My trust is that for the future India will throw great light upon the problem we are now discussing. We have a distinguished meteorologist, General Strachey, as member of the Council of India, we have General Walker and the trigonometrical survey staff, and we have Mr. Blandford and the various meteorological and magnetic observers of India, and I am glad to think that neither solar nor actinometric observations are likely to be forgotten.

Let me now briefly recapitulate the conclusions we have come to

In my first lecture I endeavoured to bring before you theoretical grounds for imagining that the sun is most powerful when there are most spots on its surface.

This has been supported by the evidence of a meteorological nature derived from these observations of rainfall, wind, barometric pressure, and temperature which have now been discussed, and likewise from such actinometric observations as have been made in Mussorree and Dehra. With regard to magnetical observations, we have the fact that diurnal declination ranges are largest in times of maximum sun-spots, and that on such occasions we have likewise a great number of magnetic storms, accompanied with earth currents and displays of the aurora. In fine we have most magnetic activity when there are most spots. There may perhaps be some doubt as to the exact method by which solar phenomena affect the magnetism of the earth, but we have already hypotheses from two distinguished physicists, the late Prof. Faraday and Prof. Stokes, while others have likewise been engaged in similar speculations.

Thus we may hope that eventually the truth will be attained. Meanwhile however we may conclude that the earth is most active both meteorologically and magnetically when there are most spots on the sun's surface. And if this be so, who will say that this is not a problem of great practical as well as of great theoretical importance?

ON GAS SUPPLY BOTH FOR HEATING AND ILLUMINATING PURPOSES[1]

WHEN, within the memory of living men, the gas-burner took the place of the time-honoured oil-lamp, the improvement, both as regards the brilliancy of the light and the convenience of the user, was so great that the ultimate condition of perfection appeared to have been reached. Nothing apparently remained for the engineer to effect but improvements in the details of the works and apparatus, so that this great boon of modern times might be utilised to the largest extent. It is only in recent years that much attention has been bestowed upon the utilisation of by-products, with a view of cheapening the cost of production of the gas, and that the consumer has become alive to the importance of having a gas of high illuminating power and free from nauseous constituents, such as bisulphide of carbon, thus providing a gentle stimulant for steady progress on the part of the gas-works manager.

This condition of steadiness and comfort has been somewhat rudely shaken by the introduction within the last year or two of the electric light, which, owing to its greater brilliancy and cheapness, threatens to do for gas what gas did for oil half a century before. The lighting of the City of London and of many public halls and works furnishes indisputable proof that the electric light is not an imaginary, but a real and formidable competitor to gas as an illuminant, and it is indeed time for gas engineers and managers to look seriously to their position with regard to this new rival; to decide whether to meet it as a foe, and contest its progress inch by inch, or to accept at once the new condition of things, conceding the ground that cannot reasonably be maintained, and to look about in search of such compensating fields as may be discovered for a continuation or extension of their labours.

For my own part I present myself before you both as a rival and as a friend; as a rival, because I am one of the promoters of electric illumination, and as a friend, because I have advocated and extended the use of gas for heating purposes during the last twenty years, and am by no means disposed to relinquish my advocacy of gas both as an illuminating and as a heating agent. Speaking as a gas engineer, I should be rather disposed to regard the electric light as a welcome incentive to fresh exertion, confidently anticipating achievements by the use of gas which would probably have been long postponed under the continued *regime* of a monopoly. Already we observe, both in our thoroughfares and in our apartments, gas-burners producing a brighter and more powerful light than was to be seen previously; and although gas will have to yield to the electric light the illumination of our lighthouses, halls, and great thoroughfares, it will be in a position, I believe, to hold its own as a domestic illuminant, owing to its great convenience of usage, and to the facility with which it can be subdivided and regulated. The loss which it is likely to sustain in large appliances as an illuminant would be more than compensated by its use as a heating agent, to which the attention of both the producer and the consumer has latterly been largely directed.

