productive of results that we should be the last to impugn; but this we believe is the first attempt at a purely scientific investigation of Central Australia, while the names of the distinguished men whom Mr. Horn has been so fortunate as to engage in it, are a guarantee of the serious way in which it will be conducted. We doubt not that he and his companions will find plenty of rough work before them, and possibly some risk; but if good wishes can help them they may rely on those of all our readers, together with their high and hearty appreciation of the spirit which has prompted that gentleman not only to defray the cost of the Expedition, but to put himself at the head of it at a time of life when most men think of retiring upon the fruits of their labours.

THE ENRICHMENT OF COAL-GAS.

I T is almost impossible to over-estimate the importance of the influence which coal-gas has exercised upon the advancement of civilisation during the past fifty years, and at the present time it has reached a phase in its existence upon which its future career and utility is very largely dependent.

Up to the middle of the century but little attention was paid to the quality of the gas supplied for illuminating purposes; the gas manager made the best gas he could with the coals at his disposal, and the consumer was content as long as he obtained a reasonable amount

of light.

In 1850 a Bill was passed which enacted that the light emitted by a brass argand burner with 15 holes, consuming five cubic feet of gas per hour, should be equal to the light of 12 wax candles of the size known as "sixes." These wax candles were, however, only equal in illuminating power to 10 3 of the sperm candles at present used for testing purposes. In 1860 an Act changed the illuminating power to 12 sperm candles, and in 1868 this was again raised to 14 candles, and by the Act of 1876 this was increased to 16 candles, and remains so to the present time.

In 1864 the 15-hole brass argand was discarded as a standard testing burner, and was replaced by a 15-hole steatite burner, which by increasing the temperature of the flame developed more light, whilst in 1869 the "London argand" 24-hole burner was introduced, and gave a still further increase in the light obtained from the gas, so that when we speak of London being supplied with 16 candle-power coal-gas, it means that the light emitted by the gas when burning at the rate of 5 cubic feet per hour from a London argand shall be equal to the light of 16 sperm candles of the size known as sixes con-

suming 120 grains of sperm each per hour.

When we come to consider what this in reality amounts to, we find that by one of those subtle strokes of humour in which our legislative body occasionally indulges, it means to the consumer almost anything except a light equal to 16 candles. The illumination which can be obtained by the consumption of coal-gas is entirely dependent upon the method by which the gas is burned. From a so-called 16-candle coal-gas the consumer rarely obtains a value of more than 12 candles per 5 cubic feet of gas consumed; whilst by using burners of rational construction, upwards of 40-candle illuminating power could be obtained for the same consumption of gas.

The light emitted by a coal-gas flame is dependent upon its temperature, and flat-flame burners, exposing a thin sheet of flame to the cooling action of the air, give the worst results. Argand burners are better, as the cooling is not so great, whilst the regenerative burners lately introduced, by utilising the heat of the products of combustion for raising the temperature of the gas and air supplied to the flame, give an enormous

increase in the light emitted.

If the gas companies could only get an Act passed authorising the use of the regenerative burner as the standard, there is no reason why they should not call the gas at present supplied 40-candle gas; the consumer, however, using the flat-flame burner would still be only obtaining the same light as at present. Incandescent mantle burners, which act on a totally different principle, also yield a high illuminating value.

On carefully testing the burners in ordinary use we find that for an equal consumption of gas the results at once show the enormous advantage to be obtained by regeneration, and also how serious is the loss which

attends the employment of ordinary burners.

Light obtained per cubic foot of 16-candle gas consumed.

	Burner. Regenerative and incandescent					Candle units.		
						•••	***	7 to 10.00
	Standard a	ırgan	d	•••	***	•••	•••	3'20
	Ordinary	. ,,		•••	***	•••		2.90
	Flat-flame	No.	7	• • •	•••	• • •	•••	2.44
	1)	,,	6	•••	•••	•••	•••	2.12
	11	,,	5	• • •	• • •	•••	***	1.87
	3.7	32	4	• • •		***	***	1.74
	,,	,,	3	• • •	***	•••	• • •	1.63
	,,	,,	2	• • •	•••	•••		1'22
	,,	,,	I	•••	• • •	•••	•••	o:8 5
	,,	,,	0	•••	*	•••	***	0.29

These burners were by well-known makers; but there are plenty of cheap German nipples in the market which will give even worse results. In the above table No. 7 is the largest flat flame burner given, as any larger size would never be used for indoor illumination; but with some of the big flat-flame burners employed for outdoor work as much as three candle power per cubic foot of gas is developed by the best make, while it is also quite possible to find cheap imitations of them, which can scarcely be distinguished by their appearance, only developing a little more than one candle per cubic foot. It seems probable that 10-candle units represent the maximum light to be obtained in practice per cubic foot from the so-called 16-candle coal-gas, as, although greater regeneration will increase it as high as sixteen units, the heat is so intense that the burner is quickly destroyed. Taking 10-candle units as being the maximum amount of light for a consumption of one cubic foot of gas per hour, an approximate idea of the waste of illumination which attends the ordinary methods of burning the gas can be formed.

