XXV. *On Respiration.* *By* William Allen, *Esq. F. R. S. and* William Hasledine Pepys, *Esq. F. R. S.*

Read June 22, 1809.

One of the most prominent features in our last communication was the evolution of a considerable quantity of azote, when oxygen gas nearly pure was respired; and although a considerable part of this azote must undoubtedly be attributed to the residual gas in the lungs, after the most forcible attempt at expiration, yet the fact seemed to demand still farther investigation, it appearing of consequence to ascertain whether the increase of azote was uniform throughout the latter stages of the experiment, or *solely* confined to the earlier periods.

By adverting to our former Paper, it will be found, that in an experiment where more than 3000 cubic inches of oxygen passed through the lungs in seven minutes and a quarter, 62 cubic inches of azote were found in the first 250 cubic inches expired, though the gas originally contained but 2,5 per cent. or only 6 cubic inches in this quantity; in the two next portions expired, consisting of 562 cubic inches, we found 56 cubic inches of azote, though this quantity of gas, before it was respired, contained only 14; these, first portions, were given off in about two minutes, and contained nearly 100 cubic inches of azote more than could be accounted for in the oxygen employed; hence it is plain, that a large proportion of the increase is evolved in the first periods of the process.

Our attention was particularly directed to this point in the following experiment. The oxygen, procured as usual from hyperoxygenised muriate of potash, was found to contain four per cent. of azote; the experiment was conducted in the same manner as the preceding ones, except that the tubes of the gasometers were filled with oxygen, and the gas was not merely passed *once* through the lungs, but breathed backwards and forwards. In order to prolong the duration of the experiment, which began and ended with a forcible expiration, portions of the respired gas were preserved for examination from each of the gasometers, in the following order:

No. 1.	244
2.	294
3.	282
4.	266
5.	230
6.	266
7.	254
8.	288
9.	252
10.	168
	2544

The portion of oxygene remaining in the water gasometer of the original quantity, not employed in the experiment, was found upon trial to contain four per cent. of azote, as before.

Summary of the Experiment.

Bar.	Therm.	Cub. Inches of Oxygen inspired.	Cub. Inches of Gas expired.	Deficiency.	Time.
29,9	51	2668	2544	124	13 minutes;

here the deficiency was greater than we had ever remarked before; but on passing an equal quantity of common air from the water gasometer, and registering it in the mercurial ones, we were satisfied that the apparatus was quite perfect. It is, however, to be considered, that the respiration in this case was not natural, and that some small degree of force was required when the inspirations and expirations were made in the mercurial gasometers, which renders this experiment rather different from those which had preceded it; and it appears to us probable, that a portion of air was forced into the extremities of the bronchea, which could not be suddenly expelled by the strongest attempts at expiration. Hence also, perhaps, the constant though smaller deficiency, even when the air was only once passed through the lungs; but when the process is continued for a much longer time, it is probable that the vessels recover their tone, and are able to expel nearly the whole of the volume admitted.

The air expired in the present instance, being examined in the manner described in our last paper, we found that 100 parts from each of the gasometers contained the following proportions:

No. 1.	10	carbonic acid
	21	azote
	69	oxygen
	100	
No. 2.	10	carbonic acid
	11	azote
	79	oxygen
	100	

No. 3.	10	carbonic acid
	8,5	azote
	81,5	oxygen
	100	
No. 4.	10	carbonic acid
	7,75	azote
	82,25	oxygen
	100	
No. 5.	10	carbonic acid
	7	azote
	83	oxygen
	100	
No. 6 to 10 mixed	10,5	carbonic acid
	5,5	azote
	84	oxygen
	100	

we shall first calculate the total quantity of azote existing in the gas before the experiment, and afterwards estimate what was produced in the different periods during the first half of the experiment.

Calculation for Azote.

2668 cubic inches of oxygen were employed containing four per cent. azote: then

100 : 4 :: 2668 : 106,72

the total quantity of azote in the gas consumed, was 106,72 cubic inches.

Azote found after the Experiments.

	Cubic Inches.			Azote found.
No. 1.	244	100 : 21	::	244 : 51,24
2.	294	100 : 11	::	294 : 32,34
3.	282	100 : 8,5	::	282 : 23,97
4.	266	100 : 7,75	::	266 : 20,61
5.	230	100 : 7	::	230 : 16,10
6 to 10.	1228	100 : 5,5	::	1228 : 67,54

Total 211,80 cubic inches.

