

normal breadth, and are classified as "widened," "more widened," and "most widened," for comparison among themselves. At South Kensington only the six most widened lines in the spectrum of a sun-spot are recorded, hence the two sets of observations are not easily comparable. The interval 1882-89 has been divided into two periods in the discussion, viz. the disturbed period of solar activity extending from 1882-86, and the quiet period 1886-89.

In the disturbed period only one of the fifty-three iron lines in the region B—D was observed to have a mean widening. During the quiet period, however, many more iron lines appeared among the more widened. In this particular, therefore, Father Cortie's results confirm the conclusion arrived at by Prof. Lockyer in 1880 from a similar discussion. With respect to other substances, the observations show that seven out of the eleven titanium lines in the region studied were very much affected in the spot spectra at both periods, the lines most persistently widened being among the faintest Fraunhofer lines, and among the brighter of the metallic lines. The mean widening of calcium lines increased slightly during the minimum period. Sodium lines were much affected in the maximum epoch, especially in the large spots. Several lines given by Ångström as "telluric" have been seen widened. The C line has often appeared less dark over sun-spots, but when bright the reversal was generally due to faculæ between the spots. From a total of 2088 individual observations of other lines it is concluded that (1) About the maximum period a great number of faint lines not in Ångström are to be seen in sun-spots. (2) Such lines are not seen exclusively in maximum spots, but reappear in minimum spots when they are large. (3) Some faint lines which have been persistently watched are to be seen greatly widened in every sun-spot, large or small, whether in the disturbed or quiet period. (4) The mean widening of all the five bright chromospheric lines coincident with unknown lines in this region has been low. A Browning automatic spectroscope with a dispersion of twelve prisms of 60° was used for the observations.

TURIN OBSERVATORY.—Some publications of interest have recently been issued from this Observatory. Signor Porro gives the results of observations of the magnitude of the star U (Nova) Orionis throughout a whole period of variation. On November 21, 1889, the star was 8.81 mag.; on April 28, 1890, it was 8.80; and a maximum magnitude = 5.80 was observed on January 21, 1890. Mr. Chandler has given the period of this variable as 371 days, with a maximum on December 7, 1885. Signor Porro finds that the observations made in 1885, in conjunction with those now given, indicate a period of 378.5 days from the epoch December 7.

A large number of determinations of the latitude of Turin has also been made. The mean of 120 observations results in the value $\phi = 45^{\circ} 4' 7''.942 \pm 0''.029$. The observations do not exhibit the periodic variation observed in the latitude observations made at Berlin, Potsdam, and Prague.

Convenient ephemerides for the sun and moon in 1891 have been calculated for the meridian of Turin by Signor Aschieri. The meteorological observations made in 1889 have been tabulated by Dr. G. B. Rizzo.

THE DUPLICATION OF α LYRÆ.—The duplication of the K line in some photographs of the spectrum of Vega taken by Mr. A. Fowler, and from which he inferred that the star was a spectroscopic double of the β Aurigæ type, has not been confirmed by photographs taken by Prof. Pickering, Prof. Vogel, and MM. Henry. Some other explanation must therefore be found to account for the phenomenon.

GASEOUS ILLUMINANTS.¹

II.

ORDINARY coal gas of an illuminating power of 14 to 16 candles can be produced at a fairly low rate, but if a higher quality is required considerable additional expense has to be incurred in order to enrich it. Up to now, the material almost universally employed for this purpose has been *cannel*; but as this article is rapidly rising in price, and the best qualities are not easily obtainable, attention is being seriously directed to other means of bringing up the illuminating power of gas. This question of enrichment has been the study of inventors from the

earliest days of the gas industry. The methods employed for this purpose may be classified as:—(1) The carburetting of low-power gas by impregnating it with the vapour of volatile hydrocarbons. (2) Enriching the gas by vapours and permanent gases obtained by the decomposition of the tar formed at the same time as the gas. (3) Mixing with the coal gas, oil gas obtained by decomposing crude oils by heat. (4) Mixing with the coal gas, water gas which has been highly carburetted by passing it, with the vapours of various hydrocarbons, through superheaters, in order to give permanency to the hydrocarbon gases.

