a pure condition, but still combined with the other extractive matter which is likewise insoluble in alcohol. The colouring matter may also be removed, so that it is possible to obtain from the extract a colourless dry substance which contains the effective principle in a much more concentrated form than the original glycerine solution.

"For application in practice, however, this purification of the glycerine extract offers no advantage, because substances so eliminated are unessential for the human organism, and the process of purification would make the cost of the remedy unnecessarily high. As regards the constitution of the more effective substance, only surmises may for the present be expressed. It appears to me to be a derivative from albuminous bodies, and to have a close affinity to them. It does not belong to the group of so-called tox-albumens, because it bears high temperatures, and in the dialyser goes easily and quickly through the membrane. The proportion of the substance in the extract is to all appearance very small. I estimate it at fractions of 1 per cent. If my assumption is correct, we should therefore have to do with a matter the effect of which upon organisms attacked with tuberculosis goes far beyond what is known to us of the strongest drugs. Regarding the manner in which the specific action of the remedy on tuberculous tissue is to be represented, various hypotheses may naturally be put forward. Without wishing to affirm that my view affords the best explanation, I represent the process to myself in the following manner. The tubercle bacilli produce, when growing in living tissues, just as artificial cultivations do, certain substances which variously and notably unfavourably influence the living elements in their vicinity—namely, the cells. Among these is a substance which in a certain degree of concentration kills the living protoplasm and so alters it that it passes into the condition described by Weigert as coagulation necrosis. In the tissue which has thus become necrotic the bacillus finds such unfavourable conditions of nourishment that it can grow no more and sometimes finally dies. This is how I explain the remarkable phenomenon that in organs which are newly attacked with tuberculosis, as, for instance, in the spleen and liver of a guinea-pig which is covered with gray nodules, numbers of bacilli are found, whereas they are rare or wholly absent when an enormously enlarged spleen consists almost entirely of a whitish substance in a condition of coagulation necrosis, as is often found in cases of natural death in tuberculous guinea-pigs. The single bacillus cannot, therefore, bring about necrosis at a great distance, for as soon as the necrosis has attained a certain extension the growth of the bacillus subsides, and therewith the production of the necrotizing substance. There thus occurs a kind of reciprocal compensation, which causes the vegetation of isolated bacilli to remain so extraordinarily restricted, as, for instance, in lupus, scrofulous glands, &c. In such a case the necrosis generally extends only to a part of the cells, which then, with further growth, assumes the peculiar form of the *Riesenzelle*, or giant cell. Thus, in this interpretation, I follow the first explanation given by Weigert of the production of giant cells.

"If now one were to increase artificially in the vicinity of the bacillus the amount of necrotizing substance in the tissue, the necrosis would spread to a greater distance, and thereby the conditions of nourishment for the bacillus would become much more unfavourable than usual. In the first place, the tissue which had become necrotic over a larger extent would decay, detach itself, and, where such were possible, carry off the enclosed bacilli and eject them outwardly; and in the second place, the bacilli would be so far disturbed in their vegetation that they would much more speedily be killed than under ordinary circumstances. It is just in the evoking of such changes that the effect of the remedy appears to me to consist. It contains a certain quantity of necrotizing substance, a corresponding large dose of which injures certain tissue elements even in a healthy person, and, perhaps, the white blood corpuscles or the cells adjacent thereto, and consequently produces fever and a quite remarkable complication of symptoms. With tuberculous patients, on the other hand, a much smaller quantity suffices to induce at certain places—namely, where the tubercle bacilli are vegetating and have already impregnated the adjacent region with the same necrotizing matter—more or less extensive necrosis of the cells, together with the phenomena in the whole organism which result from and are connected with it. In this way, for the present at least, it is possible to explain the specific influence which the remedy, in accurately defined doses, exercises upon tuberculous tissue, and further, the possibility of increasing these doses with such remarkable rapidity, and the remedial effects which have been unquestionably produced under not too favourable circumstances."

Regarding the duration of the remedy, Prof. Koch observes in a note that, of the consumptive patients who were described by him as temporarily cured, two have been again received into the Moabit Hospital for further observation, that no bacilli have appeared in the sputum for three months past, and that the physical symptoms have also gradually but completely disappeared.

