fisher was an innovator. Reference has been made to his association with Henry Edmunds in effecting the first installation of electric lighting in a British battleship in 1881. Now he backed the Dreadnought design.

By the outbreak of the First World War in 1914, the Royal Navy was at its peak. As well as the 30 pre-Dreadnought battleships completed between 1895 and 1904, there were 10 so-called "intermediate Dreadnoughts" (built 1902-08), 10 Dreadnoughts with 12-inch guns (1906-11), 12 Dreadnoughts with 13½-inch guns (1912-14), and two more under construction. In addition there were 10 ships of a new type favoured by Fisher, the battlecruiser.

But there was a problem with ships which carried more and more guns in rotating turrets: as they were trained on their targets the line of fire for one set of barrels could be obscured by another. The answer to this was Kilroy's Patent Turret Danger Signals, which appeared in 1907.

Kilroy, having used gongs to keep the stokers up to the mark, now turned to electric trumpets for the gunners. His system of turret danger signals consisted of four switches operated by cams fixed round the turret below deck. When the guns had a clear field of fire, the switch was out of contact with the cam, but as a turret moved out of its safety limits the switches would be activated. Once again the system was powered by

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the electric lighting circuit, and a two-wire ring main linked all the turrets.

In a sense, Kilroy had designed a simple computer, in which logic played an essential role. As each turret moved independently, it was not enough to sense the position of any one set of guns: it was necessary to compute a potential danger from the movement of all the guns relative to each other. This was achieved by a system of triple-contact switches, which in conditions of danger caused signals to flow to one of a pair of trumpets mounted close to the ears of the man working the gun.

"If the trumpet at his left ear sounds," wrote the magazine Engineering in its description of the system, "he is warned that his gun is endangering some other gun on that side, and vice versâ, and he must, therefore, not fire. He need not consider or remember anything else than that he must not fire when a trumpet is sounding. It is not even incumbent on him to move his gun into safety, though he will be glad to do so to stop the noise. For the noise is of a very imperative nature."

No doubt it had to be, if it was to be heard above the din of battle. Despite this the trumpet was "quite a small affair", and the man at the gun also received a visual signal.

This system of danger signals was first used on HMS Dreadnought, and was then adopted for every class of capital ship built subsequently for the Royal Navy. By 1914 the company was able to list 43 British ships, and a number of Japanese battleships and cruisers had also been fitted.

A few years later, Kilroy developed another system designed to inform those in the gun turret about the position or training of adjacent turrets. This was the Kilroy Turret Training Indicator. Unlike the danger signals, it did not give an automatic audible warning, but showed scale representations or models in plan of the turrets and adjacent portions of the ship's structure.

By means of transmitters, which varied currents derived from the ship's supply, the turret models revolved in the same way as the real ones. The bearing was shown by an index mark on the model moving over an arc or a dial, graduated and coloured to suit the particular turret.

The turret training indicator returned to the principle of the helm indicator developed by Evershed and Richards in 1893, being based on the ohmmeter. The receiver adopted the familiar design of two cores at right angles to one another, with a soft iron needle pivoted at the centre. By means of variations and reversal of the current in the coils, the resultant field - and consequently the needle - could be made to take up any direction. Unlike the cams and switches of the danger signals system, the turret was made to rotate a framework carrying four brushes on the circumference of a circle. The brushes met a series of contacts arranged to form steps on a resistance.

Just as on the instrument side of the business, Evershed & Vignoles had taken a set of basic techniques, used them first in one application, and then developed them over a period of about 20 years. In this case, the result was a wide range of products for use by the Royal Navy and other mariners. The process was not completed by any means. Indeed, innovation in naval systems has continued to the present day, although naturally new technologies have been exploited as these have become available.

In the years before the First World War, the company was also looking for wider applications of its established naval products. As well as its success in warships, it was now able to list 13 ships of the Allan, Cunard and White Star Lines which had fitted or ordered Kilroy's stoking indicator. A special brochure promoting a "merchant-service pattern" was produced.

But the timing was not propitious. It was March 1914, and within a few months the navies which the European powers had been building up for a quarter of a century were to be locked in battle. For everyone, including Evershed & Vignoles, things would never be quite the same again.

CHAPTER FOUR

Steer by Evershed: 1914-1918

This chapter is still being researched.

It will aim to tell how the company fared during the First World War, with particular emphasis on the naval products. It is hoped to establish the circumstances of the "Steer by Evershed" order at the Battle of Jutland.

Other matters being investigated include the development of the Chiswick site during this period, and the effect of the war on employment (including the addition of women to the work force).

Reference will also be made to any developments on the instrument side of the business - for example, the rail contactor.

CHAPTER FIVE

A different world: 1919-1929

There is no single view of the 1920s. For some it was the Jazz Age, when a new social freedom overturned past conventions. For others, it was a time of industrial strife, culminating in the General Strike. Yet again, the period is seen as a headlong rush towards the economic crash of 1929, which ushered in the Depression of the thirties. But wherever one places the emphasis, the decade which followed the end of the First World War was different from anything that had gone before.

Change affected Evershed & Vignoles, just like everyone else. There were some constant factors. The company was still headed by its founders, although Sydney Evershed soon withdrew from active involvement. Acton Lane continued as the company's location, as it has to this day. The product lines remained broadly the same. But all this was against a background of fundamental changes in the world in general, and particularly in the markets where the company had built its success.

The most far reaching of these changes concerned the world's navies. For 20 years up to the outbreak of the First World War, Evershed & Vignoles had prospered from the race between the great powers for naval supremacy. By 1914, Evershed telegraphs had been supplied to 68 battleships of the Royal Navy, nine battlecruisers, 39 cruisers, and 53 light cruisers. The stoking indicators, turret danger signals and fire control systems had

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also been installed in many ships, foreign as well as British. Now, with the return of peace, Germany was thought to be out of the contest, and the victors adopted a different approach.

In November 1921, delegates from Britain, France, Italy, the United States and Japan met in Washington to discuss limitations on naval arms. The result of this meeting was the Washington Treaty, which established the size and numbers of ships to be built. It was agreed that there should be a standard displacement of 35,000 tons, and a maximum gun calibre of 16 inches. Britain was allowed 22 capital ships, but this had to be reduced to 18 by 1927. The American allocation was 18 from the outset, and the French, Italians and Japanese were allowed 10 each.

This was a drastic reversal of pre-war policies. In 1918 the Royal Navy had 60 battleships in service. Now under the Treaty many of these ships were to be scrapped, and - more important for suppliers of naval equipment - very few were to be built. The Washington meeting was far less specific in putting limits on cruisers and smaller ships, and Evershed & Vignoles would benefit from building programmes for these classes. But in general, the Treaty initiated a period of naval restraint in place of unbridled expansion.

This was not the only setback for the company's naval business. In 1912 the Royal Navy, following an American lead, had built its first battleships to be powered by oil rather than coal - the Queen Elizabeth class. The pattern for the future was set, for the use of oil resulted in several benefits: a great saving in weight and space, faster refuelling, and the ability to stay at sea for longer periods. The Admiralty decided that in future oil would be used throughout the fleet, and the need for Kilroy's stoking indicators began to disappear.

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Fortunately for the company, there was a pent-up demand for the Megger throughout the world, and with the growing use of electricity there was also a need for indicating and recording meters in power stations. As a result, instruments now became the company's major activity, but it was not simply a matter of picking things up and carrying on without change. The wooden-boxed Megger had been conceived almost 20 years earlier, and technology had not stood still. The directors decided it was time for an addition to the range which would be smaller and lighter, and Sydney Evershed said, in effect, "leave it to me". Who better to tackle the job than the man who had designed the Megger in the first place?