In the first method, many points have to be taken into consideration, as the hydrocarbons which have from time to time been used for this purpose, vary so greatly in composition; a very volatile naphtha, although it evaporates quickly, and larger quantities of its vapour are taken up by the gas, often giving a less increase of luminosity than a heavier hydrocarbon of which but little is vaporized.

The great trouble which presented itself in the older carburetting systems was that all the commercial samples of naphtha are mixtures of various hydrocarbons, each having its own boiling-point, and that therefore, when used in any of the old forms of carburetters, they gave up their more volatile constituents very freely at the beginning of the experiment, while the amount rapidly diminished as the boiling-point of the residue became higher; so that when 2113 cubic feet of poor coal gas were passed through a naphtha having a specific gravity of 0.869 and a boiling-point of 103° C., the temperature during the experiment being 22° C., the first 80 cubic feet of gas took up 23.2 grains of the naphtha, while the last 450 cubic feet only took up 7.3 grains. Another difficulty found was the increase of evaporation with the rise in the temperature of the gas; as with an ordinary form of carburetter, exposed to atmospheric changes, the enrichment of the gas, which reached 54.4 per cent. in summer with an average temperature of 22° C., fell in winter to only 22 per cent. with an average temperature of 3° C. Of course, in these carburetters a good deal depended upon the form of apparatus; and it was found, on trying different shapes with the same naphtha, that when the gas merely flowed through a box containing a layer of it, only about 3.2 grains were taken up; while with a carburetter in which the naphtha was sucked up by cotton fibre, so as to expose a large surface to the gas, as much as 22 to 23 grains were absorbed. One of the most important points noticed during these experiments was, that it was only a poor gas which could be enriched in this manner, and that if a rich *cannel* gas was passed through the naphtha, it became robbed of some of its illuminating power.

It must be clearly borne in mind, in approaching this subject, that the evaporation of a hydrocarbon into a permanent gas—*i.e.*, a gas which does not liquefy within the ordinary range of temperature—is a question neither of specific gravity nor of boiling-point, although the latter has more to do with it than the former. It is purely a question of vapour tension. Most liquids, when left to themselves in contact with the atmosphere gradually pass into the state of vapour, and disappear; and those which evaporate most quickly are said to be most volatile. If ether, for example, is dropped upon an exposed surface, it at once disappears, and causes, by its evaporation, considerable cold; and the lightest forms of naphthas do the very same thing. But although this evaporation takes place with rapidity with liquids of low boiling-point, it must not be forgotten that even many solids have the same property—naphthalene, camphor, and iodine being cases in point. It must also be remembered that evaporation occurs over a very wide range of temperature; but that for each substance there is a limit below which evaporation does not seem to take place. So that, when considering the suitability of a liquid for carburetting in this way, it is far more important to determine its vapour tension than its specific gravity or its boiling-point.

So far all systems for carburetting gas with liquid hydrocarbons at the burners have proved failures, but in the *albicarbon* light the vapour of naphthalene is caused to mingle with the gas just before combustion, the volatilization being effected by a spur of metal heated by the flame itself, which conducts the heat back into a chamber containing solid naphthalene, through which the gas passes, and this process has proved very successful.

Any system to be generally adopted must be applied to the gas in bulk before distribution. In doing this, there are two factors to be considered: the vapour added must be in such proportion to the gases which have to carry them that no fear need exist of their being deposited by any sudden cooling of the gas;

¹ Continued from p. 235.

and care must be taken that the vapour added is not in sufficient quantity to throw out of suspension the volatile hydrocarbons in the gas. The carrying power of a gas depends upon its constituents; for in the same way that liquids vary in their power of dissolving and carrying—*i.e.*, keeping in solution—solids, so do gases vary in their power of bearing away the more volatile hydrocarbons. If the carrying power of air is taken as unity, then the power of ordinary coal gas is about 1.5, while hydrogen would be nearly 3.5; and it is manifest that attention must be paid to the ratio of the constituents present, if gases of varying composition are to be carburetted to the same degree.