Having in the development of the regenerative gas-furnace had exceptional opportunities of recognising the many advantages of gaseous over solid fuel, I ventured, as early as 1863, to propose to the Town Council of Birmingham the establishment of works for the distribution of heating gas throughout the town, and it has occurred to me to take this opportunity (when the gas managers of Great Britain hold their annual meeting at the very place of my early proposal) to place before them the idea that then guided me, and to suggest a plan of operation for its realisation which at the present day will not, I venture to hope, be regarded by them as Utopian. The proposal of 1863 consisted in the establishment of separate mains for the distribution of heating gas, to be produced in vertical retorts, that might be shortly described as Appold's coke oven heated by means of "producer" gas and "regenerators." The heat of the retorts was to be increased beyond the ordinary limit in order to produce a coke suitable for locomotive and other purposes; and the gas produced being possessed of less illuminating but of the same heating power, and being, with a view to cheapness, less thoroughly purified than ordinary retort gas, was to be distributed through the town as a heating agent, to be applied to the small boilers and furnaces of the numerous little factories peculiar to the district, as well as for domestic purposes. The Corporation applied for an Act of Parliament, but did not succeed in obtaining it, owing to the opposition of the existing gas companies, who pledged themselves to carry out such an undertaking if found feasible by them. I am ready to admit that at the time in question the success of the undertaking would have involved considerable practical difficulty, but I feel confident that the modified plan which it is my present object to bring before you would reduce those difficulties to a minimum, and open out on the other hand a new field of vast proportions for the enterprise and energy of those interested in gas-works, and of great benefit to the public.

The gas-retort would be the same as at present, and the only change I would advocate in the benches is the use of the regenerative gas-furnace. This was first successfully introduced by me at the Paris Gas-works in 1863, and has since found favour with the managers of gas-works abroad and in this country. The advantages that have been proved in favour of this mode of heating are economy of fuel, greater durability of retorts, owing to the more perfect distribution of heat, the introduction of an additional retort in each bed in the position previously occupied by the fire-grate, and above all, a more rapid distillation of the coal, resulting in charges of four hours each, whereas six hours are necessary under the ordinary mode of firing. The additional suggestion I have now to make consists in providing over each bench of retorts two collecting pipes, the one being set aside for illuminating, and the other for a separate service of heating gas. I shall be able to prove to you from unimpeachable evidence that the gas coming from a retort varies very greatly in its character during progressive periods of the charge; that during the first quarter of an hour after closing the retort, the gas given off consists principally of marsh gas (CH_4) and other occluded gases and vapours, which are of little or no use for illuminating purposes; from the end of the first quarter of an hour, for a period of two hours, rich hydrocarbons, such as acetylene (C_2H_2) and olefiant gas (C_2H_4) are given off; whereas the gases passing away after this consist for the most part again of marsh gas possessing low illuminating power.

M. Ellissen, the late chief of the experimental department of the Paris Gas-works, and actual President of the French Society of Gas Engineers, has favoured me with the result of a most interesting series of experiments, which he carried out in connection with the late M. Regnault, the eminent physicist, some years ago, the object of the experiments being to discover the proper period of time to be allowed for each charge.

The results of these experiments are given in a diagram showing in a striking manner that although the average illu-

[1] Paper read before the British Association of Gas Managers at Birmingham, June 14, by C. W. Siemens, D.C.L., F.R.S., Civil Engineer.

minative power produced by the distillation of the coal did not exceed 1·35 Carcel burners, or 13·5 standard candles, according to our English mode of measurement, the gas given off from the end of the first quarter of an hour, during a period of two hours, possessed an illuminating power of 1·616 Carcel burners, or 16·16 standard candles. According to the figures given in the valuable experiments of M. Ellissen, it appears that nearly two-thirds of the total production of gas takes place in the above period, whilst the remaining third is distilled during the first quarter of an hour and the last hour and three quarters. It hence follows that by changing the direction of the flow of gas at the periods indicated, allowing the first results of distillation to flow into the heating gas-main, then for two consecutive hours into the illuminating gas main, and for the remainder of the period again into the heating gas-main, one-third volume of heating and two-thirds of illuminating gas would be obtained, with this important difference, that the illuminating gas would be of 16·16 instead of 13·5 candle-power, and that the heating gas, although possessed of an illuminating power of only 11·05, would be preferable to the mixed gas for heating purposes, in being less liable to deposit soot in its combustion upon heat-absorbing surfaces, and in giving, weight for weight, a calorific power superior to olefiant gas.

