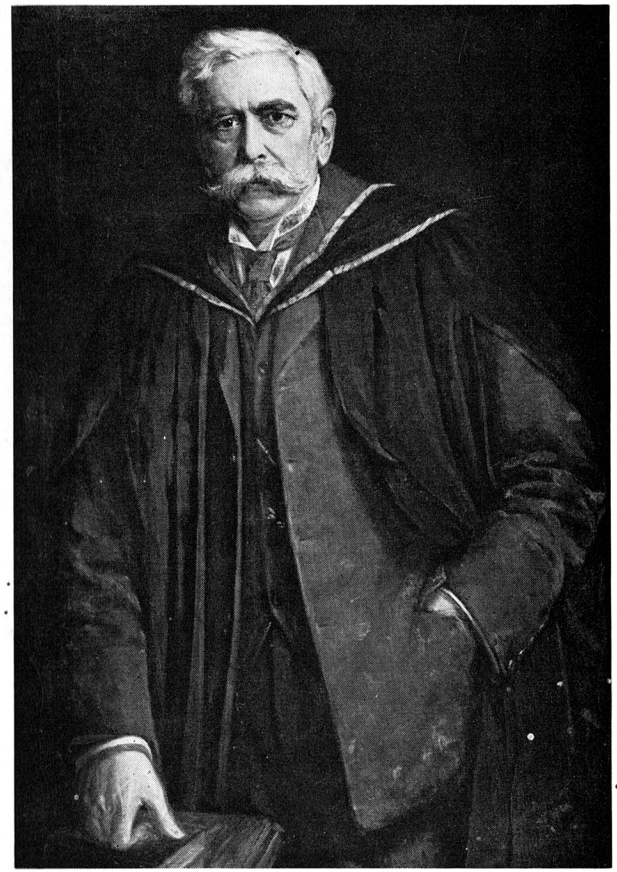
GISBERT KAPP

1852 - 1922



GISBERT KAPP

1852-1922

FIRST PROFESSOR OF ELECTRICAL ENGINEERING

AT THE UNIVERSITY OF BIRMINGHAM

Appointed 1905; retired 1919

by D. G. TUCKER

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Cover Portrait

Posthumous painting of Gisbert Kapp by Bernard Munns, 1923.

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PREFACE

This brief biography of Gisbert Kapp has been prepared primarily to mark the occasion of the Naming Ceremony at which the name "The Gisbert Kapp Building" is to be bestowed on the new building of the Department of Electronic and Electrical Engineering on the North Campus at the University of Birmingham. The ceremony will be performed by Sir Eric Eastwood, C.B.E., F.R.S., President of the Institution of Electrical Engineers, on 29 March 1973. Kapp too was President of the I.E.E.—in 1909. We are proud of our distinguished first professor, who was something of a pioneer in electrical power supply and showed how dynamos could be designed as well as made.

I have enjoyed the research into Kapp's life and work. He seems to have been a likeable man and I have grown fond of him, although I had never heard of him until ten years after his death. I was appointed to the Headship of the Department exactly 50 years after his appointment, and occupied his room for two years before we moved for our 13-year sojourn in the south-west corner of the campus.

Much of any merit this biography has is due to the co-operation and help of Gisbert Kapp's grandson, Mr John Gisbert Kapp, who put at my disposal every relevant paper, letter and photograph which the family could muster, and answered numerous questions with care and frankness. I am grateful to Professor H. M. Barlow, F.R.S., for putting me in touch with him. For much help on Kapp's first few years as an electrical engineer I am grateful to Mr Charles MacKechnie Jarvis, and for some information regarding Kapp's decade in Germany to Dr S. von Weiher of the Werner von Siemens Institut in Munich. Thanks too to Mrs Muriel Welsby, Mrs Mary Lane and Mrs Joyce Bartle of the Department for so much assistance in searching old records and in the preparation of the Bibliography.

D. G. TUCKER

Department of Electronic and Electrical Engineering,
University of Birmingham, November 1972.

"*Thou art the man*"

Silvanus P. Thompson to Kapp, 1904

"*The inventor's path is not smooth*"

Kapp to his son, 1912

"*I am not so clumsy as I look*"

Kapp to his wife, 1908

"*He started at once formula-making, and has been making formulae ever since*"

W. H. Allen, 1905, referring to Kapp in 1875

I

FAMILY AND PERSONAL HISTORY

Background and career

Gisbert Kapp was born in Mauer near Vienna on 2 September 1852. His father, Gisbert Sebastian Kapp, had been born in Linz in 1816 and was of Austrian nationality; his paternal grandfather was Christian Kapp, born a German but later becoming an Austrian by naturalization. Christian was a scientist and writer, becoming a professor of philosophy. Gisbert Sebastian became a civil servant in charge of the administration of the docks at Trieste.

Gisbert Sebastian had married Louisa Young, of Scottish parentage; she had been born in 1829, also in Linz. He unfortunately died in 1857, leaving the young Louisa with their 5-year old son Gisbert and their daughter Leopoldina. Louisa was a very fine singer, and after being widowed began to develop a career in the name of Luisa Cappiani, this being an italianisation of Kapp Young. She became very well known, travelling widely, singing, teaching, lecturing and writing. She sang in nearly every European capital, in Cairo and in the U.S.A., and occasionally before royalty, including Queen Victoria.

No doubt it was because of his mother's adoption of an Italian-style name that young Gisbert was known throughout his schooldays as Gilbert; even in her old age his mother referred to him, in writing to Leopoldina in 1909, as "Dein Bruder Gilberto", and within the family he was called Gilly (pronounced "Jilly" according to his niece Mrs Mary Mildmay). All his school reports, and more surprisingly, his documents from the Federal Polytechnic of Zurich show his name as Gilbert. He probably reverted to Gisbert when he first came to England in 1875. One other interesting point about his name is that two biographical accounts published soon after his death (*Engineering*, 18 August 1922, and the *Deutsches Biographisches Jahrbuch* for 1922) both enter him as Gisbert John Edward Kapp. No other use of the names John Edward in relation to Kapp is known either to the writer or to the family.

Gisbert went to school in Vienna until 1863 and then in Prague until 1869. He proceeded to the Federal Polytechnic in Zurich to study mechanical engineering until the end of 1871, by which time he was 19. He

then sought practical experience by taking a post as ship's engineer for a year. This was followed by a year in a machine factory at Augsburg, and two years in the Austrian Navy.

He came to England in 1875 and took a post as chief pump draughtsman with Messrs Gwynne and Co. of Hammersmith in London, a firm specializing in centrifugal pumps. Here he was concerned with the construction of a large pump for draining polders in Holland. Then in 1879 he joined Messrs Hornsby and Sons, Ltd., agricultural implement makers of Grantham in Lincolnshire. For them he travelled widely in Russia, Switzerland, Italy, Cyprus and North Africa, and was among other things concerned with the application of steam power to agriculture in those areas. During this period he visited the Paris Exhibition of 1881, and saw for the first time the vast possibilities of electrical engineering. He determined to become an electrical engineer, and got in touch with Col. R. E. Crompton, who in 1882 appointed him to be general manager of his works and laboratory at Chelmsford. Kapp's career now started in earnest, and we shall follow its more detailed development later. He made a number of inventions which he patented, and in 1884 he left Crompton to set up in consulting practice and to exploit his inventions.