During the past few months the idea of the possibility of carburetting coal gas in bulk has again been revived by the construction of an extremely ingenious apparatus, the outcome of the combined engineering skill and practical experience of Messrs. Maxim and Clark, which obviates, to a very great extent, the difficulties which arose with the older forms of carburetter. It has been shown that, when carburetting a gas with a gasoline or light naphtha spirit, the more volatile portions enrich the gas to an undue extent at first, and that, as the process continues, the amount taken up becomes gradually less. This would not so much matter in carburetting the gas in bulk before it went into the holder, as it would become to a great extent mixed by diffusion, and a gas of fairly even illuminating power would result; but the Maxim-Clark apparatus is intended not only to do this, but also to carburet the gas used in large establishments and works.

This apparatus is of such a form that in small installations the whole of the gas to be used can be passed through, and each portion supplied with its own share of hydrocarbon, whilst when carburetting gas in bulk a certain portion can be withdrawn from the main, carburetted and again return it to the main, where, mingling with the steady flow of gas, the whole becomes of uniform composition.

In the earliest days of the gas industry, attempts were made to utilize tar for the production and enrichment of gas; and the patent literature of the century contains many hundred such schemes, most of them being still-born, while a few spent a short and sickly existence, but none achieved success. The reason of this is not difficult to understand. In order to make gas from tar, two methods may be adopted: either to condense the tar in the ordinary way, and afterwards use the whole or portions of it for cracking into a permanent gas; or to crack the tar vapours before condensation by passing the gas and vapours through superheaters. If the first method is adopted, the trouble which at once presents itself, and in a few hours brings the apparatus to grief, is that tar contains 60 per cent. of pitch, which rapidly chokes and clogs up all the pipes; while, if an attempt is made to use a temperature at which the pitch itself is decomposed, it is found that a non-luminous or very poorly luminous gas is the result, and that a heavy deposit of carbon remains in the superheater and retort, and even at high temperatures easily condensable vapours escape, to afterwards create trouble in the pipes.

The most successful attempt to utilize certain portions of the liquid products of the distillation of coal is undoubtedly the Dinsmore process, in which the coal gas and the vapours which, if allowed to cool, would form tar, are made to pass through a heated chamber, and a certain proportion of otherwise condensable hydrocarbons are thus converted into permanent gases. Using a poor class of coal, it is claimed that 9800 cubic feet of 20 to 21 candle gas can be made by this process; while by the ordinary system 9000 cubic feet of 15-candle gas would have been produced.

In distilling the coal in the ordinary way, the yield of tar is 11 gallons per ton; but by the Dinsmore process only 7 gallons. On examining the analysis of the ordinary and Dinsmore tar, it is at once evident that the 4 gallons which have disappeared are the chief portions of the light oils and creosote oils; and these are the factors which have given the increase of illuminating power to the gas.

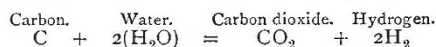
In enriching a poor coal gas by injecting paraffin oil into the retort during distillation, it must be borne in mind that, as the coal is undergoing distillation, in the earlier stages a rich gas is given off, while towards the end of the operation the gas is very poor in illuminants and rich in hydrogen; the methane disappearing with the other hydrocarbons, and the increase in hydrogen being very marked. Mr. Lewis T. Wright employed a coal requiring six hours for its distillation, and took samples of

the gas at different periods of the time. On analysis, these yielded the following results:—

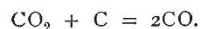
Time after commencement of distillation.	10 min.	1h. 30m.	3h. 25m.	5h. 35m.
Sulphuretted hydrogen...	1'30	1'42	0'49	0'11
Carbon dioxide	2'21	2'09	1'49	1'50
Hydrogen	20'10	38'33	52'68	67'12
Carbon monoxide	6'19	5'68	6'21	6'12
Marsh gas	57'38	44'03	33'54	22'58
Illuminants	10'62	5'98	3'04	1'79
Nitrogen... ..	2'20	2'47	2'55	0'78

This may be regarded as a fair example of the changes which take place in the quality of the gas during the distillation of the coal. In carburetting such a gas by injecting paraffin into the retort, it would be a great waste to do so for the first two hours, as a rich gas is being given off which has not the power of carrying a very much larger quantity of hydrocarbons—being practically saturated with them. Consequently, to make it take along with it, in a condition not easily deposited, any further quantity, the paraffin would have to be broken down to a great extent; and the temperature necessary to do this would seriously affect the quality of the gas being given off by the coal. When, however, the distillation had gone on for three hours, the rich portions of the coal gas would all have distilled off, and the temperature of the retort would have reached its highest point; and this would be the time to feed in the oil, as its cracking being an exothermic action, the temperature in the retort would be increased, and the gas rich in hydrogen which was being evolved would carry with it the oil gas, and prevent any re-deposition.