The result, regrettably, was a disaster. Evershed was now well past 60, and had become increasingly set in his ideas. The board felt they could not accept his design, and asked a newcomer to the company, G.B. Rolfe, to take the task on. Rolfe succeeded in producing a Series 2 Megger which was much smaller than its famous predecessor, and achieved lightness through housing the instrument in an aluminium case. The design was adopted immediately, and launched on the market in 1922 as the Meg.

Evershed was furious, and from then on would have nothing to do with Meggers. His growing conviction that his views were the right ones in matters of electrical measurement had another unfortunate effect at about this time. The company was still attracting individuals with inventions which they thought Evershed & Vignoles might take up, just as it had the ideas of Kilroy or Digby and Biggs. In the early twenties it was offered the Avometer, the first portable instrument to combine in one case the measurement of amps, volts and ohms.

On this occasion, Evershed gave short shrift to the inventor, for

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in the Avometer ohms were not measured with a ratio meter. Evershed could not accept an instrument that did not use this principle, and the Avometer went to another manufacturer, to become one of Britain's standard electrical field-service instruments. It was to be some 50 years before the Megger and the Avo came together in the same company, in circumstances which Evershed could hardly have foreseen.

Sydney Evershed withdrew from day-to-day business with the company in 1923, although he remained as chairman. He was now able to concentrate on his research interests, with a laboratory on the premises and the assistance of Sidney F.W. Finnis, who was his chief experimentalist for over 30 years.

Magnetism is the area in which Evershed will always have a place in the history of electrical research. Now he concentrated his activities in the field of magnetometers - instruments which measure the intensity of magnetic fields - and carried out a long series of studies into permanent magnets which resulted in several papers to the Institution of Electrical Engineers. After Evershed's death, Finnis prepared some notes on his work which referred to "Mr Evershed's 'Current Ring' theory of magnetism... regarded by myself as one of his masterpieces".

Although no longer directly involved in running the company, Evershed had not moved into an ivory tower. Much of his research had direct commercial value, but the development of products passed into other hands. Throughout the twenties, Ernest Vignoles remained joint managing director, a position he shared with Adolph Vines, but Vignoles was now almost exclusively concerned with financial matters. The stars in the technical firmament were G.B. Rolfe and J.C. Needham.

(Biographical information on Rolfe and Needham to be inserted.)

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With his design of the Series 2 Megger, Rolfe ensured that the position in insulation measurement which the company had secured with Evershed's original design would not slip from its grasp. Although launched under the name Meg, the instrument was usually referred to as the Series 2. It was not finally phased out of production until 1963, when it was superseded by the Major Megger. By that time it had gone through many developments, and there were no fewer than 32 different instruments in the series.

On all counts, the Series 2 must be reckoned an outstanding example of industrial design. In general outline it followed the Series 1, with a generator handle at one end and the dial on top, but in replacing the heavy teak box of the Series 1 with a cast aluminium case Rolfe had not fallen into the trap of simply reproducing the forerunner in a new material. The Series 2 was no "horseless carriage": it was given an appearance that was almost streamlined, and which did not look out of date 40 years later. It was not a direct replacement for the original Megger - the range of the first Series 2 was 0-100 megohms, while one of the Series 1 models went up to 2000 megohms. It had some other limitations compared with the original.

That was not really the point. The company had judged the market admirably, and once again had followed the classic principles of fitness for purpose. The Series 2 Megger weighed under 7 lb; this was far less than the original Megger, whose sales literature did not quote a weight at all, relying instead on references to the "strong leather handle" and the "stout metal lid".

In launching the Meg, the company said frankly: "Two objections

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only have ever been urged against the Megger Testing Set - firstly, that its weight was irksome when it had to be carried long distances, and, secondly, that its price made its acquisition difficult for the man with a small business". As well as dealing with the weight problem, the Series 2 had a lower price. It was said to be "so cheap that a contractor can largely multiply his testing facilities at reasonable cost".

In fact the first model was priced as £17, compared with £25 for a Series 1 with the same measurement range. In designing the new instrument, the company seemed to have thought of everything. Even the canvas case with which it was sold provided space for "leads, small tools, and on occasion for a packet of sandwiches".

The Series 2 Megger was extremely successful, and evolved throughout the twenties. In 1932 the Wee Megger was introduced, but the Series 2 continued to be extended with the addition of a continuity range, a high-range version, and much later a mains-operated instrument.

The growth of the business had demanded expansion at Chiswick. When the Acton Lane Works were first put up in 1905, most of the buildings were single-storey structures. Ivy Lodge was on two floors, but the main workshops behind it were on ground level, with a sawtooth roof giving north lighting to six bays. There was a separate power house, and the battery house and calibrating room were also separate structures. In addition, a two-storey main building contained the stores, adjusting room, and winding room. The general offices and drawing offices were in Ivy Lodge.

There was plenty of open space. Murray Vines, the son of Adolph Vines, remembers a huge garden with lovely mulberry trees. More alarming was a

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man called Austin, who kept pigs there, and some wild dogs which were used for security.

Some expansion of the Acton Lane Works was undertaken during the First World War, and by the mid-twenties the time had come for more. From this date the site began to take on the appearance that it has today. A three-storey block went up in 1926, housing the marine shop, test room and drawing office on two floors, and a tool room on the other floor. On another part of the site a four-storey Megger Department was erected. Within a few years the extensions had taken the floor area to 111,000 square feet, but Ivy Lodge remained, and there was still room on the site for further growth.

While Rolfe was rejuvenating the instrument side of the business, Needham was making his mark with naval systems. He first came to notice in 1920 with a system of speed control, known as Needham's Pulsator (in contrast to Rolfe, who was never given such public recognition for his work on the Series 2 Megger).

Measuring the speed of machinery had been a fairly minor part of the company's activities for several years. When W.J. Kilroy had approached Evershed & Vignoles in 1899 it was with a design of speed indicator, and this was assigned to the company when Kilroy joined the staff. It was not until 1913, however, that sales literature began to refer to "Evershed's electrical speed indicator", and this remained in the catalogues for several years.

It was a fairly simple device, depending on the variation of electromotive force developed by a magneto-generator, which was driven by the mechanism whose speed was to be indicated. The EMF was proportional

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to the speed, so a suitably calibrated voltmeter could be used as the speed indicator. With typical Evershed inventiveness, it brought together otherwise unrelated techniques used in different company products.

Needham's Pulsator was based on a different principle, and in this case Evershed seems to have had no objections to its being adopted. Indeed, the 1920 leaflet which announced the Pulsator not only pointed out the limitations of mechanical systems of speed measurement, but also mentioned the drawbacks of the voltmeter technique used in Evershed's own indicator.

The principle of the Pulsator was described as follows: "Briefly, the method consists in charging and discharging an electrical condenser at a rate proportional to the engine speed, so that a pulsating current is set up which varies in magnitude with the speed of the engine. This current is measured by a method of balancing, wherein indicators, both at the transmitting and receiving ends, show a zero reading, when a graduated rheostat is adjusted to a position corresponding with the engine speed. No permanent magnets, friction drives, variable friction gearing, or other parts involving uncertain constants, are employed, the continued accuracy of the readings being ensured by the adoption of absolute constants, namely, the capacity of a condenser and the value of a non-inductive resistance."

Though the technical principles were a new departure, the Pulsator fitted in well with the company's other naval products. Like the helm indicator, it could be run from a ship's lighting circuit, and could be used as a speed telegraph and reply, thus strengthening the company's position in the sector of the marine market served by the Evershed orders telegraph.

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When the company said the Pulsator offered a means of controlling the speed, it was not, of course, referring to automatic control. Closed loops and feedback systems would not arrive until much later. With the Pulsator, signals could be sent from the various stations to those in charge of the engine, ordering the speed at which it should be driven. The reply, however, was automatic, so that those issuing the orders could tell at once whether they had been carried out.