GASEOUS ILLUMINANTS.[1]

III.

IT has been proposed to carburet and enrich poor coal gas by admixture with it of an oxy-oil gas, in which crude oils are cracked at a comparatively low temperature, and are then mixed with from 12 to 24 per cent. of oxygen gas. Oil gas made at low temperature is *per se* of little use as an illuminant, as it burns with a smoky flame, and does not travel well; but, when mixed with a certain amount of oxygen, it gives a very brilliant white light and no smoke, while, as far as experiments have at present gone, its travelling powers are much improved. At first sight it seems a dangerous experiment to mix a heavy hydrocarbon gas with oxygen; but it must be remembered that, although hydrogen and carbon monoxide only need to be mixed with but half of their own volume of oxygen to produce the most explosive compound, yet as the number of carbon and hydrogen atoms in the combustible gas increases, so does the amount of oxygen needed. So that coal gas requires rather more than its own volume, and ethylene three times its volume, to yield the maximum explosive results; while these mixtures begin to be explosive when 10 per cent. of oxygen is combined with hydrogen or water gas, 30 per cent. with coal gas, and more than 50 per cent. with oil gas of the character used. It is claimed that if this gas were used as an enricher of coal gas, 5 per cent. of it would increase the luminosity of 16-candle gas by about 40 per cent. Oxygen has been obtained for some time past from the air, on a commercial scale, by the Brin process; and it is now proposed to make oxygen by a process first introduced by Tessié du Motay, which consists of passing alternate currents of steam and air over sodic manganate heated to dull redness in an iron tube. The process has never been commercially successful, for the reason that the contents of the tube fused, and, flowing over the surface of the iron, rapidly destroyee the tubes or retorts; and also, as soon as fusion took place, the mass became so dense that it had little or no action on the air passing over it; but it is now claimed that this trouble can bs overcome. Cheap oxygen would be an enormous boon to the gal manager, as, by mixing 0·8 per cent. of oxygen with his coal gas before purification, he could not only utilize the method so successfully introduced by Mr. Valon at Ramsgate, but could also increase the illuminating value of his gas to a slight extent.

No ordinary gas flame is in contact with the burner from which it issues, this being due to the cooling effect of the burner; but as this only affects the bottom of the flame, with a small flame the total effect is very great; with a large flame almost *nil*. The first point, therefore, to attend to in making a good burner is that it should be made of a good non-conductor. In the next place, the flow of the gas must be regulated to the burner; as, if you have a pressure higher than that for which the burner is constructed, you at once obtain a roaring flame and a loss of illuminating power, as the too rapid rush of gas from the burner causes a mingling of gas and air, and a consequent cooling of the flame, while the form of the flame becomes distorted. The tap also which regulates the flame is better at a distance from the burner than close to it; as any constriction near the burner causes eddies in the flow of the gas, which gives an unsteady flame. These general principles govern all burners.

We will now take the ordinary forms in detail. In the flat-flame burner, given a good non-conducting material and a well-regulated gas supply, little more can be done, while burning it

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[1] Continued from p. 260. Conclusion of the Cantor Lectures delivered at the Society of Arts by Prof. Lewes.

in the ordinary way, to increase its luminosity ; and it is the large surface of flame exposed to the cooling action of the air which causes this form of burner to give the lowest service of any per cubic foot of gas consumed. Much is done, moreover, by faulty fittings and shades, to reduce the already poor light afforded, because the light-yielding power of the flame largely depends on its having a well-rounded base and broad luminous zone ; and when a globe with narrow opening is used with such a flame, as is done in ninety-nine cases out of a hundred, the up-draught drags the flame out of shape, and seriously impairs its illuminating power—a trouble which can be overcome by having a globe with an opening at the bottom not less than 4 inches in diameter, and having small shoulders fixed to the burner, which draw out the flame and protect the base from the disturbing influence of draughts.