When carbon is acted upon at high temperatures by steam, the first action that takes place is the decomposition of the water vapour; the hydrogen being liberated, while the oxygen unites with the carbon to form carbon dioxide, thus—



The carbon dioxide so produced interacts with more red-hot carbon, forming the lower oxide, carbon monoxide, thus—



So that the completed reaction may be looked upon as yielding a mixture of equal volumes of hydrogen and carbon monoxide—both of them inflammable, but with non-luminous flames. This decomposition, however, is rarely completed, and a certain proportion of carbon dioxide is invariably to be found in the water gas, which, in practice, generally consists of a mixture of about the following composition:—

Hydrogen	48'31
Carbon monoxide	35'93
Carbon dioxide	4'25
Nitrogen	8'75
Methane	1'05
Sulphuretted hydrogen	1'20
Oxygen	0'51
	100'00

The above is an analysis of water gas made from gas coke in a Van Steenberg apparatus. The ratio of carbon monoxide and carbon dioxide present depends entirely upon the temperature of the generator and the kind of carbonaceous matter employed. With a hard dense anthracite coal, for instance, it is quite possible to attain a temperature at which there is practically no carbon dioxide produced; while with an ordinary form of generator, and a loose fuel like coke, a large proportion is generally to be found. The sulphuretted hydrogen in the analysis quoted is, of course, due to the high amount of sulphur to be found in the gas coke, and is practically absent from water gas made with anthracite. The nitrogen is due to the method of manufacture; the coke being, in the first instance, raised to incandescence by an air-blast, which leaves the generator and pipes full of a mixture of nitrogen and carbon mon-

oxide (producer gas), which is carried over by the first portions of water gas into the holder. The gas so made has no photometric value—its constituents being perfectly non-luminous; and attempts to use it as an illuminant have all taken the form of incandescent burners, in which thin “mantles” or “combs” of highly refractory metallic oxides are heated up to incandescence. In the case of carburetted water gas, the gas is only used as a carrier of illuminating hydrocarbon gases made by decomposing various grades of hydrocarbon oils into permanent gases by heat.

Water gas generators can be divided into two classes:—(1) Continuous processes, in which the heat necessary to bring about the interaction of the carbon and the steam is obtained by performing the operation in retorts externally heated in a furnace. (2) Intermittent processes, in which the carbon is first heated to incandescence by an air-blast, and the air-blast being cut off, superheated steam is blown in until the temperature is reduced to a point at which the carbon begins to fail in its action, when the air is again admitted to bring the fuel up to the required temperature; the process consisting of the alternate formation of producer gas with rise of temperature, and of water gas with lowering of temperature.

Of the first class of generator, none, so far, have as yet been practically successful in England.

Of the intermittent processes, the one most in use in America is the Lowe, in which the coke or anthracite is heated to incandescence by an air blast in a generator lined with fire-brick; the heated products of combustion, as they leave the generator and enter the superheaters, being supplied with more air, which causes the combustion of the carbon monoxide present in the producer gas, and heats up the fire-brick baffles with which the superheaters are filled. When the necessary temperature of fuel and superheater has been reached, the air-blasts are cut off, and steam is blown through the generator, forming water gas, which meets the enriching oil at the top of the first superheater, called the “carburetter,” and carries the vapours with it through the main superheater, where the firing of the hydrocarbons takes place. The chief advantage of this apparatus is that the enormous superheating space enables a lower temperature to be used for the fixing, which does away to a certain extent with the too great breaking down of the hydrocarbon, and consequent deposition of carbon.

The Springer apparatus differs from the Lowe only in construction. In the former the superheater is directly above the generator; and there is only one superheating chamber instead of two. The air-blast is admitted at the bottom, and the producer gases heat the superheater in the usual way; and when the required temperature is reached, the steam is blown in at the top of the generator, and is made to pass down through the incandescent fuel. The water gas is led from the bottom of the apparatus to the top, where it enters at the summit of the superheater, meets the oil, and passes down with it through the chamber, the finished gas escaping at the middle of the apparatus. This idea of making the air-blast pass up through the fuel, while in the subsequent operation the steam passes down through it, is also to be found in the Loomis plant, and is a distinct advantage—the fuel being at its hottest where the blast has entered, and, in order to keep down the percentage of carbon dioxide, it is important that the fuel through which the water gas last passes should be as hot as possible, to insure its reduction to carbon monoxide.

