cent. (a very fair average figure), and 18 per cent. as the amount present in the Van Steenbergh 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 cannel 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 cannel coal	4*d.*
By the Maxim-Clark process	$2\frac{6}{10}$*d.*
By the Lowe or Springer water gas	$1\frac{1}{2}$*d.*
By the Van Steenbergh water gas	$\frac{3}{4}$*d.*

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 $\frac{1}{2}$*d.* per gallon; though it has since been as high as $2\frac{1}{2}$*d.* per gallon. It is now about 2*d.* 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, aad 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:—

$$\underset{\text{Phenol.}}{C_6H_5HO} + C = \underset{\text{Benzene.}}{C_6H_6} + CO.$$

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.

Preston.—On the Fowlerite variety of rhodonite from Franklin and Stirling, N.J., by L. V. Pirsson.—Some observations on the beryllium minerals from Mount Antero, Colorado, by S. L. Penfield.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 11, 1890.—"On Stokes's Current Function." By R. A. Sampson, Fellow of St. John's College, Cambridge. Communicated by Prof. Greenhill, F.R.S.

In a liquid any irrotational motion which is symmetrical about an axis may be regarded as due to the juxtaposition at the origin and upon the axis of symmetry of sinks and sources.

Let us consider the system formed by a line source and a line sink, of equal strengths, extending along the axis from an arbitrary origin to infinity in opposite directions. Such a system I shall call an *extended doublet*, of strength m, where m is the strength per unit length of that part which lies on the positive side of the origin.

By the superposition of two extended doublets, of equal but opposite strengths, we can produce a sink or a source upon the axis. Hence, in a liquid, any irrotational motion which is symmetrical with respect to an axis may be produced by superposition of extended doublets, whose origins depart but little from an arbitrary point on the axis of symmetry.

Now, for an extended doublet of strength m, we find Stokes's current function ψ, for any point distant r from the origin $= -2mr$. Whence, if $r \sin\theta = \varpi$, $r\cos\theta = z - \zeta$, $\mu = \cos\theta$

$$\frac{d^2\psi}{d\varpi^2} + \frac{d^2\psi}{dz^2} - \frac{1}{\varpi}\frac{d\psi}{d\varpi} = 0 = \frac{d^2\psi}{dr^2} + \frac{1-\mu^2}{r^2}\frac{d^2\psi}{d\mu^2}.$$

Thus it will be seen that the direct distance of any point from a point on the axis of symmetry plays the same part in the theory of Stokes's current function that is played by its reciprocal in the theory of the potential function belonging to symmetrical distributions of matter.

And if r_0, 0, r, θ, be the co-ordinates of a point upon the axis, and of any other point, the distance between these points, $\sqrt{(r_0^2 - 2r_0 r\cos\theta + r^2)}$, may be developed in a convergent series, say

$$\sum_{n=0}^{n=\infty} - \frac{r^n}{r_0^{n-1}} \mathrm{I}_n(\cos\theta),$$

or

$$\sum_{n=0}^{n=\infty} - \frac{r_0^n}{r^{n-1}} \mathrm{I}_n(\cos\theta),$$

according as r_0 is greater or less than r, $\mathrm{I}_n(\cos\theta)$ being a certain function of θ, satisfying

$$(1-\mu^2)\frac{d^2\mathrm{I}_n(\mu)}{d\mu^2} + n(n-1)\mathrm{I}_n(\mu) = 0.$$

It is evident from the analogue of zonal harmonics that it is proper to discuss the function $\mathrm{I}_n(\cos\theta)$, and other solutions of this equation, before considering the applications of Stokes's current function to the motion of liquids. As might be expected, the theory closely resembles that of spherical harmonics.

The applications to hydrodynamics which I here give are chiefly in connection with the motion of viscous liquids. In *Crelle-Borchardt*, vol. lxxxi., 1876, Oberbeck has given the velocities produced in an infinite viscous liquid by the steady motion of an ellipsoid through it, in the direction of one of its axes, and from these Mr. Herman (*Quart. Journ. Math.*, 1889, No. 92) has found the equation of a family of surfaces containing the stream lines relative to the ellipsoid. I obtain Stokes's current function by a direct process for the flux of a viscous liquid past a spheroid, and it is shown that the result differs only by a constant multiple from the particular case of Mr. Herman's integral.