The Argand burner differs from the flat-flame burner in that a circular flame is employed, and the air supply is regulated by a glass of cylindrical form. This kind of burner gives better service than a flat-flame, as not only can the supply of gas and air be better adjusted, but the air, being slightly warmed by the hot glass, adds to the temperature of the flame, which is also increased by radiation from the opposite side of the flame itself. The chief loss of light depends upon the fact that, being circular, the light from the inner surface has to pass through the wall of flame ; and careful photometric experiments show that the solid particles present in the flame so reduce its transparency that a loss amounting to about 25 per cent. of light takes place during its transmission.

For many years no advance was made upon these forms of burner. But when, fifteen years ago, it was recognized that anything which cools the flame reduces its value, while anything which increases its temperature raises its illuminating power, a change began to steal over the forms of burner in use ; and the regenerative burners, fathered by such men as Siemens, Grimston, and Bower, commenced what was really a revolution in gas lighting, by utilizing the heat contained in the escaping products of combustion to raise the temperature of the gas and air which are to enter into combination in the flame. An enormous increase in the temperature of the solid particles of carbon in the flame is thereby obtained ; and a far greater and whiter light is the result.

The only drawback to this class of burner is that it is by far the best form of gas stove as well as burner, and that the amount of heat thrown out by the radiant solid matter in the flame is, under some circumstances, an annoyance. On the other hand, we must not forget that this is the form of burner best adapted for overhead lighting, and that nearly every form of regenerative lamp can be used as a ventilating agent ; and that with the withdrawal of the products of combustion from the air of the room, the great and only serious objection to gas as an illuminant disappears.

When coal gas is burnt, the hydrogen is supposed to be entirely converted into water vapour, and the carbon to finally escape into the air as carbon dioxide. If this were so, every cubic foot of gas consumed would produce approximately 0·523 cubic foot of carbon dioxide, and 1·34 cubic feet of water vapour ; and the illuminating power yielded by the foot of gas will, of course, vary with the kind of burner used.

Roughly speaking, the ordinary types of burner give the following results :—

	Illuminating power in candles per c. ft. of gas consumed.	Products of combustion per candle power.	
		Carbon dioxide.	Water vapour.
		c. ft.	c. ft.
Batswing ...	2·9	0·18	0·46
Argand ...	3·3	0·16	0·40
Regenerative...	10·0	0·05	0·13

So that the regenerative forms of burner, by giving the greatest illuminating power per cubic foot of gas consumed, yield a smaller amount of vitiation to the air per candle of light emitted. An ordinary room (say, 16 feet by 12 feet by 10 feet) would not be considered properly illuminated unless the light were at least equal to 32-candle power ; and in the following table the amount of oxygen used up, and the products of combustion formed by each class of illuminant and burner, in attaining this result, are given. The number of adults who would exhale the same amount during respiration is also stated :—

Illuminants.	Quantity of materials used.	Oxygen removed.	Products of combustion		Adults.
			Water vapour.	Carbon dioxide.	
	grs.	c. ft.	c. ft.	c. ft.	
Sperm candles ...	3840	19·27	13·12	13·12	21·8
Paraffin oil ...	1984	12·48	7·04	8·96	14·9
Gas (London)—	c. ft.				
Batswing ...	11·0	13·06	14·72	5·76	9·6
Argand ...	9·7	11·52	12·80	5·12	8·5
Regenerative ...	3·2	3·68	4·16	1·60	2·6

From these data it appears, according to scientific rules by which the degree of vitiation of the air in any confined space is measured by the amount of oxygen used up and carbon dioxide formed, that candles are the worst offenders against health and comfort ; oil-lamps come next ; and gas least. This, however, is an assumption which practical experience does not bear out. Discomfort and oppression in a room lighted by candles or oil are less felt than in one lighted by any of the older forms of gas-burner. The partial explanation of this is to be found in the fact that, when a room is illuminated with candles or oil, people are contented with a feebler and more local light than when using gas. In a room of the size described, the inmates would be more likely to use two candles placed near their books or on a table, than 32 candles scattered about the room. Moreover, the amount of water vapour given off during the combustion of the gas is greater than in the case of the other illuminants. Water vapour, having a great power of absorbing radiant heat from the burning gas, becomes heated ; and, diffusing itself about the room, causes a great feeling of oppression. The air also, being highly charged with moisture, is unable to take up so rapidly the water vapour which is always evaporating from the surface of the skin, whereby the functions of the body receive a slight check, resulting in a feeling of *malaise*. Added to these, however, is a far more serious factor, which, up to the present, has been overlooked, and that is that an ordinary gas-flame in burning yields distinct quantities of carbon monoxide and acetylene, the prolonged breathing of which in the smallest traces produces headache and general physical discomfort, while their effect upon plant life is equally marked.