In 1894 Gisbert Kapp was appointed General Secretary of the newly-formed Verband Deutscher Elektrotechniker (Association of German Electrical Engineers), and retained this post for ten years. His responsibilities extended far beyond merely running the Association; he had to get a set of rules and standards written and agreed, covering all aspects of materials, plant, installation and distribution in the electrical industries and systems in the German empire. He was also allowed to engage in private practice, and his advice was sought not only as a designer of power, lighting and traction systems, but also as arbitrator. He advised in Moscow, Trondheim, Trieste, Leipzig, London and several towns in Switzerland and Italy. As if all this work were not sufficient for one man he was also a lecturer in electrical design at the Technische Hochschule in Charlottenburg.

Thus when, in 1905, Kapp was appointed to the new Chair of Electrical Engineering at the University of Birmingham, he had acquired a breadth and depth of experience in engineering which was, to say the least, exceptional—by the standards of his own or any other period. On 17 June 1904 the famous electrical engineer, Silvanus P. Thompson, F.R.S., drew Kapp's attention to the new post thus:

> Dear Kapp,
>
> You may see this week that Birmingham University is going to appoint a Professor of Electrical Engineering, at £1000 a year, with freedom to practice (sic) professionally. Thou art the man:- at least in my judgement. I am writing tonight to Sir Oliver Lodge to tell him so. I cannot think of any one who would have a chance against you unless it were M. B. Field or Duddell. Field has had no experience in teaching, and Duddell is a rich man who would, I imagine, prefer to stay in London.
>
> Yours ever truly,
> Silvs. P. Thompson.

Kapp evidently gave the new department at Edgbaston some distinction, and an article in Cassier's Magazine in 1910 stated "it is no exaggeration to say that no more finely equipped laboratories at present exist in any of the universities or technical schools in England or in other countries". A full account of the laboratories and their equipment is given in an "Electrical Handbook" published by the Institution of Electrical Engineers in 1906 on the occasion of the visit of kindred institutions from abroad, and one feature there emphasized was the loan of equipment to the Department by the manufacturers. The Department remained in the same accommodation for just over 50 years. Kapp retired in 1919, and died at the age of 70 on 10 August 1922, after a long illness. A comment in a German obituary[1], freely translated, said:

> "What vitality and determination still remained in this man to the very end one can judge from the fact that, in spite of terrible pain, he could still busy himself with difficult technical problems. For example, only two days before his death he gave to his eldest son the basic ideas of a new discovery with which a ship's captain, from his cabin, could determine the exact position of his ship."

Unfortunately nothing more is known of this discovery.

Kapp had conferred on him the honorary degree of Doctor of Engineering by both Dresden and Karlsruhe Universities; he was an Honorary Member of the Physical Society of Frankfurt; he was a member of Council of the Institution of Electrical Engineers from 1891 to 1893, and from 1905 to 1906, was then Vice-President from 1907 to 1909, and was finally president in 1909-10.

Marriage, home, hobbies, and personal relationships

In none of the published accounts of Gisbert Kapp is there the slightest suggestion of any but the most pleasant and admirable aspects of character. Admittedly these accounts are obituaries or notices of his appointment as President of the I.E.E., and are therefore bound to be generally lauda-

tory; but there are no undertones at all. In his correspondence with his wife and sons (very little survives, unfortunately) he is always affable, kindly, often rather serious. The impression given by his portrait seems to be correct. In his letters to his sons he discusses freely his work, his negotiations for the exploitation of his inventions, politics, and so on. In a letter to Reginald dated 10 September 1914 he discusses the war in a strongly anti-German way, opposing any leniency towards the Germans in the event of an "English" victory. (It was odd that he should think of his country as England and not Britain in view of his Scottish grandparentage.) Although he was very well-to-do, he seems to have been very concerned with the commercial side of his inventions.

He became a naturalized British citizen on 5 December 1881 and three years later he married Teresa Mary Krall, who was then 20. She had been born in England, her father John Baptist Krall (1828-1900) being a coffee merchant in the City of London and a naturalized British citizen. They had two sons, Reginald Otto born in 1885 and Norman Gisbert born in 1887. Reginald became a distinguished electrical engineer: after taking his degree at the University of Birmingham, he had about 20 years

Gisbert and Teresa ("Treasy") Kapp and their two sons, 1894.
(Photo lent by Mr John Kapp)

in consulting practice with Messrs Kennedy and Donkin, and eventually in 1935 became Professor of Electrical Engineering at University College, London. He married Dorothy M. Wilkins, a medical doctor, in 1932 and had a son John Gisbert and a daughter Elinor; the former is an electrical engineer and the latter a doctor.

Gisbert had married a woman 12 years younger than himself. As far as is known, no letters from her to Gisbert survive, and only one from him to her, this being dated 27 August 1908—24 years after their wedding. There is thus little evidence by which to judge their relationship, but their descendants do not think it was a particularly happy one. She was said to have been a good hostess, a good singer (and she was indeed a teacher of singing), and an asset on formal occasions. She was said to have been very selfish and possessive, and certainly caused her son Reginald serious psychological complexes; she never forgave him for marrying, even at the late age of 48; and after Gisbert's death she lived in Italy with a rather sulky attitude to life. In surviving letters to Reginald she shows irritation with her responsibilities and with those with whom she had to do business. In contrast, the one surviving letter from Gisbert to her, written from a yacht on which he was having a holiday with four friends, is full of affection and surprising humour—e.g. "In Waldheim there was a charming little girl . . . . In temperament she reminded me much of you, so much that when I had been in her company (she sailed often with us) I longed for you all the more. In fact good and fascinating women always affect me in this way. So you need not be jealous." And "You will be surprised to learn that at Waldheim I even ventured to dance. At first the girls seemed disinclined, but afterwards they were quite ready to dance with me, from which I conclude that I am not so clumsy as I look." It is clear that Gisbert made the best of his life with her, and they had many friends.

On moving to Birmingham, the Kapps at first rented from the University and later bought the large house "Pen-y-Coed" in Pritchatts Road — the same road as that in which we now have the new building of the Department which Kapp founded. They had at various times between 3 and 6 servants, including gardeners. With his salary of £1000 a year and only a small department leaving him ample time for consulting work, he was obviously very much better off financially than his hard-pressed successors! Kapp took an interest in the gardening himself. In 1913 or 1914 they moved to 43 Upland Road, Selly Park—another large, but less attractive and less convenient house. In one letter to Reginald at the time of selling Pen-y-Coed, Mrs. Kapp refers to having inspected a "poky little house in Chad Road . . . . only five bedrooms . . . " !