If the burners most commonly in use in houses be examined they will be found to consist chiefly of No. 4 and No. 5 flat-flame nipples, and it would not be over-estimating the number in use to put them at 85 per cent. of the total. The remaining 15 per cent is made up of larger flat-flame burners, argands, and regenerative lamps, which give a higher service; but it will be found that the total value obtained will not exceed 2.5 candles per cubic foot. This means that 75 per cent of the total value obtainable from the gas is wasted, and that for our present expenditure in coal-gas we could

obtain four times as much light.

Mr. George Livesey some time ago proposed that unenriched coal-gas should be supplied to the consumer at a lower rate than is at present charged for the enriched 16-candle gas, and this question is of such interest and importance to both consumer and gas company that it deserves the gravest consideration.

In large towns like London, where the gas companies have to supply a gas of specific illuminating power, and where the gas is continually subjected to photometric tests at stations spread over the whole area supplied (any deficiency in the lighting value of the gas being visited with rigorously enforced penalties), enrichment in some form or other becomes a practical necessity. In London the gas has to have an illuminating power of sixteen

candles; and in order to ensure this over so enormous an area, the gas must be sent from the works testing up to from 16.5 to 17 candles. With seaborne Durham coals of the character most largely used in the metropolis for gas-making, the illuminating value of the gas will be about fifteen candles, and the gas manager has to enrich the gas by from 11 to 2 candles before he can with safety send it out for distribution. This enrichment is done in several ways: (a) by the admixture of a certain percentage of cannel coal with the original gas coal; (b) by carburetting the coal-gas with the vapours of volatile hydrocarbons; (c) by mixing the gas with carburetted water-gas; (d) by admixture with rich

Up to four years ago the admixture of a certain percentage of cannel coal with the Durham coal was the only method of enrichment employed by the metropolitan companies, and was perfectly satisfactory, as the coal being mixed, the gases came off together under the same conditions in the retorts, and a uniform gas was During the past few years, however, the the result. increase in price of cannel has forced the gas companies to find some other process which should take its place, and the Gas Light and Coke Company tried experiments which led to their largely adopting carburetted water-gas

for this purpose.

When steam acts upon carbon at a high temperature, the resulting action may be looked upon as giving a mixture of equal volumes of hydrogen and carbon monoxide, both of which are inflammable but non-luminous gases. The water-gas is then carburetted, i.e. rendered luminous by passing it through chambers in which oils are decomposed by heat, and the mixture of oil-gas diluted with water-gas is made of such "richness" as to give an illuminating value of 24 or 25 candles, and this, mixed with the poor coal-gas, brings up its illuminating value to the required limit. During the winter months the gas supplied by the Gas Light and Coke Company has mostly contained about 10 per cent. of the carburetted water-gas.

This form of enrichment has several serious drawbacks: it increases the percentage of the highlypoisonous carbon monoxide in the gas, and so makes leakage more dangerous, whilst carburetted water-gas burns with a short but very brilliant flame, far shorter than coal-gas, a 22 candle water-gas flame burning from a London argand at the rate of 5 cubic feet an hour, with a flame only 21 inches in height; whilst a 16-candle flame of the gas supplied up to three years ago gave a flame three inches in height; and the gas now supplied and enriched with the carburetted water gas only gives a flame 26 inches in height, in order to emit a light of

When a householder lights his gas-burners, he invariably turns on the gas until he gets the largest possible flame without roaring or smoking, and from the alteration in the composition of the gas which has taken place, this means using far larger quantities of gas than heretofore, so that although an increase in illuminating power is obtained, a substantial increase in the quarter's gas bill is also found.

Another objection to this form of enrichment applies even still more to the admixture of rich oil-gas with the poor coal-gas, and is that although gases of different gravities mix perfectly well in small vessels, yet when you come to deal with the huge gas-holders used in the modern gas works, stratification of the gas takes place, and even if the enriching gas be mixed with the ordinary gas in the foul mains, so that they may pass through the scrubbers and purifiers together, uniformity in illuminating power is never obtained, and with the London coal gas variations of from 16 to 18 candles in value are found at the testing stations.

