purpose; what I claim is, the employment of the rotating concentric hub, on which the toes, or their equivalents, of the lifters, rest, when the valves are closed, substantially as specified, when this is combined with a cam connected therewith, and which turns eccentrically thereon, for the purpose of opening and closing the valve, and regulating the period of closing the same, substantially as specified. And I also claim combining with the said hub and cam, a slide within them, and acting on an oblique groove within the cam, and a straight slot in the hub, substantially as specified, to determine the period of closing the valve, whilst the period of opening remains the same, as specified; and this I claim, whether the said slide be operated by a governor, or by other means.

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Improved Apparatus for the Analysis of Coal, and for Organic Analysis generally. By J. H. ALEXANDER and CAMPBELL MORFIT.

Early in October last, having to make an ultimate analysis of divers specimens of coal, anthracite and bituminous, we had also abundant opportunity of observing the want of certainty and uniformity of result in the methods ordinarily recommended and practised for such analysis. With all these methods, where the aim is to induce the organic or other substance under analysis to give off its carbon by combustion, in glass tubes, with oxide of copper, chromate of lead, or chlorate of potassa, either separately or mixed; and where the effects arise under a simple play of affinities at a high temperature, and are unaided by any external force or mechanical agency, variations occur to such an extent, as, in the case of anthracite coal especially, to leave the results, from several assays of the same sample, rarely identical. We have found these variations to depend, among other things, upon the grade of comminution of the matter for analysis, and its mode of intermixture with the oxidizing agents. If, for instance, the coal is too finely divided, it either protects, or is protected by the re-agents against the effect of the heat; although this may be so high as to fuse the tube and part of its contents. If, on the other hand, the coal be not finely divided enough, it protects itself. We all know the extreme difficulty of driving off the carbon from an anthracite coal, for example, even in an open crucible and over a blast; where sometimes three hours and more are spent in reducing so small a quantity as one gramme to ashes. And as for the mode of intermixture which shall be most favorable for the exposure and contact of the greatest amount of surface between the material and re-agent respectively, it is easy to see that, even after having been studied and attained in one instance, its repetition must be more the gift of good fortune than the result of any regular and unfailing manipulation.

Again, in the ordinary methods, with whatever re-agent, the heat necessary to be applied, and the apparatus for its application, prevent in a great degree, if not entirely, the experimenter from observing what is going on in the tube; so that he is left without any optical grounds, or indeed any grounds at all, beyond the cessation of bubbles in the potash bulbs and an inference from the lapse of time, for judging whether the operation is properly complete or not.

Finally, in any of these methods, the ashes of the matter being lost among the fragments of the re-agents, there is rendered necessary, for the determination of this item, a partitioning of the original sample and a second special operation under all the scope for differences—slight, perhaps, but yet differences—which such partitioning always implies.

It was under these impressions, and with the view of remedying to some extent the defects which have been noticed, that we came to arrange and use the apparatus of which this note is intended to give the description. We have found in its employment that both from the comparatively low temperature necessary, and from the mechanical mode of applying and, when requisite, urging the re-agent, the rate of the whole process becomes under the strictest and most delicate control; that its progress is all the time distinctly seen, and can be judged of; and that the elements usually sought for in organic analysis, (and especially in coals, for the purpose of ascertaining their probable heating power,) are obtained from one and the same weighed portion.

Other advantages which we find it possessing—such as its convenience, being always ready after having been once arranged; its permanence, being not at all liable to get out of order with ordinary precaution; its economy, both as to the time of the experimenter and the money for combustion tubes which, in the former modes, answer but for one experiment and are then thrown away, while in this, the tube, except from some extraneous accident, never breaks and answers for the hundredth experiment as well as for the first; and, finally, the quiet and composure of the whole process, undisturbed by any explosion or decrepitation—need not be dwelt on here. They, of course, will recommend themselves to the practical analyst and are to be duly appreciated; but are not, in our opinion, to be spoken of in the same category with the main feature of accuracy and reliability of result.

The accompanying cut exhibits in section as much of the arrangement as appears necessary to its being clearly understood in connexion with the description following. The letters there are the chemical symbols to denote the occurrence and position of the several re-agents employed.