Needham followed the Pulsator with a revolution counter, which allowed engine revolutions to be totalled and indicated at a distance. He also effected substantial improvements to the Evershed enemy bearing indicator, making it much more sensitive, so that it could bring the guns on to the target far more accurately than before. He became manager of the Naval Department, and later a director.

For most of the twenties, however, the emphasis was on the instrument side of the company, with the successful Series 2 Megger and the other portable instruments, recorders of various kinds, and indicating instruments for switchboards. Evershed & Vignoles picked up such naval work as there was. Under the Washington Treaty, Britain was allowed to build two new 35,000-ton ships armed with 16-inch guns, and these - the Nelson and the Rodney - were completed in 1927.

Murray Vines, who joined Evershed & Vignoles in that year as a draughtsman in the Naval Drawing Office, remembers this time well. In 1928 he transferred to the company's outside naval staff, and was involved in installing enemy bearing indicators, searchlight controls, turret danger signals, torpedo controls, and other systems in Rodney, Nelson and the Kent Class cruisers.

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Another development had little impact on the main business of the company at this time, but was to become a major activity in later years. This was the development of fractional horse-power electric motors. It came about to meet an internal need connected with naval equipment, and the design of special-purpose FHP motors continued throughout the thirties. These were not to be marketed outside the company until after the Second World War, but today the Powerotor rotary components represent about half of Evershed & Vignoles' business.

By the end of the twenties, the management could look back with some satisfaction. The company had made a successful transition to the changed conditions of the post-war period. The products on which its fortunes rested had been brought up to date. New men had been found to carry on the inventive strain on which the company must rely for its future development. The level of business had grown, and the Acton Lane Works had been expanded considerably during the latter part of the decade.

All these strengths were now about to be tested by the economic strains of the thirties.

CHAPTER SIX

Hoping for peace, preparing for war: 1930-1939

In 1931, Evershed & Vignoles took part in an exhibition at Olympia in London. The display included helm indicators, order telegraphs, and other naval equipment, but an exhibit which attracted particular attention was the Evershed Midworth distance repeater. It was one of the earliest indications to the general public that the company was adding yet another string to its bow.

The Midworth distance repeater had been announced earlier that year, and was a further example of an inventor being granted public recognition: Midworth was a member of the company's Instrument Department. Although the distance repeater represented a move into a new market area, it was also an application of the techniques of electrical communication in which the company was well versed.

The Midworth equipment was designed for the remote control of unattended electrical sub-stations. The device would start and stop machines, raise or lower the machine voltage, open or close circuit breakers, and indicate at the control position the conditions which existed at the sub-station.

This was a valuable addition to the array of products the company could offer, and came at a time when economic conditions made any possibility of new business doubly welcome. In the wake of the world

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financial slump, there was an inevitable reduction in the traditional areas of activity, although naval systems continued to be developed under Needham's guidance, and several new versions of the Series 2 Megger were introduced.

In its first application, the Midworth distance repeater did not take Evershed & Vignoles very far from familiar territory. It was used in the electricity supply industry, with which the company had a relationship stretching back to the 1880s through its provision of switchboard instruments, and later of the Megger and chart recorders. Before long, however, this was a departure which would lead into totally new areas, and in the forties and fifties was to give the company a significant place in process control instrumentation.

Even in the thirties the trend towards this new aspect of the business was becoming evident, and by 1935 the Midworth system had been developed for the distant indication of water level in reservoirs. It could also be used for indicating other quantities, and when it was shown at the Physical Society Exhibition in London in January 1936 the magazine The Engineer described it as "one of the most interesting exhibits".

The thirties were a time of change in several ways. Following Sydney Evershed's withdrawal from day-to-day affairs in 1923, Ernest Vignoles now decided the time had come to retire. He resigned his posts as managing director and secretary in 1931, but like his long-standing partner Evershed he did not turn his back on the business. His first step was to make a world tour, combining this with visits to the company's overseas agents. He remained on the board, and was active until a few weeks before his death in 1948, in his 84th year.

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Evershed & Vignoles continued to be a family company run by engineers, and at board meetings the talk was generally of products rather than finance. After Ernest Vignoles' retirement, the family link was retained by his brother, Walter Vignoles, joining the company. The unusual practice of having two managing directors was continued, and Adolph Vines - who had held this position since 1909 - now shared it with Walter Vignoles.

Like his elder brother, Walter Vignoles had joined W.G. Goolden & Co as a pupil. That was in 1891, and he was no doubt well acquainted with Vines, who joined the company in the same year. Walter, however, pursued his subsequent career elsewhere. This took him into the electricity supply industry, and from 1901 he was borough electrical engineer at Grimsby. During the First World War he served in France, and became a battalion commander with the Northumberland Fusiliers. He retained his rank after returning to civilian life, and was always known as Lieutenant-Colonel Vignoles.

Around the time that one Vignoles was handing over to another, a crisis blew up which had the potential for severely damaging a key part of the business. A member of the Test Room staff, a man called Clark, moved to the General Electric Co with the aim of producing a smaller insulation tester than the Series 2. At the home of the Megger, the response was immediate. G.B. Rolfe once again stepped in, and a new instrument was developed in the remarkably short time of three months, including making all the tools and getting it ready for market. This instrument was given the name of "Wee Megger".

The lightweight insulation tester being developed by GEC had gone a

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long way, but there was no doubt who had won the race. A verbal agreement was made with GEC under which Evershed & Vignoles would supply the company with the Wee Megger at a very low price, so long as GEC gave up its own product. The deal was struck, and thereafter a close relationship developed between Evershed and GEC.

(Description of the Wee Megger to be inserted.)

With the two founders in nominal retirement, by the mid-thirties it became clear that a new generation would have to take over the running of the business before many years had passed. In 1935 the directors were still Evershed, Vignoles and Horace Gregory, with Adolph Vines and Walter Vignoles as managing directors. The first three now took no active part in the business, and it was also recognised that the increasing age of the managing directors meant that the management must soon be transferred to other hands. The board considered the alternatives, and in August 1935 set out its proposals in a letter to shareholders. Most of these were the friends and relatives who had been persuaded by Ernest Vignoles to invest in the company on its foundation in 1895.

One possibility that was considered, but rejected, was the formation of a public company. It was unanimously decided to keep the status of a private company, "and to look among the present employees for suitable men to carry on the daily management in the future". The letter pointed out that the two managing directors were assisted by departmental managers who had been with the company for a long time, and this was clearly the recruiting ground.

It was not, however, simply a matter of promotion. The letter from the directors went on: "The Board are very definitely of the opinion,

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and would impress this strongly on the Shareholders, that the success of the Company in the past has been largely due to the fact that its daily work has been conducted by men who, as Shareholders, have held a large financial interest in the Company."

The way in which the rising managers were to be admitted as shareholders was fairly complex. Briefly, the existing shareholders were rewarded for their loyalty with a distribution from a general reserve which had been built up over the years. This distribution took the form of preference shares, and in return each shareholder was asked to sell a portion of his ordinary shares to the individuals likely to take over the daily management.

Although the letter setting out the scheme was signed by Walter Vignoles as company secretary, it may well have reflected the financial acumen of Ernest Vignoles. Certainly, the scheme had been devised in such a way that everyone should gain, and nobody should lose.

"Study of the scheme," the letter said, "will show that an existing Shareholder will obtain a well secured return of six per cent on shares representing approximately his original investment in the Company, with greater security than he now has for the corresponding amount of capital.

"If the Shareholder invests the money he receives by the sale of his shares under the scheme in securities bringing a return of 4 per cent, his total income will be greater than under present conditions, so long as the future profits do not surpass the average of recent years.

"If, however, as the result of the efforts of those who will be responsible for the future conduct of the business, the profits should be restored to higher levels, the existing Shareholders will derive a

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corresponding benefit in virtue of the ordinary shares he will retain under the scheme."