Gisbert maintained his habit of extensive travelling all his life. His mother had a villa at Rodi Fiesso in Italy, and both Gisbert and his sister with their respective families spent many holidays there. In his letters to his sons during his period at Birmingham he refers to business journeys on the continent. He was keen on golf and yachting, so evidently liked an active life. He was very interested in music (not surprisingly, as his mother was so eminent a musician and his wife was also very musical) and in his travels also took care to visit museums and art galleries. As his professional output (teaching, inventing, negotiating, consulting and writing) was enormous, he was clearly a man of outstanding physical and mental energy.

Something of the respect in which Kapp was held, even in mid-career, is indicated by the fact that for a "farewell dinner" given to him, presumably on his departure for his German appointment in 1894, the Committee included some of the most famous names of the period, such as Lord Kelvin, John Hopkinson, D. E. Hughes, W. H. Preece, and S. P. Thompson.

Gisbert Kapp at school

Mr John Kapp has a collection—very far from complete—of Gisbert's school reports—in the name of Gilbert Kapp. Reports covering four semesters between 1861 and 1863 (i.e. age 9-11) show he was then at school in Vienna, first at the parish school of Strozzengrunde, then at the secondary school of Josefstadt. At these schools his reports were uniformly good: "zehr gut" for manners, ability and application, and in every subject of the curriculum—sometimes "vorzüglich" (excellent). In 1864 he was apparently living in Prague, for there are reports from the "deutsche Oberrealschule zu Prag" (the German Upper Secondary School in Prague); he seems to have stayed there until 1869, although reports for the years 1866-8 are missing. At first he seems to have coped with the change quite well—moral behaviour: "quite blameless"; attentiveness: "very praiseworthy"; diligence: "excellent"; subject progress: "sufficient", or (ominously) "just sufficient". But by March 1865 we find diligence: "sufficient"; subject progress: remarks ranging from "quite sufficient" to "not sufficient". By July 1865 diligence has become "little", progress frequently "not sufficient", and he "must repeat the year". (This was the third-year course.) He evidently had to repeat no other years, for in March 1869 he was in the sixth year and his report showed moral behaviour: "exemplary"; diligence: "enduring"; progress: remarks varying from "excellent" to "satisfactory".

At the age of 17, Gisbert went to the Federal Polytechnic at Zurich, leaving in December 1871, at the age of 19, with a diploma in mechanical engineering.

Sources of information for this chapter

It does not seem appropriate to include full references to sources in this section of this short biography, but nearly all the material used is in the possession of Mr John Kapp, grandson of Gisbert, and a nearly complete set of copies is held by the author.

Gisbert and Teresa Kapp on board a yacht in the early 1900s.
(Photo lent by Mr John Kapp)

II

KAPP'S CREATIVE PERIOD, 1882-1894

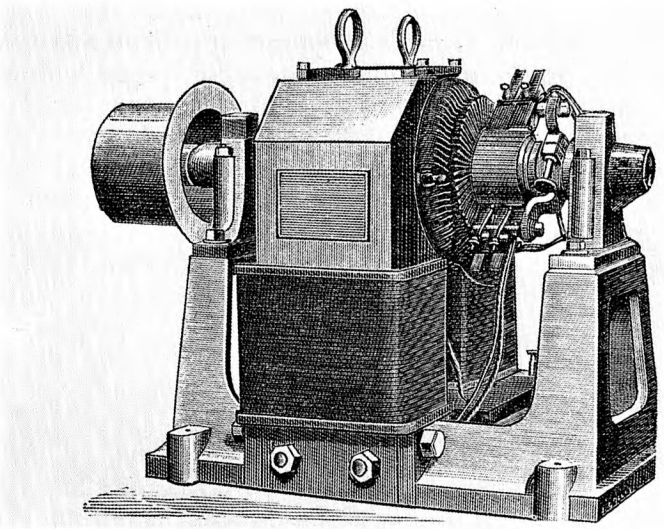
Gisbert Kapp was, as we have seen, trained as a mechanical engineer, and by the time he turned to electrical engineering in 1882 at the age of nearly 30, he had had eleven years of experience as a mechanical engineer. There were then very few professional electrical engineers; the Society of Telegraph Engineers did not add "and Electricians" to its name until 1881 and did not become the Institution of Electrical Engineers until 1889; the first full teaching department of electrical engineering had only just been set up at the City and Guilds of London Institute at Finsbury in 1879, under Professor W. E. Ayrton; the first British electrical journal, "The Electrician", started in 1878. Swan had demonstrated the first incandescent electric lamp in 1878 with Edison following in 1879; the first commercial electric power station to exploit the incandescent lamp was opened at just about the time that Kapp started electrical engineering. He thus entered the field just as its big engineering expansion commenced; just at the most stimulating, challenging and interesting period. It was an ideal time for a clever man, still young, to enter it, and Kapp did not waste his opportunity. The need of the time was to apply the basic science of electricity to the design of machinery, which hitherto had been largely empirical; or, put another way, to make the design process quantitative rather than a matter of trial and error. In realizing this need and in fulfilling it Kapp made his biggest contribution to progress.

His first electrical appointment, as manager of R. E. Crompton's new electrical laboratories and works at Chelmsford, could not have been entirely happy. Crompton, in his *Reminiscences*,[2] published 46 years later, indicates some friction between Kapp and himself in 1882 and makes spiteful fun of Kapp; whether the friction was real at the time, or merely something exaggerated at a later date by some later rivalry will presumably never be known. However, the fact that Kapp stayed with Crompton for no more than two years is suggestive. Nevertheless, he must have had very useful experience with Crompton, doing much original work, which led to five patents taken out jointly with Crompton.[3] These

covered two most important aspects of development: the design of dynamos and motors, and methods of measuring currents and voltages. Here started, too, his prolific writing of technical papers and articles, his first substantial paper [4] being published in four parts in *The Electrician* during December 1882 and January 1883. In this paper he gave a detailed analysis of the functioning of a dynamo, using mainly graphical methods, and it is clear that he had already started applying scientifically-based quantitative methods to design, although he had been involved with electrical engineering for only a few months. In February 1884, Kapp and Crompton read a paper[5] on measuring instruments to the Society of Telegraph Engineers and Electricians, and Kapp's 11-part paper[6] on mechanical measurements appeared in *The Electrician* during the winter and spring 1883-84. By this time, Kapp had also published four shorter articles, one[7] developing rules and approximate formulae for the design of the leads in a lighting system, two [8, 9] on the design and cost of electric street mains, and one [10] on a new scheme of connections to permit a series-wound dynamo to be used safely for charging batteries in place of the usual shunt machine. It can be seen what a variety of topics Kapp tackled during his two years with Crompton.

