that of Sir Robert Walpole (1716), who proposed the creation of a sinking fund, by converting certain temporary taxes (previously imposed for paying the interest of the Debt), into perpetual taxes, and devoting any proceeds not required for the payment of interest to reducing the Debt. As, however, new loans were raised as fast as the old ones were redeemed, the scheme was soon abandoned. In 1786 the Act authorising Mr. Pitt's sinking fund was passed, enacting that the sum of £1,000,000 be provided for in each Budget, and applied yearly to the reduction of the Debt, the amount of the interest of the stock so purchased being again devoted to the same purpose. As, however, the National Debt was being continually increased (as in the previous instance) by fresh loans, the scheme did not work, and in 1829 it was arranged that the yearly surplus, if any, of the national revenue over expenditure should be devoted to the reduction of the National Debt.

In 1866 a serious effort was made by the conversion of some twenty-eight millions of three per cent. stock into short annuities to terminate in 1885—that is to say, the excess of the yearly payments beyond the interest required on the capital converted will at compound interest have by that date recouped the lender the amount of the principal.

Another step was taken in 1875, when, by an Act passed on the 2nd of August of that year, the annual charge for the service of the National Debt was fixed for the year 1875-6 at £27,400,000, for 1876-7 at £27,700,000, and permanently thereafter at twenty-eight millions per annum; all moneys not required for the payment of interest and expenses being devoted to the reduction of the Debt (the amount so devoted for the year 1880–1 was £350,000).

But by far the most extensive arrangement yet made for extinguishing the National Debt is that proposed in Mr. Gladstone's Budget for 1881–2. The proposal is to extinguish by 1906 no less an amount than sixty millions, by continuing to that date two millions of terminable annuities which were to have expired in 1885, and which would then have been applicable to the reduction of taxation. By the conversion of this amount from short into long annuities, a considerable reduction will, of course, be made in that portion of the short annuities which really repays the principal borrowed, the reduction amounting to about £1,550,000 per annum. The sum so saved put aside yearly until 1906 at three per cent. compound interest will amount at that time to sixty millions sterling, so that the new terminable annuities to end in 1906 will have to consist of the yearly reduction referred to of £1,550,000, plus the interest on the sixty millions, that is to say, of £3,350,000.

The sixty millions of Consols required to be so exchanged for annuities are readily found in the existence of stocks held on account of institutions for whose liabilities the nation is responsible. As the Government guarantees the amount in the hands of the Court of Chancery (belonging to estates under the care of the Court), and also the amounts of the Deposits in the Post Office Savings Bank, the funds of these two institutions have to be invested in the Government stocks. Instead, therefore, of having to go into the open market to arrange the conversion of the stock required, the Government simply exchanges for sixty millions of the stock held by the Chancery Court and by the Post Office Savings Bank, the yearly annuity (previously explained) of £3,350,000 to terminate in 1906.

As the funds of both institutions have hitherto always increased, the payments into their hands being larger than the withdrawals, and as they will therefore have to re-invest at least, not only the £1,550,000 per annum required to reinstate the original sixty millions by 1906, but the whole of the annuity in the Government Stocks, it is probable that the result will be to materially diminish the amounts held by private investors, and bring about some scarcity in the markets. The consequence is likely to be a gradual and steady increase of the price (already at about, or over, par), and ultimately yield an opportunity for the conversion of the remainder of the National Debt into fresh stocks bearing a lower rate of interest.

Should this be done, and the amount of twenty-eight millions provided for the permanent service of the National Debt be left untouched, funds will be provided for a still more rapid reduction—to say nothing of the opportunity provided in 1885 for creating further terminable annuities, or otherwise continuing to reduce the Debt, with the present annual amount of the remainder of the annuities terminating in that year.