These experiments not having been made for the particular objects I have in view, no account was taken of the quantity or quality of the gas coming from the retort during the first quarter of an hour. Judging by the nature of the curves given by M. Ellissen, it is reasonable to suppose that during the first quarter of an hour a considerable quantity of gas of very inferior illuminating power is given off, which, if taken into account, would still further improve the result given in favour of separating the illuminating from the heating gases.

It will be observed that although the candle-power of the illuminating gas would be raised to only 16·25 if two-thirds of the gas were set apart for this purpose, *i.e.* after the first 25 minutes of distillation up to 2h. 35m. from the commencement of the charge, a gas equal to 18·04 candles would be obtained if the proportionate quantity of heating and illuminating gas were reversed, which might be effected by continuing the distillation for illuminating purposes from 0·25m. to 1h. 27m. after the commencement of the charge, whilst if equal quantities of heating and illuminating gas were produced, which would result from allowing the illuminating gas to flow into its receiver from 0·25m. to 2h. 0m., the candle-power of this portion of the gas would be raised to 16·78 candles, as shown in the figures given below.

	Cubic Feet.	Candle-power.	
Total gas produced from ton of coal...	10573·20 of	13·50	
	Illuminating Gas.		Heating Gas.
	Cubic Feet.	Candle-power.	Cubic Feet.
Illuminating gas passing into its main 25 minutes after commencement of charge:—			
If two-thirds the quantity used for illumination from 0h. 25m. to 2h. 35m.	7048·8	16·25	3524·4
If half the quantity used for illumination from 0h. 25m. to 2h. 0m.... ...	5286·6	16·78	5286·6
If one-third the quantity used for illumination from 0h. 25m. to 1h. 27m...	3524·4	18·04	7048·8

These important results are borne out by a series of photographic observations which were made some years ago by Mr. Sugg, which Mr. Sugg has further supplemented verbally in stating that the average illuminative power obtained by the distillation of Newcastle coal might be taken at 14 candle-power, whilst two-thirds of the quantity, if separated in the manner I propose, would produce an average of 16 candles.

The working out of this plan would involve the mechanical operation of changing the direction of the gas coming from each bench of retorts at the proper periods of the charge; this could be accomplished by means of a simple reversing valve similar to that applied for many years in reversing the current of the regenerative gas-furnace, and a sand-glass may be placed in front of each bench of retorts for the guidance of the man in charge as to the time when the reversal should be made. In order to distribute the two gases a double set of gas-mains would certainly be required; but these exist already in the principal thoroughfares of many of our great towns, where at one period or another competing gas companies have been established, and it would not be difficult, I think, to utilise these services for the separate supply of illuminating and heating gas, the latter being taken into such houses and establishments only where asked for by the occupiers.

The public could well afford to pay an increased price for a gas of greatly increased illuminating power, and the increase of revenue thus produced would enable the gas companies to supply heating gas at a proportionately reduced rate. It would not be necessary to employ upon the heating gas the same expense and trouble in purification as is required for illuminating gas, because the products of combustion of the heating gas would not as a rule enter the apartments, but be conducted into the atmosphere through the ordinary chimneys. Heating the retorts by means of the regenerative gas-furnace would, as already indicated, lead to an increased production of gas from each bench of retorts, and thus compensate for the reduced amount of illuminating gas in each operation. The heating gas might without inconvenience be sent through the pipes at a greater pressure than the illuminating gas, in order to make a given plant of mains transmit an increased quantity.