The transaction behind this somewhat involved argument throws an interesting sidelight on the scale of finance in the mid-thirties. The general reserve, which had been built up over the company's 40 years of life, stood at £60,000, and this was reduced to £26,250 by the creation of preference shares. It may have seemed a lot of money at the time, but even in the thirties it would not have gone far had the company wished to expand seriously in a new direction. In the period following the Second World War, the lack of real financial resources was to have far-reaching consequences once process control instrumentation became a major activity.

Two of the younger generation who were coming to the fore in the mid-thirties were Murray Vines and D.D. Walker. They were to play a leading role in later years, becoming the last to share the position of managing director.

As recorded in an earlier chapter, Murray Vines was the son of Adolph Vines, and had joined the company in 1927. After his experiences with the outside naval staff, he returned to Chiswick to work in the Naval Test Room and two of the drawing offices. He became head of the Tool Drawing Office in 1933, head of the Commercial Drawing Office the following year, and assistant works manager in 1937. He was made a director in 1938.

Walker was about the same age as Murray Vines, but his career with Evershed & Vignoles developed on the sales side. He had joined the company in 1930, and spent a few months in the Megger Test Room and Instrument Test Room, but from the beginning of 1931 was attached to the sales office.

Everyone was expected to work his way up. Walker had been educated

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at Rugby and Cambridge, where he read mathematics and mechanical science, and before joining Evershed had spent a year as assistant to the works manager of an engineering company, and another year as articled clerk to a firm of accountants. As a salesman, however, he had to do his apprenticeship "on the road", and from June 1931 to the end of 1932 was visiting customers outside London where there was no representative - roughly speaking, all of England south of a line from Hull to Bristol.

Since its earliest days the company had looked on the world as its market place, and Walker soon began to travel abroad. Between Rugby and Cambridge, and during the long vacations, he had stayed in Germany to learn the language, but his first extensive overseas trip for Evershed was to Canada and the United States from July 1934 to February 1935. He described the reason for this visit as "mainly correcting trouble in remote control equipment but also investigating the market".

When he returned he was given responsibility for overseas agents and the export business, and visited Poland, Austria, Hungary and Czechoslovakia. Another lengthy tour followed between October 1936 and March 1937, when he visited South Africa to stimulate business and attend the British Empire Exhibition. He appointed four new agents, and called on others on the way home in Rhodesia, Egypt, Palestine and Italy.

Murray Vines' foreign travels were more modest. His responsibilities tied him to Chiswick, but he was able to make a short visit to the Leipzig Fair in 1936 to get an idea of Continental instrument practice.

Within a few years, travel outside Britain was to be denied to practically everyone except the armed services. Even in 1936 it was becoming increasingly obvious that peace in Europe might not hold, and

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in that year the Admiralty began to call together those engineering companies which had a critical role to play. Each was allocated certain tasks, and in the case of Evershed & Vignoles the expenditure on naval work was to be about 10 times the amount currently being spent.

After the long period of restraint in the naval building programme, Evershed responded to the new demands with a will. The company stepped up work on the enemy bearing indicator, and also undertook the development of anti-submarine systems, turret danger signals, searchlight controls, and torpedo controls.

This upsurge in defence contracts also gave a fillip to the work on special-purpose FHP motors, which had been proceeding steadily throughout the thirties. The motors were still intended to meet only an internal need, but the foundation of an important future business was being laid.

One significant development in this area related to stepping motors - rotary units with a shaft that moves in discrete steps when the stator is energised sequentially. These devices were adopted for telegraphy on board ship early in the century, but before 1920 used soft iron rotors and single/double coil excitation, and suffered from a number of operational problems. Evershed & Vignoles had started working closely with the Admiralty during the twenties on alternative designs, and this led to the manufacture of M-type stepping motors. They were quickly established as the standard repeater motor system for all naval equipment.

A number of companies made M-type motors for the Royal Navy, but Evershed & Vignoles was particularly active in developing the type throughout the thirties, and applying it in a wide range of uses. Development has continued to the present day, and stepping motors form part of the company's Powerotor products.

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As the end of the decade approached, it became increasingly clear that war was not far away. Evershed & Vignoles was already making its contribution, and would continue to do so throughout the war years. When hostilities were over, the company was to be much bigger; and, far from being exhausted by the effort, it would be ready to tackle new ventures.

Before being launched on these momentous years, there were two events which marked a break with the past. In March 1939, Adolph Vines retired after 47 years with the company, the start of his service pre-dating the formation of Evershed & Vignoles itself by four years. He had been a managing director for 30 years. But as usual, retirement at Evershed was a relative term. Vines became chairman, and held this position until his death in December 1951 in his 85th year.

Sydney Evershed, that inventive and perhaps rather quirky man, died on September 18, 1939, two days after his 82nd birthday. Ernest Vignoles wrote his obituary for the Proceedings of the Institution of Electrical Engineers, the body to which Evershed had first been elected in 1886, and in which he had played an active role.

It was some 50 years since Sydney Evershed and Ernest Vignoles had worked together investigating the magnetic properties of iron. When they formed their company they were to prove the ideal partnership, able to do far more together than either could have done alone. In later years they may have grown apart slightly, Evershed the research man at heart, and Vignoles involved in business. But they had remained on good terms, and now Vignoles summed up his long-standing partner in these words: "Evershed was a man of great culture, and remarkable both as speaker and as writer. Favoured with a retentive memory, he seemed never to forget anything he had once acquired."

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And he made a comment which seems to give us the flavour of those early board meetings, when the talk was all of products, and never of money. "He was charming when in the company of a few chosen friends," Vignoles wrote, "and full of quaint quips and odd humour. His encyclopaedic knowledge and the wide range of his interests made him a most entertaining companion."

CHAPTER SEVEN

Under bombardment: 1939-1945

The Second World War was the first in history to place practically everyone in Britain in the front line. During the hostilities of 1914-18 there had been some bombing of London and other parts of the country, but those at home had been remote from the horrors of the trenches and the great battles at sea. By the thirties, it was realised that developments in aviation meant that war could be brought to everyone's doorstep.

After the period of the "phoney war", which lasted from the declaration in September 1939 until the early part of the next year, London and other cities suffered daylight bombing raids during the summer of 1940, night attacks throughout the following winter, and later in the war the hazards of the V-1 flying bombs and V-2 rockets.

Although not situated in an industrial area, Evershed & Vignoles was in a part of London where a number of factories had grown up. The Acton Lane Works would clearly be in the line of fire. Preparations to protect the employees and, so far as possible, the works itself began well before the outbreak of war. A factory civil defence organisation was set up early in 1939, and construction of air raid shelters to house some 1,500 people was started. The size of the shelters showed considerable foresight: in the late thirties, the numbers employed by the company totalled 800-900 people, but this figure grew to about 1,800 during the war years.

The abbreviation on everybody's lips was ARP - Air Raid Precautions -

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and these involved far more than shelters, which were provided by digging a series of tunnels under the main buildings. There also had to be an air raid warning system, camouflage, a fire brigade, and a first-aid squad with a suitably equipped centre. Employees had to take on additional duties as roof-spotters, shelter wardens and fire pickets. Murray Vines wrote later that the most irksome measure was the black-out. From the outbreak of war until its closing months, every house, factory, shop or other building had to erect curtains or screens to prevent even a chink of light showing once darkness had fallen. Outer doors were surrounded with structures of boards or curtains, so that when they were opened no stray beam of light would give the waiting enemy a chance to pounce. Throughout the war, Evershed & Vignoles was fined only once for transgressing the black-out code, but the cost of this was eternal vigilance.

Another problem, and one which was also faced by every company, was the introduction of conscription, under which all able-bodied men (and later some women) could be called up for service in the armed forces. Certain key personnel were judged to be in reserved occupations, and were able to continue working, although much time could sometimes be spent in proving the need for exemption to the committees which had been set up for this purpose.