W. J. W.

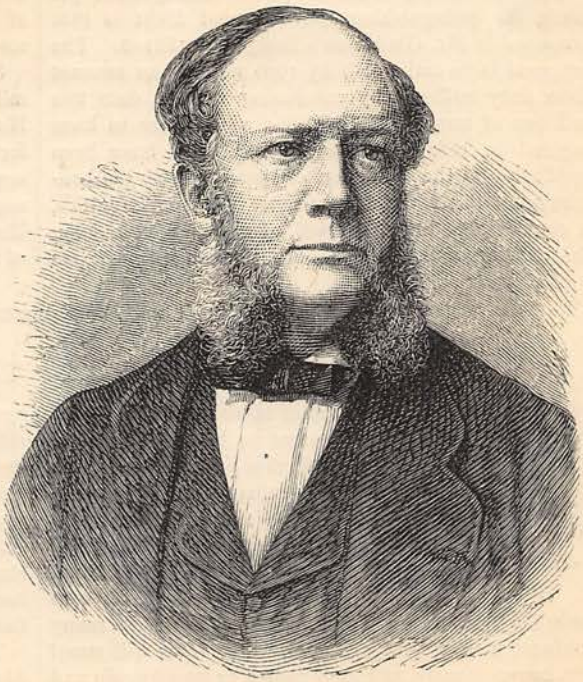
A FAMILY OF INVENTORS: THE BROTHERS SIEMENS.

THERE are families in which genius for art or literature seems to be hereditary, but we were not till this present generation aware that the genius of invention could spread its light on several members of one family. The great epoch of technical science and invention is still young, but, as every season brings with it its own peculiar flowers, so will this age enrol in it many eminent men of genius, among whom some will stand out conspicuously, and their names be heard again and again. It would be difficult to find a family more richly endowed with intellectual power and inventive genius than that of the late Ferdinand Siemens, of Lenthe, near Hanover. The sons of this gentleman numbered eight, of whom five are still living. As eminent engineers, as men of enterprise, they stand in the first rank, and three of the brothers have, through their inventions, attained a world-wide fame.

The eldest brother, Werner Siemens—the "Berlin Siemens," as he is generally designated—was born at

FREDERICK SIEMENS.

Lenthe, near Hanover, in 1816. He received his education at the Gymnasium of Lübeck, from whence he went to Berlin, and entered the Prussian Artillery as a volunteer. His eminent talents soon opened to him the doors of the Military School in Berlin; but the theories of velocity and the effects of projectiles seem not to have had much attraction for him, and he turned his attention mainly to practical chemistry and physics. Thus his first invention (1841) was eminently a peaceful one—namely, a new method of gilding and silvering by galvanic deposit. A few years later he constructed, along with his brother William, a new "governor" for steam-engines which attracted much attention, and had an extensive application. In 1845 he brought out—also in conjunction with his brother—the well-known process of anastatic printing, which also met with similar success. On the introduction of electric telegraphs, Werner Siemens' name took a prominent place. The conducting wires, being at that time laid under ground, required an insulating covering. For this purpose Werner Siemens employed gutta-percha; and the machine constructed by him for covering is even now used in the manufacture of cables. In 1848 his military duties called him to Kiel, where Danish men-of-war threatened the German fleet and the defenceless coast. Werner, along with his brother-in-law, Professor Himly, laid the first submarine mines, the precursor of the present torpedo. To this warlike undertaking there followed a more congenial work of peace—the laying of underground cables from Berlin to Frankfort and Cologne. In 1850 he left the army, and with the valuable aid of Mr. Halske, a practical mechanical engineer, founded the far-famed firm of Siemens and Halske. This establishment soon grew to large dimensions, and became one of the chief centres for the application of electricity and magnetism to the industrial arts, while at the same time affording a means of practical training for many young engineers. In 1865 Werner established the pneumatic despatch system, which his brother William in 1871 introduced into England. A very important discovery of Werner Siemens is the block-signal system on railways, the melodious bell-like tones of which may be heard in many countries, and which gives not only more security to life and limb, but lends a certain poetry to the tumult of a railway journey. A most ingenious invention is Siemens' alcohol-meter, an apparatus which registers with perfect accuracy the degree of strength of the spirit which flows through it. The apparatus has found such wide application that the firm had to erect works at Charlottenburg, near Berlin, for its manufacture. The principal purchaser of the alcohol-meter is the Russian Government. Since 1854 Siemens Brothers have had in St. Petersburg a large manufactory for telegraph apparatus, and this business was, till 1869, conducted by Carl Siemens. Very soon the whole Russian Empire was covered by a network of telegraph lines. They also established pottery works, for the purpose of making the well-known china insulating cups for telegraph posts. Werner Siemens is a partner of the London firm of "Siemens Brothers;" indeed, the three firms of Berlin, London, and St. Petersburg are the common property of the brothers Werner, William, and Carl. From these three centres issue forth many branch



WILLIAM SIEMENS.

establishments; even in the far Caucasus the brothers possess copper works and oil springs. From this may be gathered the magnitude and importance of their undertakings.