The question may fairly be asked whether a demand would be likely to arise for heating gas similar in amount to that for illuminating gas, and I may state that I am decidedly of opinion that although at the present moment the amount of gas supplied for illuminating purposes exceeds that for heating, the diminution in price of the latter would very soon indeed reverse these proportions. Already gas is used in rapidly increasing quantities for kitcheners, for the working of gas-engines, and for fire-grates. As regards the latter application, I may here mention that an arrangement for using gas and coke jointly in an open fire-place, combined with a simple contrivance (with a view of effecting the combustion of the gas by heated air), has found favour with many of the leading grate builders and with the public; although this arrangement was suggested by me only last winter, several hundred of these grates are already in use in London, Manchester, Leeds, Glasgow, and other towns, showing how fully alive the public are at the present time to that great crying evil, "the smoke nuisance."

It may be as well for me to mention here, that neither the regenerative gas-coke fire-grate just alluded to, nor the plan I here advocate of separating the produce of gas-retorts, has been made by me subject-matter of letters patent, my time being already too much occupied in other directions to give that amount of constant attention to these subjects which the working of a patent necessitates.

As regards the use of illuminating gas, I have one more suggestion to make, which I feel confident will be viewed by you not without interest. The illuminating effect produced in a gas flame depends partly upon the amount of carbon developed in the solid condition in the body of the flame, and partly upon the temperature to which these particles are heated in the act of combustion. Having already shown how by separation a gas of greater luminosity may be supplied, it remains to be seen how the temperature of combustion may be raised. This may be effected to an extent that seems surprising by certain mechanical arrangements, whereby a portion of the waste heat produced by the flame itself is rendered available to heat the gas and air sustaining the combustion of the flame, say to 600° F., or even beyond that point.

The arrangement I have adopted for this purpose is represented on the sectional diagram, and I have also the pleasure to place the burner itself before you to enable you to test its efficiency by actual trial. The burner is of the ordinary Argand type, mounted in a small cylindrical chamber of sheet copper connected with a vertical rod of copper projecting up and through the centre of the burner, and terminating in a cup-like extension at a point about four inches above the gas orifices, or on a level with the top of the flame. A small mass of fire-clay fills the cup, projecting upwards from it in a rounded and pointed form. The copper vessel surrounding the burner is contracted at its upper extremity with a view of directing a current of air against the gas jets on the burner, and on its circumference it is perforated for the admission of atmospheric air. The bottom surface is formed of a perforated disk covered with wire gauze, and wire gauze also surrounds the circumference of the perforated cylinder. The external air is heated in passing through these "regenerative" surfaces, and the flame is thus fed with air, heated to the point above indicated, which by more elaborate arrangements might be raised to a still higher degree. The ball of fire-clay in the centre of the burner, which is heated to redness, serves the useful purpose of completing the combustion of the gas, and thus diminishes the liability to blackening of the ceiling.

This arrangement for transferring the heat from the tip of the flame to the air supporting its combustion is applicable also to an open batswing burner; but I have not yet had time to ascertain accurately the amount of increase of luminosity that may be realised with this class of burner.

I may here mention that another solution of the problem of heating the incoming air by the waste heat of the products of combustion has lately been brought under public notice by my brother, Frederick Siemens, which differs essentially from the plan I have suggested, inasmuch as he draws the flame downwards through heating apparatus, and thence into a chimney. Experiments made officially and with great care have proved that by these methods the luminous effect of gas can be practically doubled. In practice both these methods of intensifying a gas-flame will probably find independent application according to circumstances, the cause of increased luminous effect being in both cases the same.

From a purely theoretical point of view it can be shown that of the caloric energy developed in the combustion of gas, a proportion probably not exceeding 1 per cent. is really utilised in the production of luminous rays, and that even in the electric light nine-tenths of the energy set up in the arc is dispersed in the form of heat, and one-tenth only is utilised in the form of luminous rays. It would lead us too far here to go into the particulars of these calculations, but it is important to call attention to them, in order to show the large margin for practical improvements still before us.

By the combined employment of the process of separation of the illuminating from the heating gas with the arrangement for intensifying the luminosity of the gas-flame, the total luminous effect produced by a given consumption of coal gas may be nearly tripled, thus showing that the deleterious effects now appertaining to gas illumination are not inseparably connected with its use.

My principal object in preparing this communication has been to call your attention generally to the important question of an improved gas illumination, and more particularly to the subject of a separate supply for heating gas, which, if carried into effect, would lead, I am convinced, to beneficial results, the importance of which, both to gas companies and to the public, it would be difficult to over-estimate.