On the right hand is seen a reservoir of oxygen, somewhat modified from the ordinary Pepys' gasometer. In this, the water reservoir above is furnished with an outlet and cock, (which during use are left open, in

order to maintain a constant level,) and is fed from another vessel of water communicating with it in any convenient manner. We use a syphon. The water reservoir is supported, as usual, by three stems; only one of them, as shown, is opened and widened to hold a thermometer with a small range and open scale, whose bulb plunges into the oxygen reservoir below, and serves to indicate the temperature of the gas. The water is allowed to pass into the lower reservoir of gas by a pipe and stop-cock, as usual; and the orifice of said pipe is also made to receive adjutages of varying bore, so as to regulate with considerable exactitude the rate of supply. Connected with the gas reservoir is a glass tube, which usually indicates the level the water may have attained and consequently the quantity of oxygen on hand; but, in this instance, it is intended to answer a more precise quantitative determination. On the tube are inscribed two scales; one, deduced from the known capacity of the gasometer and calibre of the tube, to show at once the number of cubic inches occupied by the water between any two stand-points on the scale and, of course, when corrected for pressure and temperature, the corresponding volume of oxygen introduced or expelled; and the other, to show at any epoch the fraction of inches of mercury corresponding to the actual pressure of the water, counted downwards from the constant level in the upper reservoir (the design of which constancy is now apparent) to its stand in the tube; which fraction is convenient to be added at once to the observed barometric pressure, in order to give the total pressure under which the oxygen is delivered. With this total pressure and the observed temperature, the normal volume of oxygen used from epoch to epoch can be readily ascertained; the purpose of which ascertainment is, as will be seen presently, to have a check upon the numerical results otherwise obtained. This method of registering the quantity of oxygen used is not, perhaps, the best that could be devised, and leaves something to be desired on the score of minute measurement. But it was the most convenient application to the apparatus that we possessed; and as it can be read, with a vernier, to about $\frac{1}{10}$ th of a cubic inch, (or $\frac{3}{1000}$ ths of a grain in weight nearly,) it is probably commensurate with the accuracy usually thought sufficient in checking a result furnished by other means.

With the stop-cock outlet in the upper part of the oxygen reservoir, as seen on the left of the gasometer, is connected by a pierced cork, one end of a right-angled tube that plunges its other end into a flask of strong sulphuric acid, through which the oxygen, as delivered, passes and parts with its moisture. The remainder of the moisture is supposed to be absorbed by the chloride of calcium contained in the next two tubes, as shown; the first of which, a double bulbed U tube, is connected by a caoutchouc wrapper with the branch proceeding from the upper tubulure of the sulphuric acid flask, and the small end of the second is bent at right angles and is corked into the open end of the first. There is no particular virtue in these various bends and tubulures; they were used because the pieces happened to be on hand, and possessed, as we judged, the quality of containing a sufficient extent of chloride of calcium in a short linear space.

If our judgment as to this sufficiency is correct, the oxygen passes

quite dry into the next small tube, furnished with a stop-cock, and connecting the last calc. chloride tube with the combustion tube itself.

This tube is needlessly long for the purposes it has to answer, which are in fact met by the stop-cock; but it happened to be on hand, and we did not desire to cut it. The purposes intended are threefold: 1st, by shutting off the cock while the gasometer is open and oxygen is being delivered, to secure a sufficient residence of the oxygen in the calc. chloride tubes for this gas to become dry—in fact, to secure a store of dry oxygen; 2d, by a similar shutting off, to convert the combustion-tube into a tube closed at one end, and thus allow of any incidental moisture being drawn off with an exhausting syringe in the usual way; and, 3d, by shutting off more or less, to regulate the flow of dry oxygen, or, if necessary, to cut off the supply altogether. When the experimenter has no assistant, the use of this stop-cock for regulation is more handy than of the one on the gasometer; for the second purpose, we have never used it ourselves, preferring to dry the combustion-tube and its contents by a sustained current of oxygen under pressure, from which there is no danger of vitiation to the result by introducing carbonic acid, as is always the case when a current of atmospheric air is employed in the same way; the first purpose is almost always advantageous, and in some cases indispensable.