Werner's newest invention is the electric railway, a model of which, exhibited at the late Berlin Industrial Exhibition, gave as much pleasure as it called forth appreciation. Many honours have been conferred on this most fertile inventor. The University of Berlin conferred on him a Doctorate (*honoris causâ*), and in 1873 he was elected a member of the Royal Academy of Science in Berlin. He was for some time a member of the Prussian Parliament, and is honorary member of many scientific and technical societies in Germany, England, Austria, Russia, America, and even in Asia. Not only by his brother scientists is his name held in esteem, but he is deservedly popular among the German people, who daily in their workshops are brought into contact with the results of his inventive genius.

WERNER SIEMENS.

Here we may now say a few words with regard to Carl Siemens, born 1829. As an inventor he does not come much into the foreground, but the brothers owe much to him for the energy with which he has helped to further the extension of their inventions, more especially in Russia. As formerly in St. Petersburg, so lately in London he conducted the telegraph business with eminently practical results. He has now returned to St. Petersburg, to be at the head of the establishment there. He has also received many acknowledgments of his merits in orders from various countries.

The London brother, William Siemens, was born at Lenthe, 1823, and he also received his preparatory education at the Gymnasium of Lübeck. From thence he went to the Polytechnic School at Magdeburg, and attended the University of Göttingen, where the lectures of Wöhler and Himly particularly attracted him. His practical work began at the engine-works of Count Stolberg. In 1843 it was arranged with his brother Werner that he should visit England, in order to introduce the method of gilding and silvering by galvanic deposit. A year later he returned to England to patent the brothers' joint invention of the differential governor for steam-engines. In the same year was brought out the process of anastatic printing, also an invention of the two brothers. The renowned Professor Faraday delivered a lecture on this subject in the Royal Institution.

Between the years 1844 and 1847, William Siemens was engaged in railway works, in improving Hoyle's calico-printing, and in the invention of his chronometric governor. Several of these governors are in use at the Royal Observatory at Greenwich, for controlling the motion of transit and recording instruments. In 1846 he introduced his double-cylinder air-pump, which even to the present day is exclusively used. In 1851 the introduced his celebrated water-meters (beautiful through their simplicity), which are extensively used both in this country and on the Continent. As regards practical importance and economy in fuel, the invention of the regenerative gas furnace, which he worked out in conjunction with his brother Frederick Siemens, may be looked upon as his greatest discovery, and one which should alone secure for the brothers a world-wide reputation. The properties of these furnaces are so well known that we need not dwell upon them; economy in fuel is combined with the highest degree of temperature, while, at the same time, the absence of smoke is a boon to the neighbourhoods where those furnaces are used in different manufactories.* His steel process, which has now become so general both in this country and abroad, is worked by these furnaces.† For his re-

* William Siemens is at present deeply interested in the subject of smokeless chimneys, more especially in London and other large towns, where the increase of fog has become a matter of very serious consideration.

† It is interesting to record that the last lecture given by Professor Faraday in the Royal Institution was on the merits and advantages of the Siemens furnace.

searches on heat and his metallurgical processes he received the Medal of the Society of Arts in 1850, the Telford Medal in the Society of Civil Engineers, the "Grand Prix" at the 1867 Paris Exhibition, the Royal Albert Medal in 1874, and the Bessemer Medal of the Iron and Steel Institute in 1875. For the laying of submarine cables, William Siemens planned and had built by Messrs. Mitchell, of Newcastle, the well-known steamer *Faraday*, which has proved itself perfectly adapted for the work. The Indo-European lines, as well as several Atlantic cables, were manufactured at the telegraph works of Siemens Brothers at Woolwich. The most important of these submarine telegraph enterprises was the Direct United States Cable, for which the *Faraday* was constructed, and with the laying of which Carl Siemens was entrusted.