APPENDIX

Paris, June 4, 1881

DEAR SIR,—I send you herewith the result of my experiments, together with tables and curves; the very ingenious proposal that you have made would permit such a division of the total production of gas, that two-thirds could be employed for lighting and one-third for heating purposes, resulting in splendid illumination and much more rational heating.

I am, dear sir, &c.,

Dr. C. William Siemens — A. ELLISSEN

Experiments on the Variation of Production of Gas, and of its Illuminating Power at different Periods of the Distillation

Tables I. and II. contain the results of experiments made in a bench of seven retorts of the type of the Compagnie Parisienne, each retort being charged respectively with 100, 110, and 120 kilogrammes (220, 242, 264 pounds).

Table I. corresponds to a distillation of 4 hours.

Table II. corresponds to a distillation of 4h. 48m.

The period of distillation has been divided into intervals of fifteen minutes, and the results recorded on each horizontal line refer to the gas produced during the quarter ending the time mentioned on each line.

In each of the two tables the case of a charge of 110 kilos. (242 lbs.) has been chosen as the standard, and the results have been graphically represented by means of two curves, one in red for the gas produced, and the other in blue for the illuminating power.

The line of abscissæ being divided into equal parts, each representing fifteen minutes, each ordinate of the red curve gives the gas produced during the preceding quarter of an hour, and the corresponding ordinate of the blue curve indicates the illuminating power of this same gas.

The production of the gas been further divided into two portions, the one destined for illumination, and the other for heating and motive power.

The gas produced during the first quarter of an hour is generally of low illuminating power, and varies besides with the hygrometric condition of the coal; it has, in the following calculation, been accordingly classed with the heating gas, and the gas produced during the interval from 0h. 15m. to 2h. 15m. of the working has alone been reserved for illuminating purposes.

Distillation in four hours. Charge of 110 *kilos.* (242 *lbs.*)

I. Gas produced per 100 kilos. of coal distilled—

	Cubic metres.	Per ton, cubic feet.
1. From 0h. 15m. to 2h. 15m. ...	18·062	6502·32
2. From 0h. 0m. to 0h. 15m., and from 2h. 15m. to 4h. 0m. ...	11·308	4070·88
Total	29·370	10573·20

II. Gas produced per 100 cubic metres obtained—

	Cubic metres.
1. From 0h. 15m. to 2h. 15m. ...	61·502
2. From 0h. 0m. to 0h. 15m., and from 2h. 15m. to 4h. 0m. ...	38·498
Total	100·000

III. Mean illuminating power of the produced gas—

	Litres.	In English standard candles.
1. From 0h. 15m. to 2h. 15m. ...	87·7	16·16
2. From 0h. 0m. to 0h. 15m., and from 2h. 15m. to 4h. 0m. ...	128·2	11·05
Mean of the total mixed gas as per calculation	103·3	
Illuminating power of mixed gas as per direct trial...	105·7	13·50

Distillation in 4 *hours* 48 *minutes. Charge of* 110 *kilos.* (242 *lbs.*)

I. Gas produced per 100 kilos. of coal distilled—

	Cubic metres.	Per ton, cubic feet.
1. From 0h. 15m. to 2h. 15m. ...	20·388	7339·68
2. From 0h. 0m. to 0h. 15m., and from 2h. 15m. to 4h. 48m. ...	9·741	3506·76
Total	30·129	10846·44

II. Gas produced per 100 cubic metres obtained—

	Cubic metres.
1. From 0h. 15m. to 2h. 15m. ...	67·673
2. From 0h. 0m. to 0h. 15m., and from 2h. 15m. to 4h. 48m. ...	32·327
Total	100·000

III. Mean illuminating power of the produced gas—

	Litres.	In English standard candles.
1. From 0h. 15m. to 2h. 15m. ...	101·1	14·02
2. From 0h. 0m. to 0h. 15m., and from 2h. 15m. to 4h. 48m. ...	132·4	10·07
Mean of the total mixed gas	111·2	12·77

It is not proposed to stop at the results obtained by distillation in 4h. 48m., that is five charges per twenty-four hours; experience has proved that the best conditions of working are found in the use of active charges rapidly distilled by raising the temperature of the furnaces.