We have now come to the combustion tube, which is a piece of hard German white glass, open at both ends for receiving corks. This is lined for about one-third of its length in the middle with a helix of clean and bright copper wire; the purpose of which is to reduce any of the oxides of nitrogen that might be generated from the matter in combustion, and thus to secure the transmission of this element in a free state through the remaining channels of the apparatus. It will, of course, be generally proper to clean and renew the surface of this helix by any convenient method, after each experiment. Resting on this helix is a platinum scroll of known weight, holding the matter for analysis, and retaining its ashes for being weighed after the combustion is completed. This combustion, we have always so far effected with hand-lamps of alcohol, having Argand burners; the heat given by which, is quite high enough to ensure, in a few minutes, the oxidation, in this atmosphere of oxygen, of all the carbon contained in a half grain, or even a grain of coal. To assist in the rapidity of oxidation, we found it advantageous to spread the mass of pulverized matter as thinly as possible over the surface of the platinum scroll. Instead, however, of these Argand burners, whose small extent render the scintillating and perfectly oxidizing temperature too local, we propose to employ, hereafter, a lamp with oblong hollow wicks, extending over nearly the entire length of the combustion tube, and separated by metallic diaphragms of sufficient height, to prevent the spontaneous communication of flame from one to the other, so that each wick may be lighted successively, as desired. This lighting should be commenced and the heat applied first at the end of the combustion-tube nearest the gasometer, on account of the great density of the carbonic acid produced; to assist in the discharge of which, we have found it proper to give the whole apparatus from the gasometer onward an inclination downwards of about a half inch per foot.

The gaseous products of combustion pass off first into a calc. chloride tube, whose smaller end is corked into the combustion tube, and which retains the vapor of water from the hydrogen given up by the matter; and next, into an ordinary quintuple bulb arrangement, containing a solution of potassa, which takes up the greater part of the carbonic acid that has been formed. The remaining carbonic acid (such, for instance, as may have been formed and delivered from the combustion tube faster, owing to some occasional irregularity, than could be absorbed by the potash solution, and which we have found in appreciable quantity,) is caught by, and increases the weight of the fragments of solid potassa contained in the U tube on the extreme left of the apparatus.

Finally, to complete the design which has been indicated in the calibration and graduation of the oxygen reservoir, must be imagined a bent glass tube connected with the last mentioned U tube at one end, and leading into a mercury trough under a suitable receiver, where all the remaining gases from the combustion tube are at last gathered. As these gases can be only oxygen and nitrogen, they may be transferred from the receiver into a Volta or other eudiometer; where the volume of oxygen is determined either by detonating with hydrogen, by platinum sponge, or any other eudiometric mode that may be preferred. The volume of oxygen being thus known, the volume and, consequently, the weight of the nitrogen that was in the receiver can be readily deduced.

In the mean time, the combustion being terminated, the platinum scroll, which now contains but the ashes of the matter, is withdrawn from the tube and weighed; the difference between the weight now found and the original weight of platinum alone, is that of the ashes.

We have now the weight of earthy matter and of the four principal volatile matters which constitute the coal, directly determined. And, by the use of the graduated scale on the gasometer, we have also a check upon the general accuracy of the whole operation; for, if the epochs have been carefully observed, the quantities of oxygen that by calculation must have been taken up in forming carbonic acid and water, should equal the whole quantity of oxygen directly observed to have been delivered from the gasometer during the process.

In illustration of what has been said as to the uniformity of results attainable by this method, we subjoin an extract from the note book of weights obtained successively from two portions of the same sample of coal in two different experiments; the calc. chloride tube having been changed in the interval, so as to afford a quite different initial weight, and thus having prevented any possibility of pre-occupation in making the weighings.

Quantity of coal taken in each experiment, 0.5 grain.

	1st Exp.	2d Exp.
HO	0.25 gr.	0.24 gr.
CO ² in bulbs, ...	1.59	1.61
CO ² in U tube, ...	0.06	0.04
Ash, ...	0.02	0.02

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Verité's Electric Clock.