Perhaps after this busy two years Kapp felt he had served an adequate apprenticeship in electrical engineering; perhaps his relationship with Crompton was rather strained. At any rate, he left Crompton and set up in London as a consulting electrical engineer. After a very short time he had developed a working arrangement with W. H. Allen, who had been his chief at Gwynnes from 1875 to 1879, and who had set up an engineering company of his own—W. H. Allen and Co., York Street, Lambeth[11]—in 1880. In 1884, Allen had accepted an order to supply an electrical lighting installation, and had to set up an electrical department. He got Kapp to supervise it, and Kapp did a great deal of design, as well as supervision, for Allen. It is believed that Kapp's design books (at least two in number) are still in existence and efforts are being made to find them. It is known [12] that the first design was a dynamo for Sebastian Z. de Ferranti, the founder of the famous firm, who was then only 21 but well established as an electrical engineer.

It seems fairly certain that Kapp retained his independence as a consulting engineer while working for Allen. In 1889, C. C. Hawkins was appointed by Allen as assistant to Kapp, and after a short absence returned in 1890 as Head of the Electrical Department. Whether Kapp left Allen's business altogether at this time, or whether he maintained a consulting connection, is not known, but personal relationships between Kapp and Allen seem



The Kapp Shunt Dynamo, giving an output of 9.6 kW
(see *The Electrician*, *18*, 28 Jan. 1887, p 257)

always to have been good, and Kapp was private technical tutor to Allen's son Richard during the period up to 1889.

During the years 1886 to 1889, Kapp was London Editor of an important and very comprehensive technical weekly called *Industries*. This journal was founded in 1886, and must have absorbed much of Kapp's time when he was already busy. On his retirement from the editorship, *The Electrician*[13] said:

> "The fact that Mr. GISBERT KAPP has resigned the position of London Editor of *Industries*—which he has filled with conspicuous ability and success since the foundation of that journal some three years since—must necessarily be a matter for regret amongst its wide circle of readers. Mr. KAPP's retirement has been brought about by the increasing demands upon his time in his capacity as consulting electrical engineer, to which work he intends in future to devote his whole attention. We cannot but feel it to be a matter for congratulation that at a time when there is so much practical work to be done, and so few really qualified men available, an engineer who combines in a peculiar degree theoretical knowledge with practical skill and experience should devote his whole energies to the consulting branch of the profession."

In April 1891 Kapp joined W. H. Preece (later Sir William Preece) as designer for the new electric lighting station and distribution system at Bristol. Preece had been consultant to the Bristol Corporation for some time, and had in 1889 advised them that the time was ripe for the Corporation to set up an electricity system. The Corporation decided to run their own electricity undertaking,[14] and were the first local authority to do so on a large scale—only Bradford Corporation had anticipated them, and then only on a very small scale. The power station ("Electric Lighting Station") at Temple Back, Bristol (the building of which still exists) was opened late in 1893. Kapp must have given a great deal of time to this project, and it is probable that it also involved him before April 1891 as adviser to Preece, who, as Engineer-in-Chief of the Post Office, was able to give only his spare time to consulting work. Kapp's work would have continued after the opening of the station, probably up to his departure for Germany in 1894, for an almost continuous programme of extension was necessary. There is unfortunately hardly any direct record of Kapp's work on this big project, as all reports to the Bristol Corporation were made by Preece, and Kapp must have worked entirely through Preece. Kapp's reports and designs would have been held by Preece, and, with one exception, they cannot at present be traced. Although Kapp was very fully engaged on this work and also had other projects in hand, such as a very large electric lighting system at Arundel Castle, yet his flow of publications continued during this period. In the Bristol work, Kapp was concerned with the steam and other plant as well as the electrical plant. The one report which has been found[15] gives Kapp's calculations on the effect of a proposal by Mr Proctor Baker of the Bristol Corporation to use inferior local coal instead of the Welsh coal assumed by Preece and Kapp.

On one occasion at least Kapp was directly consulted by Bristol Corporation;[16] this was in regard to possible interference with the Corporation's electric light system by the proposed electrified tramway at Kingswood.

Although during these 12 years of engineering practice, Kapp published papers on a variety of electrical topics, as before, yet there is no doubt that his inventive and analytical faculties were mainly concentrated on the two related topics that are still most closely associated with his name, that is the design of multi-polar slow-speed dynamos and the understanding of the "magnetic circuit". It is his work on the latter that now constitutes his main claim to fame. Kapp's dynamos were, however, widely used, and his six-pole design of about 84 kW output, with direct

coupling to a triple-expansion Willans steam engine (speed around 600 r.p.m.) receives a mention in most books[17] on the history of electrical power because nine sets were installed in the important St Pancras (London) power station of 1891. In passing, it is worth mentioning as a matter of curiosity that Kapp designs of dynamos and alternators were *not* used at Bristol, where Siemens machines were installed. Kapp's designs were manufactured in Britain by W. H. Allen and Co., and the choice at Bristol would no doubt be based on the lowest tender, not on a specific design.

As regards the magnetic circuit, Kapp was not alone in developing a satisfactory theory of this in 1885. The even more famous John Hopkinson was also working on it then with his younger brother Edward, and the Kapp [18] and Hopkinson [19] publications were almost contemporaneous, Kapp being first by a few months,[20] although in the discussion on Kapp's paper John Hopkinson was at pains to explain that he had been working on the matter for over two years, and that his paper had already been accepted by the Royal Society. Kapp's paper, almost certainly the most important he ever wrote, was presented to the Institution of Civil Engineers, and this is significant in showing the lower standing of electrical engineering as a profession at that time. It was a long paper and excited an incredibly long discussion in which, as might be expected, Kapp received criticism as well as praise. Almost "everybody who was anybody" contributed. Kapp stated that:

> "As far as the Author is aware nothing has yet been published on the construction of dynamos, which would be of practical value to the manufacturer. Of theories there are more than enough, but the connecting links between pure science and practical work are still missing. At present, every maker has to work out his own theory and rules of construction, which he naturally keeps as secret as he can. As a step towards generalization of the subject, and in the hope that other information of a similar character may be elicited, the Author would here submit the formulas he is using in the designing of dynamos. In establishing them his aim has been to do away as far as possible with coefficients depending on the type of machines, and to put the expressions in a form sufficiently simple for practical use. He cannot say whether they will fulfil the conditions stated above of being universally applicable; and he considers them rather as a first attempt at getting rid of those vexatious coefficients which stand in the way of general formulas. The strength of the field, or number of lines z, is the ratio of exciting-power P to magnetic-resistance R. In a dynamo-machine

> the latter consists of three parts —R_α that of the air-space, which is considered to be independent of the strength of field, and of the resistances of the armature-core (R_A), and the field-magnets (R_F), both of which are considered to increase with the strength of the field.
>
> $$z = \frac{P}{R_\alpha + R_A + R_F}$$
>
> For low degrees of magnetization this increase is so slight as to be negligible, and in that case z and P are simply proportional. . . . ."

This formulation, which is still basically in use to-day, was considered by some of those taking part in the discussion to have been Kapp's own invention, but Professor Forbes stated that it was really due to Faraday. There can be little doubt that its application to dynamo design was thought out independently by Kapp.