Some minor applications are also given—namely, the solutions are obtained for flux past an approximate sphere, and past an approximate spheroid. The solution is also obtained for flux through a hyperboloid of one sheet, where it appears that the stream surfaces are hyperboloids of the confocal system. A particular case is that of flux through a circular hole in a wall, and this is interesting because we see that, by supposing internal friction to take place in the liquid, we find an expression which gives zero velocity at the sharp edge, and thus avoids the difficulty which is always present in the solution of such problems on the supposition that the liquid is perfect.

The paper concludes with an attempt to discuss the flux past a spheroid, or through a hyperboloid at whose boundary there may be slipping. The current function is not obtained, all that appears being that it probably differs from the parallel case of the sphere in being far more complicated than when there is no slipping. From this we except the case of the flux through a circular hole in a plane wall, when the solution for no slipping satisfies the new conditions.

Chemical Society, November 6, 1890.—Dr. W. J. Russell, F.R.S., President, in the chair.—The following papers were read :—The magnetic rotation of saline solutions, by Dr. W. H. Perkin, F.R.S. The remarkable results given by solutions of the halhydrides and their compounds with ammonia and organic bases when examined as to their magnetic rotatory power (Chem. Soc. Trans., 1889, 740) made it important to study the solutions of metallic salts in a similar manner. The substances which have been examined up to the present are chiefly chlorides, bromides, iodides, nitrates, a nitrite, sulphates, and phosphates, also hydroxides of alkali metals. For haloid metallic salts in aqueous solution, the rotations were found to be practically 2·2 times greater than the calculated values for the dry substances, and greater therefore than those of the analogous ammonium compounds. A similar remarkable increase of rotation was observed with the hydroxides of the alkali metals, but with sulphates and phosphates numbers agreeing much more closely with the calculated values were obtained. In the discussion which followed the reading of the paper, Dr. Gladstone, F.R.S., said that similar excessive values were obtained on determining the refractive powers of solutions of metallic chlorides, &c., although the differences between the calculated and observed values were much smaller than in the case of Dr. Perkin's measurements. It was all-important to determine the difference in behaviour to light of a substance in its solid state and when in solution, but this was difficult as few solids were uniaxial ; as an example of the difference he mentioned that in the case of sodium chloride the solid has a refraction of 14·4, while that of the dissolved substance is 15·3.—Note on normal and isopropylparatoluidine, by Mr. E. Hori and Dr. H. F. Morley.—The action of light on ether in the presence of oxygen and water, by Dr. A. Richardson. In a recent paper by Dunstan and Dymond (Chem. Soc. Trans., 1890, 574) it is stated that hydrogen peroxide is not formed when carefully purified ether is exposed at a low temperature in contact with air and water to the electric light or diffused daylight. Employing ether which had been purified by some of the methods of Dunstan and Dymond, the author found that hydrogen peroxide is formed in the liquid in every case after exposure to sunlight in contact with moist air or oxygen, but not in the dark at the ordinary temperature.—Action of ammonia and methylamine on the oxylepidens, by Dr. F. Klingemann and Mr. W. F. Laycock.—Condensation of acetone-phenanthraquinone, by Mr. G. H. Wadsworth.—Action of phosphorus pentachloride on mucic acid, by Dr. S. Ruhemann and Mr. S. F. Dufton.—Halogens and the asymmetrical carbon atom, by Mr. F. H. Easterfield. The author has endeavoured to prepare optically active haloid derivatives similar in constitution to Le Bel's optically active secondary amyl iodide, which at present stands alone as the only active compound in which a halogen is united to the asymmetric carbon atom. The results obtained with optically active mandelic acid were negative.

November 20.—Dr. W. J. Russell, F.R.S., President, in the chair.—The following papers were read :—A new method of determining the specific volumes of liquids and of their saturated vapours, by Prof. S. Young. When a tube closed at both ends and partly filled with a liquid is raised in temperature, the liquid expands, but the apparent expansion is less than the real, for a certain amount of the substance separates and occupies the space above the liquid in the form of saturated vapour. If the density of the vapour were known, it would be possible to apply the necessary correction ; but at high temperatures and pressures this is not the case. If, on the other hand, the upper part of the tube (enclosing the vapour and a portion of the liquid) be heated to a high temperature, the lower part being kept at a constant low temperature, and if subsequently a greater length of the tube be heated to the high temperature, there will again be expansion, but in this case the observed expansion will be greater than