We owe to the friendship of M. l'Abbé Duporq, Professor of Physics in the large Seminary of Beauvais, the description of the electric clock of M. Verité. In making the clock, the electric communications are hidden so as to allow all possible grace. The valuable part of this delightful invention is, that it requires only a very feeble electric current; the action of M. Verité's battery retains sufficient intensity for more than six months; its price is insignificant; a zinc or copper plate, and a little sal ammoniac or sulphate of copper are the essentials. The whole is easily included in the case of an ordinary clock, and the most delicate sense of smell could not suspect its presence. The pendulum $s p$, with its horizontal brass cross-piece $A A'$, is suspended by an elastic steel spring from a fixed point s , in communication with one of the poles of the battery. Above, a balance beam $B B'$, fixed on a movable axis M , is composed of an insulating part $R R'$, and carries at its extremities plates of soft iron, which are alternately attracted by the electro-magnets E and E' . The current comes to the electro-magnets by a wire which divides at G , and is wrapped from right to left around the electro-magnets. Finally, the current, after traversing the wire of the electro-magnet E for instance, passes to the arm $B D$ of the beam $B B'$ re-descends by a very fine and flexible silver wire $D O$, and completes the circuit by the ball o , in its contact with the cross-piece $A A'$. The balls o and o' give the impulse to this ingenious escapement of M. Verité, applied by him in 1844.

The movement is easily understood. If a first impulse to the left is given to the pendulum, the cross-piece $A A'$ touches the ball o , and the current is established; the electro-magnet E pulls down the arm $B D$,

and with it the point of attachment *D*, of the wire which carries the ball. The ball *o*, its point of suspension being lowered, will not then abandon the cross-piece *A A'*, except at a point lower than that at which it met it, and consequently will give an impulse to the pendulum. But soon its contact with the cross-piece ceasing, the current ceases to pass around the electro-magnet *E*; then the pendulum rises on the right-hand side, the cross-piece meets the ball *o'*, and the same effects are reproduced on this side. The movement has commenced, and will continue so long as the current has sufficient force to cause the movement of the balance beam.

If a fork like that which works the needle of the receiver in electric telegraphs be adapted to the balance beam *B B'*, we have every thing necessary for marking seconds. *M. Verité* gets, moreover, from the same motive power, the force necessary for his striking-works. So that we have here a clock, marking and striking the hours without weights or springs, solely by the electric force.

For the Journal of the Franklin Institute.

The San Francisco.

HULL. —Length on deck, ...		286 feet.
Breadth of beam, ...		41 “
Depth of hold, ...		16 “
“ “ to spar deck, ...		24 “
Length of engine and boiler space, 104 ft. by 15 ft. in width, including passages.		
Draft of water at pressure and revolutions, given below, ...		11 feet 6 inches.
Area of immersed midship section at this draft, ...		443 square feet.
Capacity of coal bunkers, in tons of coal, ...	500	
Draft of water at load line, ...		13 feet 6 inches
Floor timbers at throats, moulded, ...		16 “
do. do. sided, ...		16 “
Distance of frames apart at centres, ...		3 “
Masts and rig, ...		Foretopsail schooner.
ENGINES. —Two inclined oscillating.		
Diameter of cylinders, ...		65 inches.
Length of stroke, ...		8 feet.
Maximum revolutions per minute, ...	22	
BOILERS. —Two, round shell and drop flued.		
Length of boilers, ...		34 “
Breadth of boilers, ...		13 “ 6 inches.
Height of boilers, exclusive of steam chimney, ...		13 “ 6 “
Number of furnaces, ...	4	
Length of grate-bars, ...		7 “
Number of flues, ...	24	
Internal diameter of flues, 1st range 16 inches, 2d range 21½ inches, 3d range 17½ to 15 inches.		
Diameter of smoke pipes, (two)		4 feet 4 inches.
Height of smoke pipes, ...		30 “
Maximum pressure of steam in pounds, ...	20	
Description of coal, ...		Bituminous.
Area of flue and fire surface in boilers, ...		6000 feet.
WATER WHEELS. —Feathering.		
Diameter, ...		28 “
Length of blades, ...		8 “
Depth of blades, ...		4 “
Number of blades, ...	14	