From these experiments it results that it would be possible to divide the products of distillation of coal into illuminating gas, and gas for heating purposes and motive power.

Thus in place of producing, as is generally done, by means of a distillation of four hours and 110 kilos. (242 lbs.) per retort, a mean result per 100 kilos of coal distilled, of 30 cubic metres of normal gas, which corresponds to an expenditure of 105 litres, to produce the light of a Carcel burner consuming 42 grammes of oil per hour, there may be produced:—

1. About 18·5 cubic metres of illuminating gas of an illuminative power of 87 litres; and

2. About 11·5 cubic metres of heating and motive-power gas of an illuminative power of 128 litres; or per 100 cubic metres

of gas produced, 61·50 cubic metres of illuminating gas, and 38·50 cubic metres of heating and motive-power gas.

This result would be obtained by receiving into separate reservoirs the gas produced during the first fifteen minutes, and during the last 1h. 45m. of the distillation, and in reserving for illuminating purposes the gas made in the interval of 0h. 15m. to 2h. 15m. of the charge from the commencement of the distillation.

STORAGE OF ELECTRIC ENERGY

THE following correspondence on this subject has appeared in the *Times*. By help of this and the communication in our issue of to-day from Sir W. Thomson, the reader will be able to understand the present position of this important question.

THE marvellous "box of electricity" described in a letter to you, which was published in the *Times* of May 16, has been subjected to a variety of trials and measurements in my laboratory for now three weeks, and I think it may interest your readers to learn that the results show your correspondent to have been by no means too enthusiastic as to its great practical value. I am continuing my experiments to learn the behaviour of the Faure battery in varied circumstances, and to do what I can towards finding the best way of arranging it for the different kinds of service to which it is to be applied. At the request of the Conseil d'Administration of the Société de la Force et la Lumière, I have gladly undertaken this work, because the subject is one in which I feel intensely interested, seeing in it a realisation of the most ardently and unceasingly felt scientific aspiration of my life—an aspiration which I scarcely dared to expect or to hope to live to see realised.

The problem of converting energy into a preservable and storable form, and of laying it up in store conveniently for allowing it to be used at any time when wanted, is one of the most interesting and important in the whole range of science. It is solved on a small scale in winding up a watch, in drawing a bow, in compressing air into the receiver of an air-gun or of a Whitehead torpedo, in winding up the weights of a clock or other machine driven by weights, and in pumping up water to a height by a windmill (or otherwise, as in Sir William Armstrong's hydraulic accumulator) for the purpose of using it afterwards to do work by a waterwheel or water pressure on a piston. It is solved on a large scale by the application of burning fuel to smelt zinc, to be afterwards used to give electric light or to drive an electro-magnetic engine by becoming, as it were unsmelted in a voltaic battery. Ever since Joule, forty years ago, founded the thermodynamic theory of the voltaic battery and the electro-magnetic engine, the idea of applying the engine to work the battery backwards and thus restore the chemical energy to the materials so that they may again act voltaically, and again and again, has been familiar in science. But with all ordinary forms of voltaic battery the realisation of the idea to any purpose seemed hopelessly distant. By Planté's admirable discovery of the lead and peroxide of lead voltaic battery, alluded to by your correspondent, an important advance towards the desired object was made twenty years ago; and now by M. Faure's improvement practical fruition is attained.