As the war went on, Evershed & Vignoles was involved in a continual juggling act to match production with personnel. The level of work on the company's established products continued to increase, but many of those who knew how to make them were called up, and replaced with others who had less experience. Women began to play a more prominent role in

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the production areas, setting the pattern that was to continue in the post-war period of full employment. Later in the war, the company was making products for the Royal Air Force, as well as for its old customer the Navy, and this introduced the additional strain of becoming familiar with new designs and technologies.

The first real test of wartime conditions came in the summer of 1940 during the Battle of Britain. Daylight raids on London started in earnest on August 15, 1940, and the company followed the procedure which had been laid down during practice periods: everyone went to the shelters when the public air raid alert was sounded. It soon became evident that this would not do. Between August 13 and September 5, some 32,000 production man-hours were lost.

Following a meeting attended by representatives of all the employees, it was decided that work would not stop when the public alert sounded. The company's spotters on the roof of the works would give a warning only when there was local danger. Bells in each department were then sounded to signal a rapid withdrawal to the shelters. After the war, Murray Vines wrote a booklet called A Factory at War, and estimated that this system saved the country about 213,000 of the company's production man-hours between September 5, 1940 and February 1, 1941.

For Evershed & Vignoles, the loss of production was the most serious effect of the air raids. Fortunately the Acton Lane Works suffered only one direct hit, when incendiary bombs did extensive damage on the night of September 27, 1940. It was early morning before the fire was brought under control. The works brigade had worked swiftly to contain it as much as possible, and were then joined by appliances from the local fire

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brigade to finish it off. In A Factory at War, Murray Vines wrote:

"Daylight revealed the 'R' Drawing Office and Costs Office to be a complete shambles into which molten castings and other contents of the 'Museum' Stores above had tumbled when the roof and floor collapsed. The main Machine Shop was flooded, but no machinery had suffered any serious damage."

The Drawing Office and Costs Office staffs saved as much as they could, and moved to the top floor of a new canteen building. Work was back to normal within a week. Temporary repairs were carried out to the damaged buildings, but within a year it was possible to replace them with a larger and more modern structure.

The worst of the air raids came to an end in the spring of 1941, but the works civil defence force had to keep in training. The next big test came at the beginning of 1944, when a new series of night attacks started, this time with the use of marker flares. Several high-explosive and incendiary bombs fell in the Acton area, but this time the factory was spared. There was a serious effect on the work of the night shift, however, and many production hours were lost.

In June 1944 the attacks by V-1 flying bombs began, and a new technique of warnings had to be devised. Flying bombs had the advantage (if that is an appropriate word) of being visible to the roof-spotters before they crashed, making warnings possible. The problem was that the missiles appeared at such frequent intervals that use of the shelters was not practicable. Instead, as soon as a flying bomb was spotted a "crash" warning was issued, and everyone would dive under his bench or to some other nearby place of relative safety. They would stay there until

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the spotters broadcast the signal "Immediate danger passed". This saved a lot of production time, although the interruptions were far from negligible. There were as many as 22 "crash" warnings in one day, and some of these could last as long as 15 minutes.

This system had to be revised when it was discovered that some flying bombs glided for considerable distances after cutting their engines. As a result, a "crash" warning was given when a V-1 had penetrated a 10-mile radius of the works. Most people now used the protection of the staircases as shelters, and Murray Vines recorded his belief that the majority took more precautions against injury at this period than at any other time during the war. During June, July and August of 1944, there were 892 "crash" warnings, and the stoppages meant that a lot more production was lost.

The final stage of aerial bombardment opened in September 1944 with the arrival of the V-2 rockets. This time no warnings at all were possible. Murray Vines wrote: "A sudden 'crump', another V-2, produced at first a short silence in a workshop, followed by a buzz of conversation and apprehension as to where it had fallen." The organisation which the works civil defence services had set up during the period of the flying bombs was maintained, but nothing else could be done. Fortunately, the Acton Lane Works once again escaped damage from both the V-1 and V-2 weapons, although numbers fell in West London.

In the late thirties, when war seemed possible, plans were drawn up for some companies engaged in vital work to be sent to safer locations throughout the country. Many moved at least part of their production in this way. Evershed & Vignoles stayed where it was, and it was only

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at a late stage of the war, during the period of flying bombs and rockets, that the Admiralty and the management completed details for a move away from London at a few days notice, should this become necessary. The instrument work would have gone to Birmingham, where an option on a building had been obtained, and the naval section to Norwich, where Laurence, Scott & Electromotors Ltd would have acted as "host" firm.

Murray Vines wrote: "This plan, requiring such quantities and diversity of transport and mass billeting at the reception ends, was happily never put to the test, but it hung, like the Sword of Damocles, over our heads for two months." At the time, of course, very few people in the works knew of the plans.

All these problems with bombs and rockets, black-out and "crash" warnings, were only the background to the real purpose of life, which was to increase production and develop new products that were being demanded by the increasingly technological forms of warfare coming into use. About 70% of the company's work was now on the naval side of the business, but as the war went on its responsibilities widened to take in an increasing amount of aircraft work.

This had started in 1941, when an Evershed & Vignoles proprietary design for a free-float fuel tank gauge was adopted for the Stirling bomber, and later for the Mosquito. The company was then asked to undertake more aircraft work, and, although it was heavily engaged in meeting the demands of the Royal Navy, it was able to expand into this area, too. The company made a lot of trim tab controls, which were used to adjust the aircraft to load and conditions. These made use of the M-type motors, so were a good match for Evershed's expertise, and were

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fitted to the Sunderland flying boats, to the Stirling, and to several other machines. This work was followed by proprietary designs for a flap synchroniser and aero-engine throttle controls.

Some of this work continued after the war, until it was decided to withdraw from serving the aircraft industry altogether in the fifties. The developments which were undertaken during the latter part of the war in FHP motors, however, carried the company further along the road which was to lead to a major part of today's business. One of these was the proprietary design for the Powerotor position transmitter, a DC three-wire system, which was developed in 1944. It was followed the next year with a series of miniature high-acceleration DC servo motors.

These FHP motors are a key component in the company's naval equipment, but aircraft applications were also involved. Such uses were spurred on when a German aircraft which had been shot down was found to be using FHP electric motors to manage the control surfaces, rather than the hydraulic systems which had been the normal practice up to this date. The advantages were rapidly recognised by British aircraft designers, and Evershed & Vignoles was one of the companies asked to make the motors by the Ministry of Aircraft Production.

Hostilities ended in 1945 with the capitulation of Germany in May, and of Japan in August. Throughout the war there had been the problems of building up and maintaining production with a shortage of skilled staff and materials, of wrestling with new product designs from unfamiliar customers, of air raids and much more. Many employees had taken on additional duties in civil defence, not only in the works but in the areas where they lived. A Home Guard unit had been formed in June 1940 to

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protect the factory. It began with the members wearing civilian clothes, parading with broomsticks, but after many evenings and weekends had been given up, the unit evolved to a high pitch of efficiency.

Now that peace had at last arrived, anyone might be forgiven if he or she thought the time had come for respite. But that was not the way of things at Evershed & Vignoles. The company had already started on a new field of endeavour which was to become increasingly significant in the post-war years - the instrumentation and control of industrial processes using the new techniques of electronics. The consequences of this were to be far reaching.

CHAPTER EIGHT

New fields to conquer: 1945-1961

Until the fifties, when the transistor became commercially available, electronics depended on the vacuum tube, or valve. The technology had originally been applied in radio communications, and then broadcasting. By the end of the Second World War, engineers were looking forward to a further expansion of electronics as television services were resumed, and research laboratories on both sides of the Atlantic were making the first faltering attempts to build digital computers. But the use of electronics in manufacturing industry was in its infancy, and some believed that the demands of industrial environments would prevent the technology ever being used successfully.