William Siemens' great services have also been recognised and acknowledged. He was elected a Fellow of the Royal Society in 1862, and has served twice on the Council; he is Member of Council of the Institution of Civil Engineers, and of the British Association, of which he is President-elect for the meeting of 1882. He has been President of the Mechanical Engineers, was first President of the Telegraph Engineers, and was re-elected to that post in 1878; was President of the Iron and Steel Institute in 1877;* made D.C.L. of Oxford (*honoris causâ*) in 1870, LL.D. of Glasgow University in 1879. He is also a member of the Royal Academy of Science in Stockholm. It would be difficult even for himself to enumerate the various scientific societies which have elected him honorary member. The Emperor of Brazil made him first a Commander and then a Dignitario of the Order of the Rose. In the midst of so much practical activity, William Siemens has still found time to write a number of articles on scientific and technical matters which would require a catalogue for themselves. In theoretical science he is an authority of the first importance.

The fourth of these highly-gifted brothers, Frederick—the Dresden Siemens, as he is called—was born in 1827 at Menzendorf, near Lübeck, a large property rented by their father. Frederick, like his brothers, was intended to pass through the classes of the Gymnasium of Lübeck, but having reached the third class, the desire of liberty urged him to abandon his place on the school-bench and to go forth into the world. He went on board a merchant ship when scarcely sixteen years of age, and there this youth, whose mental capacities afterwards proved so great, had to work as a common sailor. After two years of this seafaring life, his brother Werner tried at Berlin to get him into the Prussian marine service. In the meantime, Frederick was allowed to assist in the manifold experiments of the brothers. This chained him with a very different power from that which bound him to the ship, and out of the young sailor there was soon formed a clever, industrious assistant, who was also an originator.

In 1848 Frederick went to England, and continued his practical studies with his brother William. The principal interest was the newly-discovered regenerative system, and he was so fortunate as to make this system practical by its application to the ordinary furnaces where a very high temperature is required. In 1858 Frederick built, in the works of the brothers in Berlin, the first regenerative gas furnace, which was the precursor of the many now employed in Germany, Austria, &c. The second brother, Hans, possessed a large glass manufactory in Dresden, and on his death in 1867 Frederick undertook the management of this establishment, and concentrated his great talents on perfecting the manufacture of glass. His works at Dresden, as regards the quantity exported, may be considered the most important in Germany. He has established three other factories in Bohemia and Saxony, which give employment at present to 2,000 workmen. The application of gas furnaces to glass-making was a marked epoch in this branch of industry. Important, also, is his invention of the continuously-working glass furnace, in which the materials are inserted, and flow out thoroughly melted and ready for working. A further discovery is a new method of cooling glass quickly, and thus producing "toughened glass." This material will soon compete, for many purposes, with wood and iron. Its power of resistance is extraordinary, and even surpasses that of cast-iron. Frederick has also turned his attention to the possibility of producing a "motor" to perform cheaply and efficiently those small operations in workshops and households which have still to be done by manual labour—such as turning the grindstone, churning butter, driving sewing-machines, &c. Although his idea has not yet been realised, his hot-water "motor," devised on a new scientific principle, has come near the fulfilment of it, and obtained for him at the Vienna Exhibition of 1873 the medal for Progress. In paper-mills there has hitherto been a great waste of the soda used in the preparation of paper, which is allowed to flow away into the streams, on account of the noxious odours which the recovery of the same would create in the neighbourhood. In the large paper-mills of Hainsberg, near Dresden, however, there has lately been erected a Siemens furnace, in which these poisonous gases are entirely consumed. It is to be hoped many will follow their example; indeed, in large towns there are many dangerous gases in the air, which the fiery jaws of a Siemens furnace might easily absorb.