The Flannery apparatus is also only a slight modification of the Lowe plant, the chief difference being that, as the water gas leaves the generator, the oil is fed into it, and with the gas passes through a D-shaped retort tube, arranged round three sides of the top of the generator. In this tube the oil is volatilized, and passes with the gas to the bottom of the superheater, in which the vapours are converted into permanent gases.

The Van Steenberg plant stands apart from all other forms of carburetted water gas plant, in that the upper layer of the fuel itself forms the superheater, and that no second part of any kind is needed for the fixation of the hydrocarbons. This arrangement reduces the apparatus to the simplest form, and leaves no part of it which can choke or get out of order—an advantage which will not be underrated by anyone who has had experience of these plants. While, however, an enormous advantage is gained, there is also the drawback that the apparatus is not at all fitted for use with crude oils of heavy specific gravity, such as can be dealt with in the big external superheaters of the

Lowe class of water gas plant, but requires to have the lighter oils used in it for carburetted purposes. This, which appears at first sight to be a disadvantage, is not altogether one, as, in the first place, the lighter grade of oils, if judged by the amount of carburetted property they possess, are cheaper per candle-power added to the gas than the crude oils, while their use entirely does away with the formation of pitch and carbon in the pipes and purifying apparatus—a factor of the greatest importance to the gas manufacturers. The fact that light oils give a higher carburation per gallon than heavy crude oils is due to the fact that the crude oils have to be heated to a higher temperature to convert them into permanent gases; and this causes an over-cracking of the most valuable illuminating constituents. This trouble cannot be avoided, as, if a lower temperature is employed, the result is the formation of non-permanent vapours, which, by their condensation in the pipes, give rise to endless trouble. The simplicity of the apparatus is a factor which is a considerable saving of time and expense, as it reduces to a minimum the risk of stoppages for repairs, while the initial cost of the apparatus is necessarily low, and the expense of keeping it in order practically nil.

In such an apparatus 1000 cubic feet of carburetted water gas, having an illuminating value of 22 candles, can be made with the consumption of about 30 pounds of coke or anthracite and 2.5 gallons of light naphtha.

The great objection to the use of carburetted water gas is undoubtedly the poisonous nature of the carbon monoxide, which acts by diffusing itself through the air-cells of the lungs, and forming with the colouring of the blood corpuscles a definite compound, which prevents them carrying off their normal function of taking up oxygen and distributing it throughout the body, and at once stops life. All researches on this subject point to the fact that something less than 1 per cent. only of carbon monoxide in air renders it fatal to animal life; and this at first sight seems to be an insuperable objection to the use of water gas. It has, indeed, influenced the authorities in several towns—notably Paris—to forbid the introduction of water gas for domestic consumption. It would be well, however, to carefully examine the subject, and see, by the aid of actual figures, what the risk amounts to, compared with the risks of ordinary coal gas. Many experiments have been made with the view of determining the percentage of carbon monoxide in air which is fatal to human or rather to animal life, the most trustworthy as well as the latest results being those obtained by Dr. Stevenson, of Guy's Hospital, after an investigation instituted in consequence of two deaths which took place at the Leeds Forge, from inhaling uncarburetted water gas containing 40 per cent. of carbon monoxide. Dr. Stevenson found that 1 per cent. visibly affected a mouse in 1½ minutes, and killed it in an hour and three-quarters, while 0.1 per cent. was highly injurious. Taking, for the sake of argument, the last figure as being a fatal quantity, so as to be well within the mark, it is found that in ordinary carburetted water gas, as supplied by the superheater processes, such as the Lowe, Springer, and others, the usual amount of carbon monoxide is 26 per cent.; but in the Van Steenberg gas, for certain chemical reasons to be discussed later on, it is generally about 18 per cent., and rarely rises to 20 per cent. An ordinary bedroom is 12 feet by 15 feet and 10 feet high; and therefore it will contain 1800 cubic feet of air. Such a room would be lighted by a single ordinary batwing burner, consuming not more than 4 cubic feet of gas per hour. And if this were left full on, in one hour the 1800 cubic feet of air would be mixed with four-fifths of a cubic foot of carbon monoxide (the carburetted water gas being supposed to contain 20 per cent.) or 0.04 per cent. In such a room, however, if the doors and windows were absolutely airtight, and there were no fire-place, diffusion through the walls would change the entire air once in an hour. Therefore the percentage would not rise above 0.04; while in any ordinary room, imperfect workmanship and an open chimney would change it four times in the hour, and reduce the percentage to 0.01—a quantity which the most inveterate enemy of water gas could not claim would do more than produce a bad headache. The point under consideration, however, was the use of carburetted water gas as an enricher of coal gas, and not as an illuminant to be consumed *per se*; and it might be calculated that it would be probably used to enrich a 16-candle coal gas up to 17.5-candle power. To do this, 25 per cent. of 12-candle power carburetted water gas would have to be mixed with it. Taking the quantity of carbon monoxide in London gas at 5 per