The decision of Evershed & Vignoles to apply electronics to the control of industrial processes was therefore a brave one. As we have seen, the company had expanded its activities in the thirties to embrace the remote control of electricity sub-stations and the distant indication of water level in reservoirs, using the Midworth system. This was a straightforward extension of the work in electrical telegraphy which dated back to the helm indicator in the 1890s, but the company's traditional expertise in measurement and control had always lain in electromagnetism, rather than electronics.

Despite this, the directors had started to consider the application

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of electronics to process control as early as 1944, when the war was still far from won. By 1946, with the help of some Polish employees who were excellent mathematicians, the company had devised the first three-term process controller - a device which automatically regulates a process in proportional, integral and derivative terms, thereby neutralising and terminating an error condition. This development attracted a lot of interest, and it was put to the test in a lime washeries plant, followed later by the full-scale electronic control of a sulphur dioxide plant.

To move strongly into this market, however, needed the backing of a major customer. While efforts were being made to attract such interest, electronics was applied successfully to some of the company's earlier developments. By 1947, Evershed was able to demonstrate an electronic repeater which operated over telephone lines to give a distant indication of variable physical quantities. Another development was a modified form of the Noflote control system, which automatically operated electrically driven pumps in accordance with variations in water level, but without the use of floats.

Then in 1948 came the step which took the company into the front rank of industrial instrumentation. The Anglo-Iranian Oil Co (later British Petroleum) decided to investigate the possibility of process control by electronic means, and focused its attention on the work being carried out by Evershed & Vignoles. Up to this time the size of the American petrochemical industry meant that instrumentation and control in oil and chemical refineries had been dominated by US companies, and the technology they had employed had been exclusively pneumatic. Now the

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use of electronics was being pioneered by a British instrument company, and one which had not previously had a significant place in process control at all.

The man who did more than any other individual to take Evershed into this new territory was W.T. Marchment. He was not a newcomer. Tony Marchment had joined the company in 1932, when it had purchased a small manufacturer of water-level indicators called C & S. But his remarkable foresight only had full rein in the immediate post-war period.

Working with British Petroleum, he contributed to the design of the world's first fully-electronic process control system at a refinery in Llandarcy, South Wales. It was not until 1954 that the first American electronically controlled refinery went into operation, and by that time Evershed had made its mark with the oil industry, applying electronics to a widening range of processes. The company even attempted to enter the highly competitive American market, exhibiting its electronic process control equipment at the first International Instrument Exhibition in the United States in 1954.

Just as Evershed & Vignoles had benefited during the years before the First World War from the expansion of the world's navies, so it was now well placed to gain business from the rapid growth of the oil industry in the period after the Second World War. Once the technology had been demonstrated, other industries using continuous processes also began to adopt electronic control. Sugar, steel, cement, general chemicals and food - any process which involved the measurement of temperature and flow - all followed the trend. There was the first electronically controlled Bessemer converter plant for the steel company, Richard Thomas

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& Baldwins, at Ebbw Vale, and the first closed-loop control system for beet-sugar extraction at Wissington for the British Sugar Corporation.

The company received a contract to supply equipment for the first electronically controlled boiler plant in the world in 1954, and this led to increasing work for the Central Electricity Generating Board. A form of complete automatic control was applied for the first time at the Little Barford power station in 1959. By 1961, when the Board was planning the West Thurrock power station, it was possible to link Evershed's analogue automatic control system with a Ferranti Argus digital computer, which would carry out supervisory operations during start-up and shut-down of the plant.

But by this time the strains of entering such a demanding new field were beginning to tell. The move into process control had been based on pioneering technology, and the world had not stood still. The American companies, though their adoption of electronics had been tardy, had far larger resources than Evershed, and it became clear that it would take a lot of money if the British company was to maintain its lead.

Unfortunately, process control instrumentation was not a cash generating business; on the contrary, the supplier had to carry a substantial investment while the work was being carried out, which could stretch over many months or even years. The West Thurrock power station was widely publicised as an engineering achievement in 1961, but in fact it was not finally commissioned until 1965.

Evershed was not geared to this type of financing. Its background was the straightforward manufacture and sale of Meggers, or the production of naval systems against orders from the Admiralty. In process control,

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turnover was high but profitability was low, because customers were always demanding changes. Evershed, not certain how much to charge, tended to charge too little.

As a result, the undoubted successes of the process control business had a darker side. Technically, the company was riding high, and there was a feeling that nothing was impossible; but there was a price attached. At first, nobody quite understood the timescales of this new line of business: that a contract could be signed to install a control system and put it into commission, yet the building in which it was to be installed did not yet exist. The first big post-war sale by a Western company to the USSR was made by Evershed, but this meant having employees in the country for months on end.

Eventually, these problems were to swamp the successes, with a result that would reverberate for many years, but in the brave pioneering days of the late forties and fifties everybody was buoyed up by a sense of real achievement.

Process control, in any case, was only one of the company's activities. There was a falling off in naval work immediately after the war, but this was only temporary. The Megger continued to hold its place in the market, and was further developed in the post-war period. There were also developments in FHP motors, and this activity, almost without its being realised, was soon to become an important new business in its own right.

As we have seen, the development of motors had started in the twenties to meet an in-house need, and during the thirties and throughout the war years the range of technology had been expanded to include stepping motors, tachgenerators, servo motors, and other types of rotary component.

The war had also taken the company into supplying such motors to the aircraft industry, as well as using them for its own naval equipment.

When peace returned, the motors activity tailed off, and by 1948 only 480 motors were being made in a year - about 10% of the production level immediately after the war. Things did not begin to pick up until the following year, when the Royal Dutch Navy started to modernise. An order was placed with Evershed for gunnery control servos, with a requirement for 3,000 of one type and 700 of another. This was the turning point. At about this time, J.H. Askew joined the company from the Admiralty Research Laboratory, Teddington, to head the motors activity, and took it in new directions.

The Dutch order helped to reaffirm that Evershed's true market lay in naval systems. Aircraft work which had grown up during the war was gradually left to other companies, so there were no repercussions when the aircraft industry suffered defence cancellations and rationalisation in the sixties. The naval tradition, however, paid dividends when it came to selling motors to industry. In aviation, motors are designed to work well for 100 hours, and are then checked over with the rest of the aircraft. This is not the case in the navy, nor is it in industry. Both applications demand robust, long-lasting motors which will withstand rugged environments over extended periods without attention.

Motors were now being marketed extensively outside the company, but there was still no single department responsible. If they were for the navy, they were sold by the Naval Division, and if they were for industry they came under the Instrumentation Division. Anyone else would buy them through the Megger Division, because this was the only department with a

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commercial sales organisation for the general market. It was not until 1960 that a separate FHP Motors Division was established, and this was the forerunner of the Powerotor Division which forms an important part of the company today..

The availability of the motors also led to the creation of another new line of business which soon became a separate company, Evershed Power-Optics Ltd. Around 1960, zoom lenses were being used increasingly in television cameras, and Evershed worked closely with the manufacturer of the Varotal II lens, Taylor Taylor & Hobson, to devise the remote control of zooming. Following discussions with the British Broadcasting Corporation, a pan-and-tilt head for remote control was also developed. Later servo control systems designed to work with Angenieux zoom lenses were introduced, and overseas manufacturers of TV equipment began to use Evershed servo controls in the cameras they produced.

While these new activities were going on, the traditional interests of the company were not being neglected. Although naval business declined after 1945, it came back strongly in subsequent years, and even in the dog days new developments were under way. There was work on torpedo firing sights, carrier landing servos, gunnery controls, and several other applications. A new departure came in 1950, when a wind velocity integrator was introduced. This was to lead to a range of wind measuring and indicating gear for shipboard use which has been supplied both to the Royal Navy and to the navies of many other countries.