The whole azote, found after the experiment, was - - - 211,80 cubic inches.

Azote detected by the same tests before the experiment only - - 106,72

Increase of azote 105,08

Now, as the whole time was thirteen minutes, if we divide this by the number of gasometers filled, it will give us one minute eighteen seconds for each, and the following will be the periods in which the azote was evolved.

	Time. ′ ″	Azote found.		Azote in the Oxygen.		Increase.
No. 1.	1.18	51,24	less	9,76	equal to	41,48
2.	1.18	32,34	—	11,76	=	20,58
3.	1.18	23,97	—	11,28	=	12,69
4.	1.18	20,61	—	10,64	=	9,97
5.	1.18	16,10	—	9,20	=	6,90
6 to 10.	6.30	67,54	—	49,12	=	18,42
	13 min.	211,80		101,76		110,04

Here the increase of azote appears rather greater, *viz.* 110 cubic inches, but the calculation in this case is made upon the gas *expired*, and, from the above statement, we may see, that the evolution of azote goes on diminishing; we have sometimes even found, that towards the close of an experiment it has been almost reduced to nothing. The question now is, whether this increase of azote can be owing to the residual gas contained in the lungs at the beginning of the experiment, or whether a portion of oxygen is not actually exchanged for azote, when pure oxygen gas is respired.

Here it may be useful to compare the azote found in our former experiments on oxygen, with the present.

	Bar.	Therm.	Oxygen Gas inspired.	Gas expired.	Deficiency.	Time.	Quantity respired in a Minute.	Azote evolved.	Inferred Capacity of Lungs.
		°				′ ″			
No. 1.		53	3260	3193	67	9,20	348	110	141
2.	30,3	70	3420	3362	58	7,25	461	177	225
3.	30,15	70	3130	3060	70	8,45	357	187	236
4.	29,9	51	2668	2544	124	13,	205	105	133

The greatest increase of azote was in the 2d and 3d experiments, when the thermometer was at 70°, which might materially influence the results: in the other cases, it was not higher than 53.

From the experiments of GOODWIN, we might be inclined to admit the capacity of the lungs, inferred from the 1st and 4th experiments, as very possible; but it seems difficult to conceive that it can amount to 236 or 225 cubic inches, and yet this must be the case, unless a portion of azote is given off from the blood, or there is some process in nature by which it is capable of being produced from oxygen.

Having, by the kindness of our friend HENRY CLINE, jun.

been furnished with the lungs of a stout man, about five feet ten inches high, taken from the body not long after death, and in a sound state, we proceeded to ascertain the quantity of air contained in this organ after the most complete expiration, as in death.

HENRY CLINE had judiciously taken the precaution to divide the trachea just below the crichoid cartilage, before he opened the thorax; he then inserted a tube with a brass stop-cock, which he tied firmly to the trachea, and attached an empty bladder to the other end. The cock was then turned, so as to communicate with the bladder, and on opening the thorax 31½ cubic inches of air were expelled into it. The weight of the lungs was four pounds one ounce. A very large glass jar being placed in a shallow tin vessel, was filled to the brim with water, the lungs were then completely immersed, and the water which flowed over, and was the measure of their volume, weighed six pounds two ounces; we next cut a portion of the lungs into small pieces, under a large inverted glass of water, and attempted to squeeze the air from the cells, but although several cubic inches were thus procured, we were soon convinced that it was utterly impossible to arrive at our object by these means, as no force that we could use seemed capable of expelling the air from the cellular membrane, into which it escaped from the vesicles. We therefore took portions of the lungs, which weighed 2774 grains; the mass being put into a piece of new hair cloth, was subjected to the action of a powerful screw press, and the fluid was received in a vessel; after twice undergoing this operation, the mass weighed only 660 grains. Its specific gravity was very nearly that of water, *viz.* ,930 water being 1,000: the fluid procured

by the press, was of the specific gravity of 1,019; this would make the specific gravity of the lungs ,997, water being 1,000; hence it appears, that the substance of the lungs, and the contents of the blood-vessels together, are so near the specific gravity of water, that they may be fairly considered as the same.

Then, as the mass of the lungs was equal to 4 pounds of water, though 6,2 pounds of water were displaced by them, and as a pound of water occupies the space of 28,875 cubic inches, we have the following calculation:

lbs.	oz.	
6	2	water displaced by the lungs
4	1	weight of the lungs
2	1,	or 59,554 cubic inches of air in the lungs, to which
		must be added 31,580 the volume of the air forced into the bladder on opening the thorax.
		91,134

and this gives us 91,134 cubic inches, as the air contained in the lungs of this person after death; and when we reflect that the air must have been under compression, when the lungs were immersed in water, some force being required to keep them down, and also that not less than 7 or 8 cubic inches must be contained in fauces, &c., we cannot estimate the whole at less than 100 cubic inches.