Ever since the structure of flame has been noted and discussed, it has been accepted as a fact beyond dispute that the outer, almost invisible, zone which is interposed between the air and the luminous zone of the flame is the area of complete combustion ; and that here the unburnt remnants of the flame gases, meeting the air, freely take up oxygen, and are converted into the comparatively harmless products of combustion—carbon dioxide and water vapour—which only need partial removal by any haphazard process of ventilation to keep the air of the room fit to support animal life. I have, however, long doubted this fact ; and at length, by a delicate process of analysis, have been able to confirm my suspicions. The outer zone of the luminous flame is not the zone of complete combustion. It is a zone in which luminosity is destroyed in exactly the same way that it is destroyed in the Bunsen burner—*i.e.* the air penetrating the flame so dilutes and cools down the outer layer of incandescent gas that it is rendered non-luminous, while some of the gas sinks below the point at which it is capable of burning, with the result that considerable quantities of the products of incomplete combustion (carbon monoxide and acetylene) escape into the air, and render it actively injurious. I have proved this by taking a small platinum pipe with a circular loop at the end, the interior of the loop being pierced with minute holes ; and by making a circular flame burn within the loop, so that the non-luminous zone of the flame just touched the inside of the loop, and then by aspiration so gentle as not to distort the shape of the flame, withdrawing the gases escaping from the outer zone, and analysing these by a process which will be described elsewhere, I arrived at the following results :—

Gases Escaping from the Outer Zone of Flame.

	Luminous.	Bunsen.
Nitrogen	76·612	80·242
Water vapour	14·702	13·345
Carbon dioxide	2·201	4·966
Carbon monoxide ...	1·189	0·006
Oxygen	2·300	1·430
Marsh gas	0·072	0·003
Hydrogen	2·388	0·008
Acetylene	0·036	*nil*
	100·000	100·000

The gases leaving the luminous flame show that the diluting action of the nitrogen is so great that considerable quantities even of the highly-inflammable and rapidly-burning hydrogen escape combustion, while the products of incomplete combustion are present in sufficient quantity to perfectly account for the deleterious effects of gas-burners in ill-ventilated rooms. The analyses also bring out very clearly the fact that, although the dilution of coal gas by air in atmospheric burners is sufficient to prevent the decomposition of the heavy hydrocarbons, with liberation of carbon, and so destroy luminosity, yet the presence of the extra supply of oxygen does make the combustion far more perfect, so that the products of incomplete combustion are hardly to be found in the escaping gases.

The feeling has gradually been gaining ground in the public mind that, when atmospheric burners and other devices for consuming coal gas are employed for heating purposes, certain deleterious products of incomplete combustion find their way into the air; and that this does take place to a considerable extent is shown by the facts brought forward in a paper read by Mr. W. Thomson at the last meeting of the British Association, at Leeds. Mr. Thomson attempted to separate and determine the quantity of carbon monoxide and hydrocarbons found in the flue gases from various forms of gas stoves and burners; but, like every other observer who has tried to solve this most difficult problem, he found it so beset with difficulties that he had to abandon it, and contented himself with determining the total quantities of carbon and hydrogen escaping in an unburnt condition. His experiments proved that the combustion of gas in stoves for heating purposes is much more incomplete than one had been in the habit of supposing; but they did not show whether the incompletely burnt matter consisted of such deleterious products as carbon monoxide and acetylene, or comparatively harmless gases such as marsh gas and hydrogen.