In 1961 a famous name reappeared when Evershed supplied pitch and roll units to HMS Dreadnought - this time, of course, the nuclear submarine, rather than the battleship, which had been the first vessel fitted with Kilroy's turret danger signals in 1907.

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There was also an important development of the helm indicator (now being called the rudder indicator), when a new system of transmission named Syntorque was introduced in 1948. This system consists of a resistance toroid tapped at three equal intervals, and connected by three wires to the three-phase stator winding of a polarised rotor indicator. The supply is connected to two contacts spaced 180° apart which rotate on the toroid. The resulting currents flowing in the indicator winding set up a field corresponding to the position of the contacts, and these act on the polarised rotor, causing it to move in sympathy with the contact rotation.

The advantages were much improved damping of the indicating needle and a more robust movement, although the advantage of earlier rudder indicators were also retained. There have been subsequent developments, and the rudder indicator continues to be supplied today, more than 90 years after Sydney Evershed devised the first version with A.E. Richards. Syntorque transmission was later also adopted for electric engine telegraphs.

It was still very much a family business. Lieut-Col Vignoles retired in 19--, but the link with one of the founding families was retained when his son, Charles M. Vignoles, became chairman in July 1961. Although a nephew of the founder, he had not previously been involved with the company. His career had been in the oil industry, and he was managing director of Shell Mex & BP for 10 years. His chairmanship of Evershed & Vignoles was regrettably short, for he died in September 1961, only three months after taking up the post.

Murray Vines, who became joint managing director in 1941, set a precedent when he became the company's first sole managing director in

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1963. D.D. Walker, with whom he had shared the position, decided to give more time to Evershed Power-Optics, of which he was chairman.

Times were changing in more ways than one. British industry was about to enter a period in which the term "take-over" became common currency. Acquisitions were now particularly frequent in the electrical industry. This was partly because the founders of several companies had died or reached retirement in the fifties, and their families were often ready to sell out; indeed, they sometimes had no choice, because of the demands of estate duty. Another reason was the growing international character of the electrical and instrument industries, with new competition frequently coming from American companies. Sometimes these firms bought local manufacturers to give them a base in new markets, sometimes the local companies merged with others when alone they could not match the resources of American competition.

Evershed & Vignoles made some acquisitions itself. The most significant was the Record Electrical Co Ltd, which had been founded by John Westmorland Record in 1911, and was best known for its Cirscale instruments. J.W. Record was the first person to solve the practical difficulties of producing an instrument with a scale length double the diameter of the dial. In many respects, however, Record's company was in direct competition with Evershed & Vignoles, for it supplied vast numbers of ammeters and voltmeters to the Royal Navy during the First World War, and had introduced insulation testing sets in the twenties. It prospered during the thirties and the Second World War, and in 1953 added a revolutionary graphic recorder.

The link with Evershed & Vignoles came in 1955. It was all very

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gentlemanly. This was before managements had been gripped with a passion for rationalisation, and the two firms simply had an interchange of directors and continued to operate as separate entities. This perhaps made sense, for Record Electrical Co was based in Altrincham, Cheshire.

Soon, however, it was to be the turn of Evershed & Vignoles itself. At the company's annual general meeting in November 1961, a new chairman was elected to succeed the late Charles Vignoles. It was B.D. Misselbrook, who had already been making frequent visits to the Acton Lane Works. Mr Misselbrook was a director of the British-American Tobacco Co Ltd.

CHAPTER NINE

Times of change: 1961-1971

Behind the somewhat muted arrival of an outside chairman were several factors, some general and some specific. Among the general was the belief that diversification was a good thing. Before long management theorists would be talking about the "conglomerate", in which many disparate companies were brought under a single ownership. It was primarily an American concept, and at its most extreme was based on the belief that management was an absolute science, and that it was not necessary to know anything about the industries being served to run the companies profitably.

The more down-to-earth followers of the conglomerate philosophy believed that it was a sound idea to spread risks, and it was no doubt this aspect which appealed most to British-American Tobacco (known familiarly to the investing community as BATS). At the time it took a stake in Evershed, it also bought an ice cream business called Toni's.

A specific factor behind the appearance of BAT on the scene was simply the sheer cost of the process control work with which Evershed & Vignoles was by this time heavily involved. The much larger American companies were now catching up with the technology, and Evershed had a very difficult task in finding enough money for further development. It had to look outside its own resources.

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At first BAT took a minority stake, increasing its investment after a couple of years to secure control in 1963. By then it must have recovered from its first reactions to a company in which the management, if not actually related, had largely grown up together. Murray Vines recalls that the newcomers thought they had taken over a club, rather than a commercial concern.

One of Misselbrook's first moves was to have a computer installed, so as to find out which of the company's activities were profitable, and which were losing money. His suggestion that they should then cut out all the unprofitable ventures was not well received.

Despite this, things did not change fundamentally during the early sixties. The company had by now outgrown even the greatly extended Acton Lane Works. Evershed Power-Optics was at Harlequin Avenue Works, off the Great West Road in Brentford, and the FHP Motors Division was located at Devonshire Works, in another part of Chiswick. The motors activity was now expanding apace. A new design called the Steromotor, which can provide high torque at low speeds without the use of gearing, was introduced in 1963, and remains in the product range today. Production started at the Devonshire Works in 1964.

On the instrument side of the business, new types of Megger continued to be introduced, although the parentage of Evershed's original design or of G.B. Rolfe's Series 2 was often in evidence. The availability of the transistor made it possible to design a version operated by batteries, rather than the hand-operated generator, and this appeared in 1962. This was a departure in more ways than one, for the instrument used a milliammeter type of movement for the resistance measurements, rather

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than the cross-coil ohmmeter which Evershed had favoured so strongly.

The leading figure in the development of the Megger was now Dr G.F. Tagg. He was an expert on earth resistances, and his interests ranged far beyond instrument design. The Oxford University Expedition to Northern Spain was at this time carrying out archaeological surveys in the Picos de Europa mountains, and the Series 1 Megger was used to trace the positions and depths of potholes and underground caves by means of resistivity measurements. Then in 1963 an archaeological team from Leeds University carried out resistivity surveys in Sicily using the Megger null balance earth tester.

These surveys were followed by a more ambitious programme the next year, and this time Tagg himself led one of the two teams. As a result of these experiences, he devised a technique of producing three-dimensional resistivity maps, which were in effect models of the archaeological discoveries.

The Megger operating on the null balance principle, which was used in the Sicily surveys, was introduced in 1962. Until now, Megger earth testers had operated on the ammeter-voltmeter principle. The null balance method had some advantages, but had suffered from insulation and capacitance leakages in the instruments themselves. The new Evershed design overcame these problems by the use of a guard system and a guard electrode.

Another development came the following year, with the Megger line-earth loop tester, which was designed to help electrical contractors carry out tests in safety to meet the new IEE Wiring Regulations. Also in 1963 came the Major Megger, replacing the Series 2, which was now to be phased out after more than 40 years.

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In the original Series 2 Megger of 1922, the testing pressure was directly related to the speed at which the generator handle was turned. This was modified in 1928, when a slipping clutch was added, and this became part of the standard design. From then on, many new versions were introduced, so that by the sixties there were 32 different instruments being manufactured in the series, all requiring different parts, different manufacturing techniques, and different calibration.

The Major Megger swept these away by providing the same coverage with only four instruments. The hand generator lived on, but now used a modern AC armature which allowed a stable testing voltage to be generated over a reasonably wide range of handle speeds. There were many changes in detail, and the design of the case was radically different, but the basic concept remained, and only confirmed the remarkable foresight of Sydney Evershed.