John Hopkinson stated in the discussion that his own work, which was awaiting publication, was carried further than Kapp's "so that he was able to make a fairly approximate calculation of the intensity of a field from a given configuration of iron, and a given winding". To the present writer there seems little difference between Kapp's and Hopkinson's work but other recent writers have taken sides in the matter. Sharlin[21] considers that "The curve derived by Kapp was a more generalized one than that obtained by the Hopkinsons", while Greig[22] states that "Hopkinson's analysis was the more elegant and its development the more thorough". John Hopkinson was only three years older than Kapp, but had been working in electrical science and engineering for ten years longer, and was already an F.R.S. There can be little doubt that Kapp had now established his reputation as a leading electrical engineer.

It is a matter of some interest and importance that in this outstanding paper Kapp had devoted much consideration to the question of economic design of dynamos, and expressed the merits of different dimensions of machine in terms of cost of machine per lamp lit.

Kapp's ideas on dynamo design were put into the perspective of historical development and of complete electrical power systems in his book *Electric Transmission of Energy* published in London in 1886; it ran to many editions and was a big contribution to progress. The subject was again reviewed in his Cantor lectures [23] to the Society of Arts in 1891.

III

KAPP IN GERMANY, 1894-1905

There can be little doubt that Kapp's work as General Secretary of the Verband Deutscher Elektrotechniker, which also included the Editorship of the journal *Elecktrotechnische Zeitschrift*, involved him in much administrative work and in the servicing and guidance of many committees. Direct documentary evidence of his activities has not yet been traced, in spite of enquiries in Germany, but it is known [24] that in 1901, for example, at least six committees of the V.D.E. were active in the following fields:

1 Revised code-of-safety regulations for electric railways and tramways
2 Standard specification for testing of dynamos and other electrical machinery
3 Standards for rubber wires and cables
4 Standard specification for testing iron for dynamo and transformer cores
5 Rules for protection against lightning
6 Earth currents in electric railways and tramways.

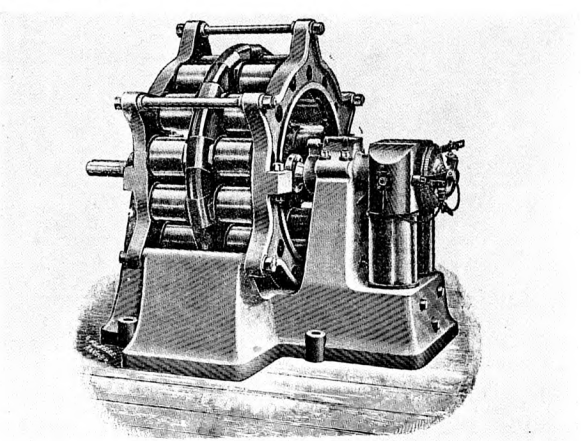
In a commentary on a report from the second committee listed above, *The Electrician* [25] attributed the item to Kapp in its index. Later the same year, Kapp himself presented a paper [26] on the subject to the International Engineering Congress at Glasgow.

With these commitments it is surprising, not that Kapp's research activities were somewhat reduced, but rather that he managed to do any research at all. Yet he read several research papers to the V.D.E. and published several more in *Elektrotechnische Zeitschrift*, covering a variety of topics such as the rotary transformer, [27] the spark limit in continuous current machines,[28] a meter for measuring tractive force on electric tramcars,[29] and the potential drop on tramway rails.[30] In the last-mentioned paper, in 1902, Kapp introduced and analysed the "booster" system of raising the voltage on the track at intervals along its length by the interpolation of small dynamos; and at the meeting at which it was presented it excited a lengthy discussion. The booster system itself was far from new; as applied to electric railways, the firm of Siemens and Halske claimed that their patent of 1889 was the first disclosure of the principle,[31] and there is no doubt that it was in use on American railways [32] by 1896.

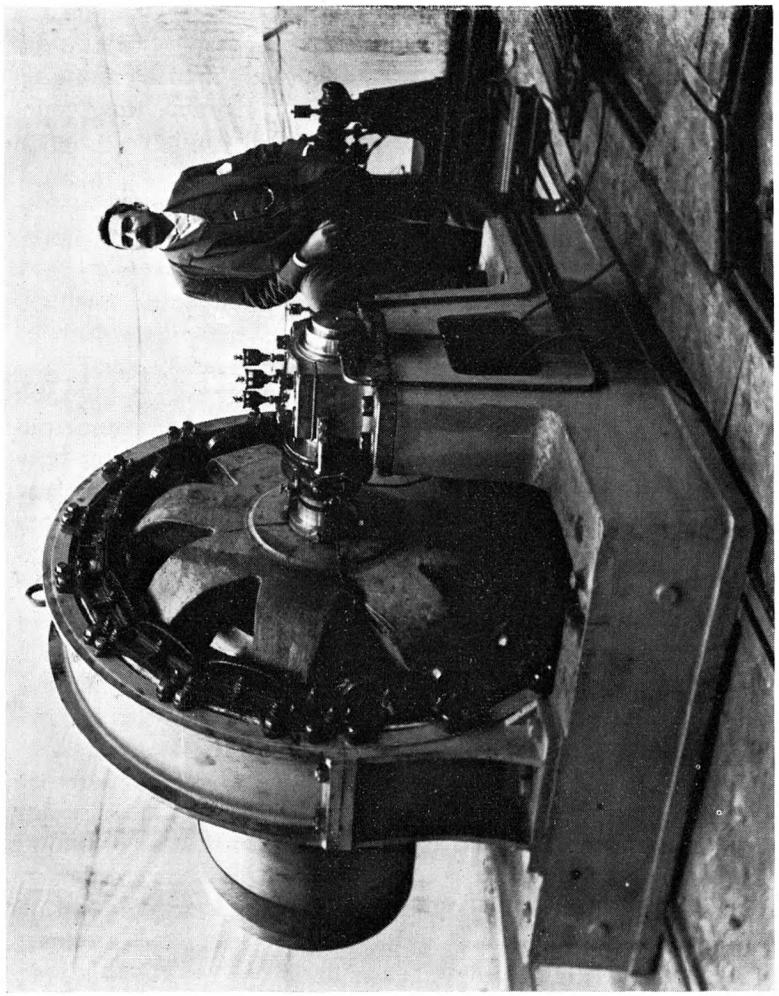
Kapp claimed that he had proposed a booster system for tramways in 1896 that had been used in a few instances in Germany, in many cases in England, and most spectacularly in Glasgow where there were over a dozen boosters each of 1000 amperes capacity. But all these systems used the boosters in feeder cables. Kapp's new proposal of 1902 did away with feeder cables and connected the boosters actually between consecutive sections of track. For long routes, he claimed, this would prove very economical. However, it is believed that it was never adopted on any important system.

In addition to these activities, Kapp lectured on the design and construction of dynamo-machinery and transformers at the Technischen Hochschule in Berlin (Charlottenburg), and in a German obituary,[33] Herr Perlewitz (a former student of Kapp's) comments on his genial method of teaching, on the inspiration he gave to his students, and on his modesty coupled with willingness to give praise to others.