The newest invention of Frederick Siemens is known as the regenerative gas-burner, one of the most important improvements in the system of illumination. The effect produced by this gas-burner approaches very nearly that of electric light. The Dresden Skating Rink, a very large enclosure without a roof, is at present brilliantly lighted by four of these regenerative gas-burners, which only consume gas equal to

* In his Presidential Address to this Institute he proposed the transmission of power by means of the electric current, and said that a 3-inch copper rod would transmit 1,000 horse-power a distance of thirty miles from a waterfall or other natural sources of energy. It was during his visit to the Falls of Niagara that this idea first suggested itself to his mind.

sixteen ordinary fantail gas-burners, and these would scarcely produce any effect in so large a space.

In the midst of colossal undertakings and responsibilities, the flight of genius seems to bear these inventors ever higher and higher in the regions of research, and with renewed energy they set themselves to solve new scientific problems. If their success in the future shall equal that in the past, the world has yet much to learn from them. It would be well-nigh impossible to reckon up all their services to technical science, and to the welfare and progress of the working classes, to whom their inventions open up new sources of industry. As Moses caused springs of refreshment to flow from the rock, so such minds create sources of usefulness and prosperity for all nations.

AUNT SUSAN.

A SHORT STORY. BY KATHARINE ROCHE.

"YOU'RE to go down to the railway station, sir, at once; there has been an accident upon the line."

Cutting short the enumeration of symptoms of a curious and unique disorder, concerning which its proud possessor, a cheerful old apple-woman, was at that moment consulting me, I hurried to the station, expecting to find there one of those scenes of destruction with which we of the present day are, at least by hearsay, unfortunately so familiar. On my arrival, however, I found the train standing whole and sound by the platform, while a little knot of railway officials and some few passengers were collected round the motionless figure of a girl of some fifteen or sixteen years of age, who lay on one of the benches in the dusty waiting-room. An elderly woman, apparently a respectable servant, stood by her side sobbing helplessly, while the officials were discussing the accident and its causes, and disputing as to where lay the blame.

"'Twas altogether her own fault," said the guard; "what business had she to be getting out of the train till it stopped?"

"The door ought to have been locked, Tom," said the station-master.

"So 'twas, sir, but she had a key of her own. I never see such a young lady. Didn't she offer Jim half-a-crown, while ago, to let her travel on the engine? She'll get no compensation anyhow."

"Compensation! it's fined she ought to be."

"Hush!" said the first speaker, "here's the doctor." And the little crowd, dividing, made way for me to pass.

My patient was a tall overgrown girl, with a freckled face, and a quantity of dark red hair, hanging in thick plaits over her shoulders; the mischievous cast of countenance, with its turned-up nose and wide mouth, forming a painful contrast to the death-like pallor which now overspread it. A short examination showed me that the case was not serious; a dislocated shoulder, and broken collar-bone, making up the sum of the girl's injuries. I turned to the servant, who had suspended her sobs and was watching me eagerly.

"Is there no one with her but you?" I asked.

"No one, sir. I'm sure I did my best to take care of her, but Miss Violet is one that will never be gainsaid by any one. Will she die, sir, do you think?"

"I think not. As far as I can judge at present, her injuries are but trifling. She must be taken to my house at once; I can deal with her better there than anywhere else. You had better go with the guard, and look for the young lady's luggage."

I spoke in a peremptory tone, taking the law into my own hands, as I saw that nothing either of help or suggestion was to be looked for from the woman in her present terrified condition. She went off submissively with the guard, and a few minutes later, a door having been taken off its hinges and covered with the dark blue cushions of one of the railway carriages, the injured girl was carefully conveyed to my house, and taken possession of by my sister Mary, who is never so happy as when she has a sick person under her really skilful care.

As soon as I had reduced the dislocation, and seen my patient comfortably settled in bed, I went in search of the maid, who had now recovered sufficient equanimity to be of some use. Telling her that she might go up and sit with her young mistress, I asked to whom I was to send news of the young lady's accident.

"I think you had better write to Miss Violet's aunt, sir," she said after a moment's consideration. "My master is ill at present, and a shock would be bad for him."

"Very well," I said, "will you kindly tell me the lady's name and address?"

"Miss Ferrars, Templearden Rectory, Carlingham."

"I suppose," I said as I pencilled the words in my note-book, "that Miss Violet's name is Ferrars also?"

"Yes, sir. Her father is the Rector of Carlingham; he is a great invalid, and his sister Miss Ferrars manages everything. He has been worse than usual