If a cold substance—metallic or non-metallic—be placed in a flame, whether it be luminous or non-luminous, it will be observed that there is a clear space, in which no combustion is taking place, formed round the cool surface, and that, as the body is heated, this space becomes gradually less, until, when the substance is at the same temperature as the flame itself, there is contact between the two. Moreover, when a luminous flame is employed in this experiment, the space still exists between the cool body and the flame; but it will also be noticed that the luminosity is decreased over a still larger area, though the flame exists. This means that, in immediate contact with the cool body, the temperature is so reduced that a flame cannot exist, and so is extinguished over a small area; while over a still larger space the temperature is so reduced that it is not hot enough to bring about decomposition of the heavy hydrocarbons, with liberation of carbon, to the same extent as in hotter portions of the flame.

Now, inasmuch as, when water is heated or boiled in an open vessel, the temperature cannot rise above 100° C., and as the temperature of an ordinary flame is more than 1000° C., it is evident that the burning gas can never be in contact with the bottom of the vessel; or, in other words, the gas is put out before combustion is completed, and the unburnt gas and products of incomplete combustion find their way into the air, and render it perfectly unfit for respiration. The portion of the flame which is supposed to be the hottest is about half an inch above the tip of the inner zone of the flame. It is at this point that most vessels containing water to be heated are made to impinge on the flame; and it is this portion of the flame also that is utilized for raising various solids to a temperature at which they will radiate heat in most forms of gas-stove.

I have determined the composition of the products of combustion and the unburnt gases escaping when a vessel containing water at the ordinary temperature is heated up to boiling-point by a gas-flame; the vessel being placed, in the first case, half an inch above the inner cone of the flame, and in the second at the extreme outer tip of the flame. The results are given in the following table:—

Gases Escaping during Checked Combustion.

	Bunsen flame.		Luminous flame.	
	Inner.	Outer.	Inner.	Outer.
Nitrogen	75·75	79·17	77·52	69·41
Water vapour...	13·47	14·29	11·80	19·24
Carbon dioxide	2·99	5·13	4·93	2·38
Carbon monoxide	3·69	*nil*	2·45	2·58
Marsh gas	0·51	0·31	0·95	0·39
Acetylene	0·04	*nil*	0·27	*nil*
Hydrogen	3·55	0·47	2·08	*nil*
	100·00	100·00	100·00	100·00

These figures are of the greatest interest, as they show conclusively that the extreme tip of the Bunsen flame is the only portion which can be used for heating a solid substance without liberating deleterious gases. This corroborates the previous experiment on the gases in the outer zone of a flame, which showed that the outer zone of the Bunsen flame is the only place where complete combustion is approached. Moreover, this work sets at rest a question which has been over and over again under discussion, and that is, whether it is better to use a luminous or a non-luminous flame for heating purposes. Using a luminous flame, it is impossible to prevent a deposit of carbon, which is kept by the flame at a red heat on its outer surface; and the carbon dioxide formed by the complete combustion of the carbon already burnt up in the flame is by this reduced back to carbon monoxide. So that, even in the extreme tip of a luminous flame, it is impossible to heat a cool body without giving rise to carbon monoxide, although, acetylene being absent, gas-stoves in which small flat-flame burners are used have not that subtle and penetrating odour which marks the ordinary atmospheric burner stove with the combustion checked just at the right spot for the formation of the greatest volume of noxious products. It is the contact of the body to be heated with the flame before combustion is complete that gives rise to the great mischief. Any cooling of the flame extinguishes a portion of it; and the gases present in it at the moment of extinction creep along the cooled surface, and escape combustion.

In utilizing a flame for heating purposes, combustion must be completed before any attempt is made to use the heat; in other words, the products of combustion and not the flame must be used for this purpose.

I think I have said enough to show that no geyser or gas-stove should be used without ample and thorough means of ventilation, being provided; and no trace of the products of combustion should be allowed to escape into the air. Until this is done, the use of improper forms of stoves will continue to inflict serious injury on the health of the people using them; and this will gradually result in the abandonment of gas as a fuel, instead of, as should be the case, its coming into general use.