Kapp also managed to find time in Germany to produce a book on electromechanical construction,[34] which included as examples numerous descriptions of machines produced in different countries, showing how well he was in touch with the whole European electrical scene. As already stated, it is understood that Kapp also acted as consultant to numerous electrical undertakings in various parts of Europe, but so far no confirmation or details of this have come to light. He was certainly a man of extraordinary activity.



The Kapp alternator, giving an output of 60 kW, made by Oerlikon for a power station in North Italy.
(see *The Electrician*, *23*, 30 Aug. 1889, p 425)



A later Kapp Alternator, manufactured by Johnson and Phillips around 1895, with Gisbert Kapp standing beside it.
(Photo lent by Mr John Kapp; for technical description see G. Kapp, *Dynamos, Alternators and Transformers*, 1902 edition, pp 494-5)

IV

KAPP AS PROFESSOR AND ELDER STATESMAN, 1905-1922

Gisbert Kapp came to Birmingham as Professor of Electrical Engineering in October 1905 at the age of 53. By then he was a very distinguished and highly-regarded electrical engineer. His return to England after a decade in Germany was celebrated by a special dinner of welcome to him. The report [35] on the dinner makes interesting reading. Col. Crompton was in the Chair; Sylvanus P. Thompson had travelled 250 miles to be present and said that Birmingham had not advertised for a professor but had looked round for the best man and found him. Then

> "Mr. Allen told a story of how he had been induced by Madame Kapp to take her son—a shock-headed young student—on as chief draughtsman many years ago; how he started at once formula-making, and had been making formulae ever since".

So this was how young Gisbert came to work at Gwynnes in 1875! Kapp, in his own speech, appealed for help from manufacturers in the way of drawings:-

> "In Germany he had found manufacturers very ready to help in that way, and whenever he tested a machine and found the results good he asked for particulars for the benefit of his classes".

This speech is valuable in showing that Kapp was already deeply interested in teaching and particularly in teaching good design.

Thompson's comment is interesting. The post *had*, in fact, been advertised, although it is possible that the advertisement was little more than a formality. As we have seen, Thompson had evidently been consulted about the appointment before it was advertised and had recommended Kapp for it. Nevertheless, the original recommendation from Senate to Council,[36] formulated at the Senate meeting on 27 April 1904 and received by Council on 4 May, was that the appointment of a Professor of Electrical Engineering be advertised at a salary of £600 plus a quarter of the fees from tests made with University appliances. (£600 was a normal professorial salary, and the Professor of Civil Engineering, S. M. Dixon, was appointed at this salary in June 1905.) Council referred the matter to a Special Committee, whose report was received and approved

on 1 June; it proposed that the Chair of Electrical Engineering be advertised at £1000 p.a. with liberty to undertake a certain amount of consulting work. The wording of a long, detailed advertisement was approved, and this stated that if the right man was not found the post would not be filled. Gisbert Kapp fitted the requirements so well that it is possible that the advertisement was prepared with him in mind; however, it is clear from Thompson's letter to Kapp of 17 June 1904 that the latter had not been approached before the advertisement was drafted. Furthermore, on 5 July Senate requested Council to constitute a joint committee of Senate and Council "to consider the applications" for the Chair: Council agreed to this the next day and directed the committee to report diredt to Senate. This it did not do until 6 December 1904; its report, which was approved by Senate and then by Council, was as follows:

> "The Joint Committee recommends to the Senate that Mr. Gisbert Kapp, Lecturer on the Construction of Dynamos and Transformers at the Technical High School, Charlottenburg, be appointed Professor of Electrical Engineering for a period of five years from the 1st October 1905 at the inclusive stipend of £1000 per annum."

It thus seems certain that the post was advertised, that Kapp had applied for it in the normal way, and that all applications had been properly considered. No doubt Thompson, as one of the most eminent electrical engineers of his time, felt that his recommendation had been decisive—quite possibly it had been—but he was wrong in his facts, and his remarks, so widely publicised, were unfortunate.

The short-term nature of Kapp's appointment is noteworthy; five-year appointments were not normal. It was renewed in 1910 for a further five years at the same salary; then renewed one year at a time from 1915 to 1918, with final retirement in September 1919. These annual renewals were during the World War I, and special difficulties were faced. Kapp wrote to the Principal, Sir Oliver Lodge, on 3 March 1915 thus:-

> "Dear Lodge,
>
> Thank you for your letter of the 8th. The question of the stipend for the Chair of Electrical Engineering was not discussed at all at the Faculty Meeting today: only the question of whether the Chair should be retained. It was unanimously resolved to recommend the retention of this chair.
>
> Should the Council accept this recommendation and agree to my continuing to fill the Chair I shall be pleased to meet the Council's wish for greater economy by agreeing to a reduction of my stipend from £1000 (the present figure) to £600 per annum, the new rate to commence at the end of my present agreement, that is with the first of next October.
>
> Yours faithfully,
> Gisbert Kapp"

The re-appointment at £600 p.a. was finally agreed, and this salary held until his retirement.

In the session before Kapp's appointment, Electrical Engineering was represented by a staff of two: a Lecturer, Dr D. K. Morris, and an Assistant Lecturer, G. A. Lister. New accommodation was becoming available on the new Bournbrook site and the University was evidently anxious to develop the subject, for Morris was sent to Berlin in December 1904 or January 1905 to discuss plans with Kapp, and on his return an expenditure of £336 for equipment was approved, with further sums of £916 and £1259 a few months later. Also a laboratory assistant and a mechanic were appointed, the latter at £2 per week.

Immediately after taking up his appointment, Kapp asked for his staff to be strengthened by the appointment of a Lecturer on Electrical Machine Design. This was eventually agreed to, and E. J. Kipps, A.M.I.E.E., was appointed as Assistant Lecturer and Demonstrator. While Morris resigned at the end of 1906, and Lister during 1906, and few of their successors stayed for very long, Kipps remained in the Department for nearly 40 years, attaining the position of Senior Lecturer.

Kapp evidently overhauled the electrical syllabus, for by 1906 it was very different from that of 1904-05—indeed, much more advanced, with more emphasis on design. He did not change the basic pattern of the degree course, however, in which electrical engineering was introduced only in the two final years. Indeed, this remained the pattern until 1955, when the present writer was appointed to the Chair! The only other major change which Kapp introduced was the offering of a course (as yet not a compulsory one) on Telegraphy and Telephony soon after the appointment of T. F. Wall as Assistant Lecturer in 1909.

Considering the importance of electrical communications in the life of the nation, and the fact that it was a much older subject than electrical power (about 70 years old at Kapp's appointment) it is very surprising that universities were so slow to teach it. By the end of Kapp's tenure of the Chair even the electronic era had become well established (broadcasting by the B.B.C. came only 3 years later). Yet the Department, like some others, remained primarily a heavy-current department for many decades, and was still known as such until 1955, although by then some excellent work in communications was being done in it.