cent. (a very fair average figure), and 18 per cent. as the amount present in the Van Steenberg gas, we have 8.25 per cent. of carbon monoxide in the gas as sent out—a percentage hardly exceeding that which is found in the rich canal gas supplied to such places as Glasgow, where it is not found that an unusual number of deaths occur from carbon monoxide poisoning. Moreover, carburetted water gas has quite as strong a smell as coal gas, and can be quite as easily detected by the nose.

The cost of most of these methods of enriching coal gas can be calculated, and give the following figures as the cost of enriching a 16-candle gas up to 17.5-candle power per 1000 cubic feet:—

By canal coal	4d.
By the Maxim-Clark process	2½d.
By the Lowe or Springer water gas	1½d.
By the Van Steenberg water gas	¾d.

In adopting any new method, the mind of the gas manager must, to a great extent, be influenced by the circumstances of the times; and the enormous importance of the labour question is a main factor at the present moment. With masters and men living in a strained condition, which may at any moment break into open warfare, the adoption of such water gas processes would relieve the manager of a burden which is growing almost too heavy to be borne. Combining, as such processes do, the maximum rate of production with the minimum amount of labour, they practically solve the labour question.

The cost of paraffin oil of lighter grades, and the fear that the supply might be hampered by the formation of a huge monopoly, has been a great drawback, but we have materials which can be equally well used in this country of which an almost unlimited supply can be obtained.

At three or four of the Scotch iron-works, the Furnace Gases Company are paying a yearly rental for the right of collecting the smoke and gases from the blast-furnaces. These are passed through several miles of wrought-iron tubing, gradually diminishing in size from 6 feet to about 18 inches; and as the gases cool there is deposited a considerable yield of oil. At Messrs. Dixon's, in Glasgow, which is the smallest of these installations, they pump and collect about 60,000,000 feet of furnace gas per day, and recover, on an average, 25,000 gallons of furnace oils per week; using the residual gases, consisting chiefly of carbon monoxide, as fuel for distilling and other purposes, while a considerable yield of sulphate of ammonia is also obtained. In the same way a small percentage of the coke-ovens are fitted with condensing gear, and produce a considerable yield of oil, for which, however, there is but a very limited market; the chief use being for the Lucigen light, and other lamps of the same description, and also for pickling timber for railway sleepers, &c. The result is that four years ago the oil could be obtained in any quantity at ½d. per gallon; though it has since been as high as 2½d. per gallon. It is now about 2d. per gallon, and shows a falling tendency. Make a market for this product, and the supply will be practically unlimited, as every blast-furnace and coke-oven in the kingdom will put up plant for the recovery of the oil. As, with the limited plant now at work, it would be perfectly easy to obtain 4,000,000 or 5,000,000 gallons per annum, an extension of the recovery process would mean a supply sufficiently large to meet all demands.