Let us now consider for a moment what is likely to be the future of gas during the next half-century. The labour troubles, bad as they are and have been, will not cease for many a weary year. The victim of imperfect education—more dangerous than none at all, as, while destroying natural instinct, it leaves nothing in its place—will still listen to, and be led by the baneful influence of irresponsible demagogues, who care nothing so long as they can read their own inflammatory utterances in the local press, and gain a temporary notoriety at the expense of the poor fools whose cause they profess to serve. The natural outcome of this will be that every possible labour-saving contrivance will be pressed into the gas manager's service, and that, although coal (of a poorer class than that now used) will still be employed as the source of gas, the present retort-setting will quickly give way to the inclined retorts on the Coze principle; while, instead of the present wasteful method of quenching the red-hot coke, it will, as far as it can be used, be shot direct into the generator of the water gas plant, and the water gas, carburetted with the benzene hydrocarbons derived from the smoke of the blast-furnaces and coke-ovens, or from the creosote oil of the tar-distiller, by the process foreshadowed in the concluding sentences of the preceding lecture, will then be mixed with the gas from the retorts, and will supply a far higher illuminant than we at present possess. In parts of the United Kingdom, such as South Wales, where gas coal is dear and anthracite and bastard coals are cheap, water gas, highly carburetted, will entirely supplant coal gas, with a saving of 50 per cent. on the prices now existing in these districts.

While these changes have been going on, and improved methods of manufacture have been tending to the cheapening of gas, it will have been steadily growing in public favour as a fuel; and if, in years to come, the generation of electricity should have been so cheapened as to allow the electric light to successfully compete with gas as an illuminant, the gas-works will still be found as busy as of yore, and the holder of gas shares as contented as he is to-day; for, with the desire for a purer atmosphere and white mist instead of yellow fog, gas will have largely supplanted coal as a fuel, and gas-stoves, properly ventilated and free from the reproaches I have hurled at them to-night, will burn a gas far higher in its heating power than that we now use, far better as regards its capacity for bearing illuminating hydrocarbons, and entirely free from poisonous constituents. As soon as the demand for it arises, hydrogen gas can be made as cheaply as water gas itself; and when the time is ripe for a fuel gas for use in the house, it is hydrogen and not water gas that will form its basis. With carburetted water gas and 20 per cent. of carbon monoxide, we shall still be below the limit of danger; but a pure water gas, with more than 40 per cent. of the same insidious element of danger, will never be tolerated in our households. Already a patent has been taken by Messrs. Crookes and Ricarde-Seaver for purifying water gas from carbon monoxide, and converting it mainly into hydrogen by passing it at a high temperature through a mixture of lime and soda lime—a process which is chemically perfect, as the most expensive portion of the material used could be recovered.