Actually something did stimulate a small amount of work in Wireless Telegraphy in the Departments of Electrical Engineering and Physics. Perhaps it was only coincidence that it was on the very day the present writer was born, 17 June 1914, the Senate approved a proposal:

> "(a) that the Department of Electrical Engineering be authorized to erect an experimental aerial on the roof of the central building, in accordance with designs submitted by Professor Kapp.
>
> "(b) That the Physics Department be authorized to suspend two thin wires from the balcony of the Clock Tower to the roof of the Harding Library, and thence across to the Physics block, for receiving purposes only.
>
> "(c) That the two Departments be requested to draw up detailed schemes of research and instruction in wireless telegraphy, and to specify the funds required for such purposes."

Perhaps it had something to do with the fact that the Principal, Sir Oliver Lodge, was an expert on wireless. At any rate, the proposal was approved, and £50 granted by Council for the equipment.

An educational matter in which Kapp held strong views was the need for practical training in industrial firms. He stated in his Inaugural Address [37] as Chairman of the Birmingham Section of the Institution of Electrical Engineers in 1907 that manufacturers should allow students to work in their shops during vacation time, no premium being required nor pay given. He made arrangements of this kind for his own students (there were never more than one or two taking Honours and a handful taking an Ordinary degree in electrical engineering) during most of his tenure at Birmingham. He believed that what was really wanted was a "sandwich system" whereby students spent at least four months at a stretch in industry in each year of their course. Unfortunately he got no support from the Faculty when he made the proposal around 1908, and had to let the matter drop until 1916, when the prospects of a post-war demand for greater numbers of better-trained engineers enabled him to enlist the support of his colleagues and get the scheme approved in principle. It meant some alterations to the university calendar, and it seems that in the event it was not actually adopted, presumably because by 1919 Kapp had retired.

How good Kapp was as a teacher it is now hard to discover. His successor, Professor W. Cramp, said [38] in 1923:

> "That the University of Birmingham did not benefit by the best of him as teacher is certain enough; how could it, when he was already 53 years old before he entered upon his career there?"

Cramp was only in his mid-forties when he was appointed! But he did go on to say that Kapp's students had a high regard for him.

Kapp's researches and inventions while at Birmingham

There is no indication of any student research in Kapp's department; this was something which started in the 1920s after his retirement. But Kapp himself pursued the advance of knowledge and techniques with great energy. His flow of publications and patents continued, including numerous text-books which were reprinted, published in many revised editions and translated into other languages. He was much concerned with the commercial exploitation of his ideas, and travelled widely to promote them. His letters show him to have been acquainted with most of the leading electrical industrialists in Europe.

The list of his publications shows his interests, within the field of electrical power, to have been very wide, ranging over the design of machines, measurements on machines and transmission systems, and the economic operation of machines. In this last topic he was particularly concerned with the improvement of power factor in a.c. machines, and it was here that he made what he seems to have regarded as his most outstanding invention, the "vibrator". His successor, Professor Cramp, said [39] after Kapp's death:

> "Since the invention of his vibrator, no public speech of his could avoid reference to that machine, it was said. Possibly so; but I will not believe that there was an ulterior and commercial motive in these references."

This invention, made in 1911, and described (after patenting) in published papers, [40, 41] was essentially a machine for producing wattless volt-amperes with a leading power factor, so that it could be connected to an induction motor (which normally produces a lagging power factor on its power supply) to improve the overall power factor. Other ways of achieving this were known, either using machines having continuously-rotating armatures so driven or so excited that wattless volt-amperes with a leading angle were produced (generically known as "rotary condensers") or using huge static condensers (now known as capacitors). Kapp's vibrator, however, was a machine the armature of which, while capable of rotation as in a normal machine, did not rotate but merely vibrated or oscillated at the slip frequency. It was quite successful, but seems to have gone out-of-use after a time. By the 1940s the term "vibrator" meant something quite different.

Although he developed his vibrator principle quite independently,

Kapp acknowledged that Leblanc had been the first to demonstrate the underlying physical principle "that a leading E.M.F. is generated in an alternating-current conductor allowed to swing freely in a continuous-current field." Leblanc had used a swinging disc, but Kapp used a bipolar cylindrical iron-cored armature of large length/diameter ratio, thus minimizing the effect of inertia, with minimal air-gap and high saturation of the teeth and core to avoid unbalance effects. He claimed that the effect of the vibrator as a phase-advancer (i.e. as a corrector for lagging power-factors) was relatively greater at low loads, which was just what was wanted.

Kapp promoted this invention vigorously, and had negotations with Oerlikon of Switzerland and Ganz of Hungary among others, but found them very difficult. He had also to deal with objections to his German patent lodged by Siemens. He discussed all this in a letter to his son Norman dated 23 April 1912. Economics were at the heart of the problem; Oerlikon turned down the invention because it added too much to the cost of the main motor—50% they said, 25% Kapp said! But Kapp goes on to tell Norman:

> "The Oerlikon disappointment has however had one good result: it made me go more closely into the design in order to see whether it could be cheapened and I have got out a line of vibrators by investigating what sort of proportion would give a maximum of voltamperes with a minimum of cost. The armatures of the vibrator I got out for Oerlikon were 15 cm diameter by 30 cm long. I found that by some improvement in design I could get the effect just sufficient for their motor (though not a leading current) with 13 by 24 armatures. This means a reduction of cost by about 30%."

He also comments: "The inventor's path is not smooth."

He was still concerned with this problem of phase advancing, or power-factor correction, after his retirement, and his very last paper, read, discussed, and published after his death,[42] gives an excellent review of all the available methods and, of course, includes some performance results for his vibrator.

It is an interesting indication of the pace of development in the use of electrical power that there should be so much concern with the subject of power factor correction in the early 1900's. When the electricity generating station at Bristol, which Kapp had designed, opened in 1893 it was envisaged as supplying only electric lamps, and was in fact labelled in large letters in stone (which survive to this day) CENTRAL ELECTRIC

LIGHTING STATION. Electric lighting presented no power-factor problems, whether operated by direct or alternating current. Electric motors for traction purposes, which came into use very quickly, were always direct-current and thus also had no power-factor problem. Electric motors for industrial drives came into use more slowly at first, but then their applications expanded so rapidly that the demand for electricity for power rapidly outstripped that for lighting. Since a large proportion of electrical generation was on the alternating current system, the avoidance of the losses due to bad power factor in such systems became a matter of prime economic importance.

Kapp as elder statesman

From quite early in his electrical engineering career, Gisbert Kapp had taken part in committee work at the Institution of Electrical Engineers; for example, in 1886 he was a member of a committee appointed to report on the best means for standardizing electrical apparatus, and it included such people as Lord Rayleigh, Sir William Thompson, Glazebrook, Fleming, Ayrton, Preece, Perry, Hopkinson and Crookes. Again, in 1893, he was a member of a small committee comprising Ayrton, Fleming, Forbes and himself to consider the meaning of the term "Inductance". Then, in Germany, he was primarily concerned with this sort of matter as well as the organisation of electrical engineering. During his Birmingham period, he served the I.E.E. well, and was elected President in 1909. So he was a public man in this sense as well as an eminent researcher and designer.