Many gas managers have from time to time tried if they could not use some of their creosote oil for producing gas; but, on heating it in retorts, &c., they have found that the result has generally been a copious deposit of carbon, and a gas which has possessed little or no illuminating value. Now the furnace and coke-oven oils are in composition somewhat akin to the creosote oil; so that, at first sight, it does not seem a hopeful field for search after a good carburetter. But the furnace oils have several points in which they differ from the coal-tar products. In the first place, they contain a certain percentage of paraffin oil; and, in the next, do not contain much naphthalene, in which the coal-tar oil is especially rich, and which would be a distinct drawback to their use. The furnace oil, as condensed, contains about 30 to 50 per cent. of water; and, in any case, this has to be removed by distilling. Mr. Staveley has patented a process by which the distillation is continued after the water has gone off, and by condensing in a fractionating column of special construction, he is able to remove all the paraffin oil, a considerable quantity of cresol, a small quantity of phenol, and about 10 per cent. of pyridine bases, leaving the remainder of the oil

in a better condition, and more valuable for pickling timber, its chief use.

If the mixed oil so obtained, which we may call "phenoloid oil," is cracked by itself, no very striking result is obtained; the 40 per cent. of paraffin present cracking in the usual way, and yielding a certain amount of illuminants. But if the oil is cracked in the presence of carbon, and is made to pass over and through a body of carbon heated to a dull red heat, it is converted largely into benzene. As this is the most valuable of the illuminants in coal gas, and also the one to which it owes the largest proportion of its light-giving power, it is manifestly the right one to use in order to enrich it. On cracking the phenoloid oil, the paraffin yields ethane, propane, and marsh gas, &c., in the usual way; while the phenol interacts with the carbon to form benzene:—



And in the same way the cresol first breaks down to toluene in the presence of the carbon; and this in turn is broken down by the heat to benzene. A great advantage this oil has is that the flashing-point is 110° C., and so is well above the limit; this doing away with the dangers and troubles inseparable from the storage of light naphthas in bulk.

In using this oil as an enricher, it must be cracked in the presence of carbon; and it is of the greatest importance that the temperature should not be too high, as the benzene is easily broken down to simpler hydrocarbons of far lower illuminating value.

(To be continued.)

SCIENTIFIC SERIALS.

American Journal of Science, December 1890.—Long Island Sound in the Quaternary era, with observations on the submarine Hudson River channel, by James D. Dana. The discussion of a chart containing some new soundings recently made under the direction of the U.S. Coast and Geodetic Survey leads Prof. Dana to conclude that during the Glacial period "Long Island Sound, instead of being, as it is now, an arm of the ocean twenty miles wide, was for the greater part of its length a narrow channel serving as a common trunk for the many Connecticut and some small Long Island streams, and that the southern Sound river reached the ocean through Peconic Bay. Under these circumstances the supply of fresh water for the Sound river would have been so great that salt water would have barely passed the entrance of the Sound." He attributes the origin of the channel over the submerged Atlantic border to the flow of the Hudson River during a time of emergence.—The preservation and accumulation of cross-infertility, by John T. Gulick. The author discusses some of the conclusions arrived at by Mr. Wallace in his work on "Darwinism."—The deformation of Iroquois Beach and birth of Lake Ontario, by J. W. Spencer. The author believes that the great Iroquois Beach was constructed approximately at sea-level and that its upheaval was the means that gave birth to Lake Ontario. This episode commenced almost synchronously with the creation of the Niagara Falls.—Experiments upon the constitution of the natural silicates, by F. W. Clarke and E. A. Schneider.—Eudialyte and eucolite, from Magnet Cove, Arkansas, by J. Francis Williams.—Prediction of cold waves from Signal Service weather maps, by T. Russell. In addition to the regular fall of temperature that takes place from day to night, irregular falls occur from time to time. When the fall in the latter case exceeds 20°, and covers an area greater than 50,000 square miles, and the temperature in any part of the area falls as low as 36°, it is called a cold wave. The author has investigated the shapes and relative positions of the various high and low areas of pressure preceding cold waves, and proposes a method for the prediction of them.—On a peculiar method of sand transportation by rivers, by James C. Graham. Numerous blotches of sand, some about six inches square, have been observed floating on the surface of the Connecticut River. This indicates that, by surface tension, it is possible for coarse sand to be floated away on a current having less velocity than would otherwise be required, and affords a possible explanation of the coarser particles of sand usually found in otherwise very fine deposits.—Note on the Cretaceous rocks of Northern California, by J. S. Diller.—Magnetic and gravity observations on the west coast of Africa and at some islands in the North and South Atlantic, by E. D.