From the earliest days of gas making the manufacture of hydrogen by the passage of steam over red-hot iron has been over and over again mooted and attempted on a large scale; but several factors have combined to render it futile. In the first place, for every 478·5 cubic feet of hydrogen made under perfect theoretical conditions never likely to be obtained in practice, 56 pounds of iron were converted into the magnetic oxide; and as there was no ready sale for this article, this alone would prevent its being used as a cheap source of hydrogen. The next point was that, when steam was passed over the red-hot iron, the temperature was so rapidly lowered that the generation of gas could only go on for a very short period. Finally, the swelling of the mass in the retort, and the fusion of some of the magnetic oxide into the side, renders the removal of the spent material almost an impossibility. These difficulties can, however, be overcome. Take a fire-clay retort 6 feet long, and 1 foot in diameter, and cap it with a casting bearing two outlet tubes closed by screw-valves, while a similar tube leads from the bottom of the retort. Enclose this retort, set on end, by a furnace chamber of iron, lined with fire-brick, leaving a space of 2 feet 6 inches round the retort; and connect the top of the furnace chamber with one opening at the top of the upright retort, while an air-blast is led into the bottom of the furnace chamber below rocking fire-bars, which start at the bottom of the retort, and slope upwards to leave room for ash-holes closed by gas-tight covers. The retort is filled with iron or steel borings—alone if pure hydrogen is required, or cast into balls with pitch if a little carbon monoxide is not a drawback, as in foundry work. The furnace chamber is filled with coke, fed in through man-holes or hoppers in the top, and the fuel being ignited, the blast is turned on, and the mixture of nitrogen and carbon monoxide formed passes over the iron, heating it to a red heat, while the incandescent coke in contact with the retort does the same thing. When the fuel and retort full of iron are at a cherry-red heat, the air-blast is cut off, and the pipe connecting the furnace and retort, together with the pipe in connection with the bottom of the retort, is closed. Steam, superheated by passing through a pipe led round the retort or interior wall of the furnace, is injected at the bottom of the red-hot mass of iron, which decomposes it, forming magnetic oxide of iron and hydrogen, which escapes by the second tube at the top of the retort, and is led away—to a carburetting chamber if required for illumination, or else direct to the gas-holder if wanted as a fuel: the mass of incandescent fuel in the furnace chamber surrounding the retort keeping up the temperature of the retort and iron sufficiently long to enable the decomposition to be completed. The hydrogen and steam valves are now closed, and the air-blast turned on; and the hot carbon monoxide, passing over the hot magnetic oxide, quickly reduces it down again to metallic iron, which, being in a spongy condition, acts more freely on the steam during later makes than it did at first, and, being infusible at the temperature employed, may be used for a practically unlimited period. What more simple method than this could be desired? Here we have the formation of the most valuable of all fuel gases at the cost of the coke and steam used—a gas also which has double the carrying power for hydrocarbon vapours possessed by coal gas, while its combustion gives rise to nothing but water vapour.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Candidates for the newly founded Clerk-Maxwell Scholarship in Experimental Physics are requested to send their names to Prof. Thomson, 6 Scroope Terrace, Cambridge, before February 21. Each candidate is requested to forward a statement of the original work which, in accordance with the conditions of the tenure of the Scholarship, he would undertake if elected.

The University Lecturer in Geography (J. Y. Buchanan, F.R.S.) announces a course of lectures in Physical Geography and Climatology, to be given on Mondays and Wednesdays, at 10 a.m., beginning January 26.

The degree of M.A. *honoris causâ* is to be conferred on James Alfred Ewing, F.R.S., Professor of Mechanism and Applied Mechanics, who gave his inaugural lecture on Tuesday, January 20. His subject was "The University Training of Engineers."

On Monday, January 26, the following communications will be made to the Philosophical Society:—Prof. J. J. Thomson, on the electric discharge through rarefied gases without electrodes; Mr. J. Larmor, St. John's College, on diffraction at caustic surfaces.

SCIENTIFIC SERIALS.

The *American Meteorological Journal* for December 1890 contains an account, by H. J. Cox, of a waterspout which occurred at Newhaven, Connecticut, on October 19 last, between two thunderstorms about five miles apart. A funnel-shaped cloud rapidly descended, while the water below it rose upward, first about 3 feet, and, when the spout was complete, above 30 feet. The spout was about 300 feet high, and 25 feet in diameter. It moved about two miles in ten minutes, and when it met the thunderstorm it moved back in the opposite direction about a mile.—A summary of Dr. Hann's paper on temperature in anticyclones and cyclones, the subject of which has already been noticed in Nature.—Observations and studies on Mount Washington, by Prof. Hazen, to determine, by means of the sling hygrometer, the temperature and humidity at each mile by walking down the mountain and up again. The results of sixteen journeys show that in the cases with partly dry air the decrease of temperature with elevation did not differ widely from the theoretical value, but with moist air the theoretical difference per 100 feet was much less than the observed difference.—Cyclones and tornadoes in North America, by J. Brucker. The object of the paper is to show that tornadoes or local air-whirls are analogous to water-whirls, and the subject is illustrated by diagrams.—The cooling of dry and moist air by expansion, by Prof. Marvin. The author refutes Prof. Hazen's objections to the principle that moist or saturated air is warmed by the latent heat set free from that portion of the vapour that is condensed by expansion. Prof. Marvin states, *inter alia*, that Prof. Hazen's calculations are not made by the proper thermodynamic equations, and are incorrect. Prof. Hazen, on the other hand, offers a prize of 100 dollars for the proof of the proposition, that Espy's experiments, when properly interpreted, prove his theory.