A burner which is giving its best duty with a 16 candle

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gas, will be very apt to smoke when burning a gas of higher quality, and under these conditions the products of combustion become more injurious to health from the presence in them of a larger proportion of the products

evolved during incomplete combustion.

Enriching gas by the vapours of volatile hydrocarbons enables the manager to bring his gas up to the legal requirements as regards the illuminating value at the testing stations, which are mostly fixed where the great trunk mains deliver the gas to the districts to be supplied, and it is only under exceptional circumstances that the illuminating value of the gas is ever found to be below the required limit at these points. The consumers, however, reap but little benefit from it, as the loss of illuminating value during distribution is very great where this method of enrichment is employed.

No matter how enriched, change of temperature, and other troubles incidental to distribution generally reduce the illuminating power of the gas to a considerable extent before it reaches the consumers' burners, so that its actual value is far more often fifteen candles, although it may have been tested over sixteen at the station.

In the big mains the gas is continually flowing at a fairly steady rate, and is neither exposed to any great alteration in temperature, nor from the size of the mains to any very great amount of "skin friction," i.e. rubbing of the gases against the sides of the pipes; but as soon as distribution commences, both these factors come into play, and as some of the chief illuminants of the gas are vapours and not permanent gases, lowering of temperature causes condensation of some of them, whilst the power which friction against the sides of the main service pipes, coated with deposited hydrocarbons, has of withdrawing the illuminants from the gas, still further decreases its light-giving value, and anywhere near the dead end of a service, stagnation of the gas during a large portion of the twenty-four hours when gas is not being consumed, adds still further to the trouble, so that even at the testing stations, the influence of the small consumption of gas on Sundays, and consequent stoppage in the manufacture on that day, can be traced in the illuminating value found on Monday morning.

Coal-gas, as made from Durham coal at the temperature employed in the Metropolitan Gas Works, has an illuminating value of about fifteen candles, and the enrichment of this gas up to the required value costs far more pro rata than the amount of light obtained from

the unenriched gas.

This cost has entirely to be borne by the consumers, and the whole practical question to be decided resolves itself into-"Is the game worth the extra candle and a

half?"

If coal-gas were used for illuminating purposes only the consumer would be a considerable gainer by having the unenriched gas supplied at a lower price; and when we consider the amount of gas used as a fuel, and that the quantity so employed is daily increasing, the cost of the enriched gas becomes of the greatest importance.

The value of one candle in illuminating power in the gas supplied in London at $1\frac{1}{2}d$, per candle is £180,000, and if this calculation be correct, consumers in the metropolis would be saved about £270,000 a year by using unenriched coal gas, and probably not one of them would notice the slightest difference in the light emitted by the

gas in the burners ordinarily in use.

In the regenerative burner the increase in illuminating value is almost entirely due to the rise in temperature causing methane, which forms about 34 per cent. of the coal-gas by volume to become a very valuable illuminant, and as there is just as much or more methane in the unenriched gas, it is manifest that this increase will still be found.

In the incandescent burner the coal-gas is burnt in an atmospheric burner, and the non-luminous flame is made to heat a mantle of refractory material up to incandescence, and for this purpose the 15-candle gas will do as well as the 16.

One argument which has been raised against the lowering of the standard is that if a 16-candle gas is reduced to 15 candles during distribution, a 15-candle gas will be lowered to 14. This I think is a mistake. An enriched gas is lowered in illuminating value because certain vapours are condensed from it; but it will be found that with an unenriched gas, made at a high temperature, this action is decreased to a minimum, on account of the small proportion of vapours present.

One of the most important experiments ever tried on a large scale has been made this year, the London County Council having given permission to the South Metropolitan Company to supply unenriched gas to South London for the space of a fortnight, in order to practically ascertain the result during distribution and

the loss of light to the consumer.

At the testing stations the gas for the fortnight showed the average value of about 15 candles, ranging from 14 to 16 according to the coal used at the various works, whilst tests made with portable photometers on the consumers' premises gave identical results, before, during, and after this period, clearly showing that the whole value of the enrichment consisted in satisfying the legal requirements, whilst the consumer gained absolutely nothing but the privilege of paying for it.

It is to the interest of the gas consumer and gas company alike that the price of gas should be reduced to the lowest possible figure, and the possibility of reduction in price is entirely dependent upon the

discarding of the costly enrichment.