References to Kapp, apart from his own writings, were common in the technical press. During his tenure at Birmingham he made many controversial speeches and got involved in matters of industrial policy and commerce. Over his Presidential Address to the I.E.E. in November 1909 there was a great furore. It was a long address,[43] reviewing the development of the electrical industry which had grown from little over £100m to nearly £400m in capital investment between 1899 and 1909, and covered specifically generators, transformers, motors, transmission, electric railways, winding engines, rolling mills, electric steel furnaces, electro-chemistry and electricity in agriculture. This seems harmless enough (as well as useful), but most of his examples were taken from foreign practice and not from British. He concluded with a reproach to British industry:

> "In the time at my disposal I have only been able to refer to a few of the industries which have benefited by the application of

electricity; but when one reflects that nearly every industry in the country has been, or might be, furthered by the use of electricity in one form or another one comes to see that an enormous field of useful work is open to the electrical engineer—not only useful to himself, but even more so to the interests that employ him. How, then, comes it that electrical engineering is not as prosperous as it might be? Some of our members say, because we are backward as compared with our foreign competitors. If by that term they mean that our electrical engineering works cannot produce equally good plant as our rivals, I cannot agree. I have frequently visited continental shops, and, although I am quite willing to admit that excellent work is done there, I am also convinced that British shops can turn out work equally well and generally at a slightly lower prime cost. There is certainly no justification in reproaching the makers of electrical plant with backwardness; and, moreover, it is bad business policy. If, however, the reproach is levelled against the potential users of such plant there is some justification, and also a reason. Our great staple industries are old-established and have been fairly prosperous for generations; those on the Continent are of recent growth, and had to struggle into existence against English competition. To become successful they had to adopt every improvement which science put at their disposal. With them the application of electricity is almost a vital matter; with us only a desirable improvement. Is it, then, to be wondered at if a works manager or owner, who has grown up in the pre-electric days and has been doing a prosperous business ever since, should be rather slow in embarking in new methods of working which, to his thinking, might entail the possibility of risk, and the certainty of greater mental exertion? There are, of course, exceptions; and a good many of them, as witnessed by the great strides which electrical methods applied to our staple industries have already made; but, compared to what the development might be, we must admit that we have as yet only touched the fringe of this vast field. There is progress, but it is not fast enough and to accelerate it we must educate the potential users of electrical plant. A beginning in this direction has already been made by the managers of electric light stations. They are educating the householder by local exhibitions and literature that he can understand. On the Continent every large electrical engineering firm has a literary department whose business it is to educate possible customers. No sooner is

> a new winding plant started, or a cotton mill electrically equipped, than well-written, well-printed, and beautifully illustrated leaflets are sent out into the world to tell possible clients of the work done by the firm. Here, such literary departments are the exception; and thus it comes about that we hear so much about the great advances made on the Continent and so little about equally good work done here."

The Electrical Times was very critical of the Address and asked:[44]

> "is it not a little unfortunate that all Dr. Kapp's examples of great achievement are selected from German or other foreign sources?"

but it was not at first particularly against the general conclusion. The real trouble was that Kapp allowed himself to be interviewed by the *Daily News* and was drawn into a discussion on free trade which appeared with the headlines

TARIFF MOONSHINE
SCATHING EXPOSURE BY PRESIDENT OF
ELECTRICAL ENGINEERS
BOGUS MILLIONS

The *Electrical Times* thoroughly disapproved [45] of his enthusiasm for free trade and thought the great majority of those concerned with electricity would also. Other information presented to the I.E.E. indicated that Germany, with tariff protection, managed, during 1907 and 1908, to export electrical equipment worth £1,266,133 to Britain while accepting British goods to the value of only £92,405. Clearly Kapp was allowing politics to enter the I.E.E. and he was asking for trouble. He gave a dignified reply [46] to the Electrical Times:

> "This is my honest opinion based on German business methods and newspaper work and you do me an injustice by telling your readers that I show my partisan spirit in a presidential free trade agitation. A man who has worked both in a protectionist and a free trade country cannot help forming an opinion, and in a free country like ours he has also the right to impart it to others . . . "

He was not repentant over his criticisms of British industry, for a little later he took the opportunity of the I.E.E. local centre Dinner at Leeds to speak about the woollen industry.[47] Why was the woollen trade of Bradford so destitute of electrical power? he asked. Why should we be so unfortunate, when even in Schaffhausen a mill was being driven electrically some twenty years ago?—i.e. around 1890. And he went on to criticise a recent report of the Bradford commission on electrical driving of machinery.

Later on, he also offered comment on electric cooking and heating.[48]

There is no sign that he lost the respect of his profession through these excursions into politics.

A year before Kapp died the I.E.E. was granted its Royal Charter; he appears in the Charter as a founder member of Council.[49]

Kapp's reminiscences

Shortly before he died, Kapp contributed some reminiscences [50] of the early days of electrical engineering to a special session of the I.E.E. Although short (less than 2000 words) these make fascinating reading and show how clear his mind and judgment were in assessing the successes and failures of the 1880s and 1890s.

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LIST OF BRITISH PATENTS BY GISBERT KAPP

Date		*Number*	*Subject*
10 October	1882	4810	Dynamo-electric machines
13 April	1883	1877	Measuring electric currents etc.
18 September	1883	4453	Measuring electric currents and electromotive force
12 March	1884	4794	Measuring currents of electricity
20 August	1884	11,453	Magneto-electric and dynamo-electric machines and electric motors
(N.B.—The above five patents were held jointly with R. E. B. Crompton)			
2 March	1885	2776	Dynamo-electric machines
24 April	1885	5123	Exciting field magnets of dynamo machines
29 December	1886	17,056	Dynamo-electric machines
7 February	1887	1904	Transformers
5 April	1887	5096	Dynamo-electric machinery
21 March	1888	4345	Distributing electrical energy
5 July	1888	9817	Transformers
7 July	1888	9910	Continuous current dynamo-electric machines
2 November	1888	15,807	High speed steam engines
not given in index	1889	6728	Distributing electrical energy
,, ,,	1889	20,326	Magnets of dynamos
12 March	1890	3913	Alternate current transformers
28 March	1890	4858	Dynamo-electric machines
7 April	1892	6707	Registering supply of electricity
15 July	1892	12,999	Distributing electric currents
20 February	1893	3729	Supplying electric current for railway, tramway, etc. purposes
28 March	1893	6532	Recording excess currents in working electro-motors
15 September	1893	17,341	Alternate current dynamos
3 June	1908	12,044	Electric transformers
24 December	1910	29,998	Testing durability of material
4 May	1911	10,856	Resonating relays
7 November	1911	24,823	Alternating-current asynchronous machines
10 January	1912	741	Alternating-current machines
9 March	1912	5950	Resonating relays
31 August	1912	19,900	Resonating relays
7 January	1913	444	Resonating relays
15 January	1913	1134	Resonating relays
24 November	1913	27,063	Resonating relays
8 May	1914	11,372	Signalling
4 February	1915	1802	Dynamos
27 March	1915	4795	Dynamos

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