The "million of foot pounds" kept in the box during its seventy-two hours' journey from Paris to Glasgow was no exaggeration. One of the four cells, after being discharged, was recharged again by my own laboratory battery, and then left to itself absolutely undisturbed for ten days. After that it yielded to me 260,000 foot pounds (or a little more than a quarter of a million). This not only confirms M. Reynier's measurements, on the faith of which your correspondent's statement was made; it seems further to show that the waste of the stored energy by time is not great, and that for days or weeks, at all events, it may not be of practical moment. This, however, is a question which can only be answered by careful observations and measurements carried on for a much longer time than I have hitherto had for investigating the Faure battery. I have already ascertained enough regarding its qualities to make it quite certain that it solves the problem of storing electric energy in a manner and on a scale useful for many important practical applications. It has already had in this country one interesting application, of the smallest in respect to dynamical energy used, but not of the smallest in respect to beneficence, of all that may be expected of it. A few days ago my colleague, Prof. George Buchanan, carried away from my laboratory one of the lead cells (weighing about 18 lbs.) in his carriage, and by it ignited the thick platinum wire of a galvanic *écraseur* and bloodlessly removed a nævoid tumour from the tongue of a young boy in about a minute of time. The operation would have occupied over ten minutes if performed by the ordinary chain *écraseur*, as it must have been had the Faure cell not been available, because in the circumstances the surgical electrician, with his pharaphernalia of voltaic battery to be set up beforehand, would not have been practically admissible.

The largest useful application waiting just now for the Faure battery—and it is to be hoped that the very *minimum* of time will be allowed to pass till the battery is supplied for this application—is to do for the electric light what a water cistern in a house does for an inconstant water supply. A little battery of seven of the boxes described by your correspondent suffices to give the incandescence in Swan or Edison lights to the extent of 100 candles for six hours, without any perceptible diminution of brilliancy. Thus, instead of needing a gas engine or steam engine to be kept at work as long as the light is wanted, with the liability of the light failing at any moment through the slipping of a belt—an accident of too frequent occurrence—or any other breakdown or stoppage of the machinery, and instead of the wasteful inactivity during the hours of day or night when the light is not required, the engine may be kept going all day and stopped at night, or it may be kept going day and night, which will undoubtedly be the most economical plan when the electric light comes into general enough use. The Faure accumulator, always kept charged from the engine by the house supply wire, with a proper automatic stop to check the supply when the accumulator is full, will be always ready at any hour of the day or night to give whatever light is required. Precisely the same advantages in respect of force will be gained by the accumulator when the electric town supply is, as it surely will be before many years pass, regularly used for turning lathes and other machinery in workshops and sewing-machines in private houses.

Another very important application of the accumulator is for the electric lighting of steam-ships. A dynamo-electric machine of very moderate magnitude and expense, driven by a belt from a drum on the main shaft, working through the twenty-four hours, will keep a Faure accumulator full, and thus, notwithstanding irregularities of the speed of the engine at sea or occasional stoppages, the supply of electricity will always be ready to feed Swan or Edison lamps in the engine-room and cabins, or arc lights for mast-head and red and green side lamps, with more certainty and regularity than have yet been achieved in the gas supply for any house on *terra firma*.

I must apologise for trespassing so largely on your space. My apology is that the subject is exciting great interest among the public, and that even so slight an instalment of information and suggestions as I venture to offer in this letter may be acceptable to some of your readers. WILLIAM THOMSON.

The University, Glasgow, June 6.

ALTHOUGH agreeing with every word of Sir William Thomson's letter in the *Times* of to-day, and entirely sympathising with his enthusiasm as regards the marvellous box of electricity, still I feel that it would have been desirable if in pointing out the importance of this new discovery Sir William Thomson had guarded against a very probable misconstruction of the purport of his letter.

The means of storing and re-storing mechanical energy form the aspiration not only of Sir William, but of every educated mechanic. It is, however, a question of degree—of the amount of energy stored as compared with the weight of the reservoir, the standard of comparison being coal and corn. Looked at in this way one cannot but ask whether, if this form of storage is to be the realisation of our aspirations, it is not completely disappointing. Large numbers are apt to create a wrong impression until we inquire what is the unit. Eleven million foot pounds of energy is what is stored in 1 lb. of ordinary coal. So that in this box, weighing 75 lb., there was just as much energy as in $1\frac{1}{2}$ oz. of coal, which might have been brought from Paris or anywhere else in a waistcoat pocket, or have been sent by letter.

When we come to the question of the actual conveyance of energy for mechanical purposes, this view is of fundamental importance. The weight of the same amount of energy in the new form is 800 times greater than the equivalent amount of coal; and as a matter of economy, supposing that energy in this