Under the present legal conditions the companies gain nothing by supplying a gas a candle better than the standard, and if they fall a candle below have to pay the absurd fine of 40s., a state of things which if the London companies did not show the greatest anxiety to fulfil all their obligations might lead to a considerable reduction in the value of the gas distributed, as to pay a daily fine and to send out gas of a value of 15°1 candles would save the companies many thousands a year.

This is all manifestly wrong, and if the consumers are to get the full benefit of coal-gas, and if coal-gas is to take its proper place as a fuel as well as an illuminant, its sale must be placed on a sound commercial basis. Enrichment should be entirely given up, and the gas that can be made direct from the coal supplied to the

consumer.

A minimum of illuminating value should be fixed for each town based upon the coal used, and any fall belowthis should be visited by a fine of £50 for the first half-candle, and an increment of £100 for each half-candle below that, whilst the price charged for the gas should be governed by its illuminating value for the quarter as averaged from the testing station returns, a low initial price, say 2s. 2d per thousand, being charged for 14-candle gas, and $1\frac{1}{2}d$. a candle for each candle above it, with a maximum price of 2s. 5d. If some such scheme as this could be adopted, not only would the consumer obtain the full value for his money, but the gas companies would reap the benefit of an enormously increased consumption for fuel purposes, and the atmosphere of our big cities would gain in proportion. VIVIAN B. LEWES.

NOTES.

THE Council of the Society of Arts have, with the approval and sanction of the President, H.R.H. the Prince of Wales, awarded the Albert Medal to Sir Joseph Lister, Bart., F.R.S., "for the discovery and establishment of the antiseptic method

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of treating wounds and injuries, by which not only has the art of surgery been greatly promoted and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

WE are requested to state that before long a memoir of the late Dr. James Croll, F.R.S., will be ready for publication. Persons having letters from Dr. Croll, or information likely to be of interest, are requested to forward such to J. C. Blackwell, 10, Royal Terrace, Edinburgh. The letters will be returned when their contents have been noted.

A PASTEUR Institute was opened at Tunis on Tuesday by Dr. Loir, a nephew of M. Pasteur.

THE death is announced from Paris of M. Ed. Lesevre, known for his work in entomology and botany.

PROF. CANNIZZARO has been elected a correspondent of the Paris Academy of Sciences, in the place of the late M. de Marignac.

We learn from La Nature that a department of agricultural entomology has recently been formed at the Institut National Agronomique, and placed under the direction of Prof. Brocchi Tne work of the department will be to identify insects sent for that purpose by agriculturists, and to point out the means of destroying insect pests or diminishing their ravages.

THE Cape Times says that among the latest accessions to the South African Museum are an old imperfect skull and other bones of a white rhinoceros, presented by Mr. W. G. Schmidt. These remains of the now all but extinct "white" or Burchell's rhinoceros were found at a depth of about 8 feet, in black turfy soil, at about twelve miles from the Vaal River.

A COMPLETE statement has been issued of the different sections of the Mining and Metallurgical Exhibition to be opened at Santiago in September next. The classification is as follows:—(1) Motive Power; (2) Electricity; (3) Mining Machinery; (4) Mechanical Preparation of Minerals; (5) Metallurgy; (6) Chemical Industries; (7) Statistics and Plans; (8) Mining and Metallurgical Products.

THE Paris correspondent of the Times reports that, at the first meeting of the 1900 Exhibition Commission, the following scheme of classification was read: - The first group of exhibits is entitled "Education," and contains six classes. Group II. comprises "Works of Art," containing paintings, drawings, engraving, lithography, sculpture, the cutting of precious stones, and architecture. Group III. is called "Instruments and General Processes of Literature, Sciences and Arts," including typography, photography, binding, newspapers, maps, instruments of precision, coins and medals, medicine and surgery, musical instruments, and the theatrical art. The IVth Group is "The Matériel and General Processes of Mechanics," including steam engines, motors, divers apparatus of general mechanics, and implements. The Vth Group deals with electricity, including the production and mechanical application of electricity, electro-chemistry, electric lighting, telegraph, and telephone. Then come locomotion, agriculture, horticulture, forestry, alimentation, mines, furniture, textiles, chemicals, social economy, and military weapons.

It is reported by the *British Medical Journal* that a committee of the Calcutta municipality have resolved to recommend that a sum of money be voted for two years in order to test thoroughly M. Haffkine's system of cholera inoculation. This method, worked out by M. Haffkine in the Pasteur Institute