So, with all these developments, Evershed & Vignoles continued to forge ahead on well-established lines, even though BAT was now the ultimate arbiter on policy. In the event, the BAT involvement was relatively short-lived. In April 1965 it sold out to George Kent Ltd. This was a very different matter, for Kent was to some extent a competitor. Based in Luton, it was one of the relatively few British companies to hold a position in process control instrumentation.

Kent's acquisition of Evershed occurred when a remarkable change of industrial atmosphere had overtaken Britain. Following the formation of the first Labour Government of Harold Wilson in 1964, the talk was now all of industrial reorganisation and the economies of scale, with automation being hailed as the saviour of the British economy. Clearly, the relationship between Kent and Evershed was not going to be the

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arm's-length affair that had existed between Evershed and Record Electrical.

One of the first moves of the new owners was to form a company called Kent-Evershed Ltd. This brought together the industrial control activities of the two firms, but only those which served the water, drainage and gas distribution fields. No longer would Evershed deal with those sectors where it had made pioneering contributions in electronic control, such as oil refining and petrochemicals. These were now the responsibility of other companies in the group.

The problem with industrial rationalisation is that all the pieces seldom fit exactly. Evershed & Vignoles had not grown haphazardly, but by its own brand of logic. The ohmmeter principles devised by Ayrton and Perry had been applied first to insulation testing, and then to the helm indicator. This had led the company along two separate but parallel paths, one concerned with portable instruments (the Megger, the Ducter, the Dionic water tester) and the other with communication on board ship. In time this had led to the development of FHP motors, which were needed for use in naval equipment, and to remote indication systems on land. Eventually, much of the expertise the company had gathered was brought together to take it into industrial instrumentation and process control.

In other words, the logic of Evershed & Vignoles was technological, leading back to electromagnetism and telegraphy - the two pillars of the company's foundation. The logic of the merger between Evershed and George Kent was that of marketing: together, they would be stronger in the process control markets than they were separately. This was a perfectly valid argument so far as it went, but it took no account of

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those Evershed activities which Kent had acquired along with process control - the Megger and other instruments, Record Electrical, the naval business, and the FHP motors. Before the Kent management could decide what to do about these, however, it was plunged into another acquisition which was to become a cause célèbre.

It was the very issue of industrial logic which brought this about. One of the actions taken by the first Wilson Government was to create a body called the Industrial Reorganisation Corporation, which was charged with effecting a new industrial structure in key parts of British industry. When the Rank Organisation made a take-over bid for Cambridge Instrument Co, the IRC sprang into action.

Cambridge was a company with a fine record stretching back to the 19th century, and it specialised in medical and analytical instrumentation. For reasons which were never satisfactorily explained, the IRC decided that Cambridge with George Kent made better industrial sense than Cambridge with Rank. It did everything possible to sway the outcome of the battle, even to the extent of buying Cambridge shares in the market and pledging them to Kent, which finally succeeded in gaining control of Cambridge Instrument.

None of this, of course, was of direct concern to Evershed & Vignoles. The activities of Cambridge did not overlap with it in any way. One result of the Kent-Cambridge merger, however, was that some new management was brought in to the parent company as part of the price exacted by the IRC for its support. To these newcomers, given the task of making a fresh beginning from the unlikely marriage of a process control company to a manufacturer of analytical equipment, the outstanding problems of

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Evershed & Vignoles must have seemed almost an irrelevance.

First the marketing and then the manufacturing operations of Evershed's Instrumentation and Controls Division were transferred from Chiswick to Luton. Then in January 1971, George Kent sold what it did not want of Evershed & Vignoles to Metal Industries Ltd, part of the Thorn Electrical group. It was the third change of ownership in eight years.

CHAPTER TEN

Under new management: 1971 to the present

Metal Industries has a history which is as interesting, in its way, as that of Evershed & Vignoles. It was originally a scrap metal dealer, but its deals were on the large side: it bought and disposed of the German Grand Fleet which had been scuttled at Scapa Flow at the end of the First World War. In more recent years it had become an industrial holding company, and one of the firms it acquired was the manufacturer of the Avometer. Then Metal Industries was itself taken over by Thorn Electrical Industries.

Thorn (now Thorn EMI) was obviously attracted by the instrument side of Evershed, but that was not all that George Kent sold them. Kent naturally kept the process control part, and it held on to Evershed Power-Optics, although this too was disposed of later. The rest went to Metal Industries: the Megger and other instruments, the Naval Division, the FHP Motors, Record Electrical at Altrincham, and H.W. Sullivan Ltd, an old-established manufacturer of electrical standards based in Beckenham, Kent, which had come into the fold a few years earlier.

Eventually, some of these interests were to experience a further change of ownership. In December 1983 it was announced that Thorn EMI had sold Evershed & Vignoles to Bestobell, an engineering group which specialises in instrumentation and control. By this date, much had

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happened to change the shape of the original Evershed company.

In the sorting out process which followed the Metal Industries acquisition in 1971, the Acton Lane Works lost some activities, but gained others. The first and most obvious move was the transfer of the Megger to join the Avometer, the instrument which Sydney Evershed had been offered the chance of manufacturing in the early twenties, but had turned down. Following Thorn's acquisition of Metal Industries, Avo Ltd had moved from its premises in Westminster to a modern factory in Dover. The Megger now made the same journey, together with H.W. Sullivan. For several years all three companies kept their own names, with the Chiswick contingent being referred to as the Megger Instruments Division of Evershed & Vignoles Ltd. But they had come closer together as time passed, and in May 1982 they were incorporated under a new name, Thorn EMI Instruments Ltd. This forms part of the wider test and measurement operations within Thorn EMI Technology, although Metal Industries Ltd is still the official parent company. The insulation testers, of course, are still marketed as the Megger - a valued trade name, as it has been ever since Ernest Vignoles coined it in 1904.

During the George Kent regime, some of the recording instruments had been transferred from Chiswick to Record Electrical at Altrincham. This move was confirmed by the new management, and Record Electrical is also now part of Thorn EMI's test and measurement operations.

What were left at Chiswick, therefore, were the activities in naval systems and FHP motors. On this basis, a successful business has been continued and further developed. In the years before the acquisition of Evershed & Vignoles, Thorn had built up or taken over a number of

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performing the same function. Ship's telegraph systems have come into the modern world with ADEPTS (Advanced Digital Engine and Propulsion Telegraph System), which uses four-wire, full-duplex serial data transmission for communication between six "order" or "reply" locations.

The measurement of wind speed and direction on board naval vessels has become a significant activity, and this has taken the division into the use of microprocessor control. The latest retransmitting indicator, used in conjunction with the company's anemometer and wind vane unit, can automatically interpret input data. Versions of this equipment can select the windward anemometer automatically, and display on demand the true wind information, as well as the normal relative information. Electronics also plays its part in the range of compass repeaters, which are available in solid-state, bowl or endless-tape versions.

Other defence contracts have broadened the range of interests. Test equipment for the Clansman military manpack radio includes HITS, the harness installation test set, and IBRA, the interconnecting box radio adaptor test set. These were both designed in the Electro-Dynamics Division, and have entered production following successful acceptance trials. A manufacturing contract was also awarded by the Ministry of Defence (Army) for a unit to test Clansman battery chargers on tanks.

Another equipment for use with mobile radio systems is a battery-operated handheld RFI detector, which allows non-specialist personnel to check vehicles for excessive radio-frequency interference, and then trace the source. So Evershed & Vignoles is still making contributions to easy-to-use portable instrumentation, even though the Megger is no longer at Chiswick. Another link with the past is the quick-response chart

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the many achievements of the founders, of their associates and their successors, live on. They survive not just as memories, but as products which are still being made today - the rudder indicator, the Megger, electronic process control systems, rotary components.

"We did so many things," said Murray Vines, while this book was in preparation. The story is not over yet.

THE END