It is farther to be noted, that these 100 cubic inches would occupy much more space in the temperature of the human body, than in the mean temperature in which the examination was made; and this difference would be nearly 8 cubic inches; the air left in the lungs, after complete expiration, would

therefore be 108 cubic inches; but the mean of our experiments would make it 183.

Experiment 1.	141
2.	225
3.	236
4.	133
	4)735
	183

we are then almost compelled to allow that when pure oxygen is respired, a portion of azote is given off from the blood.

We now resolved to perform a series of experiments upon some animal which lived wholly upon vegetable food, and made choice of the Guinea pig as one of the most manageable.

The apparatus consisted of our two large mercurial gasometers, which were made to communicate with a strong trough E, in the middle of which a small mahogany table D was made fast by a screw, for the purpose of supporting the animal under the bell-glass A, two holes were made through the table for the insertion of tubes to supply, and take off the air, each of them communicated with one of the mercurial gasometers; the tube B delivered gas towards the upper part of the glass A, in order to bring the supply of fresh air near the head of the animal: the opening of the tube C was placed within half an inch of the table to convey off the respired air; the gasometer connected with this tube, was made to communicate with a mercurial bath G, in which portions of the respired air were preserved for examination. Quicksilver being

poured into the trough E, so as to rise to a level with the top of the mahogany stand, we placed a Guinea pig upon it, with the bell-glass over him, and as its edges were immersed in quicksilver, the animal was completely confined in atmospheric air: we found that his body occupied the space of 39 cubic inches, which deducted from the cubic contents of the glass A, left 55 cubic inches for the air confined with the pig, to which must be added 5 more for that contained in the tube C.

First Experiment with Atmospheric Air.

The pig was placed upon the stand, and the apparatus arranged as represented in the plate: 250 cubic inches of atmospheric air were admitted into the mercurial gasometer communicating with B: the gasometer communicating with C was quite empty, the apparatus being tried was found perfectly air tight, and the whole quantity of air 310 cubic inches.

The cocks H and I being opened, gentle pressure was made upon the glass of gasometer B, so as to cause the air to pass through A, which consequently drove an equal portion through the tube C into the empty gasometer; a quarter of an hour was employed in passing the gas, which measured exactly 250 cubic inches in C, so that there was no alteration of volume; the cocks H and I were now closed, and the respired air being examined by the usual methods, 100 parts were found to contain

5	carbonic acid
16	oxygen
79	azote
100	

As the air after the experiment had experienced no alteration of volume, and as it contained the same proportion of azote as atmospheric air, this substance had remained unaltered. But 15,50 cubic inches of oxygen had been converted into carbonic acid gas.

100 : 5 : : 310 : 15,50.

Summary of the Experiment.

Bar.	Therm.	Atmos. air Inspired.	Gas after experiment.	Cub. inches of carb. acid.	Cub. in. of carb. acid per minute.	Time.
30°	43°	310	310	15,5	,62	25 min.

Experiment II. *Atmospheric Air.*

The experiment was repeated in exactly the same manner; the animal, except from confinement, appeared much at his ease all the time. The air after the experiment contained in 100 parts

5,5 carbonic acid
15,5 oxygen
79 azote

100

here the proportions of azote were undisturbed, and 17,05 cubic inches of carbonic acid procured

100 : 5,5 : : :310 : : 17,05

Summary of the Experiment.

Bar.	Therm.	Atmos. air Inspired.	Air after Experiment.	Carb. acid found.	Carb. acid per minute.	Time.
29,66	38°.	310 .	310	17,05	,68	25 min.

Experiment III. *Atmospheric Air.*

The apparatus being arranged as before, we kept the pig in the glass A for one hour, and during that time passed 1000

cubic inches of atmospheric air through it, which measured 1001: portions of the respired gas had been preserved in the mercurial bath, and the usual trials made upon the mixture, which was found to contain 5 parts of carbonic acid in every 100, or 53 cubic inches in the whole quantity; the azote was unaltered; 100 : 5 : : 1060 : 53.

Summary of the Experiment.

Barom.	Therm.	Atmos. air before expt.	Air after expt.	Increase.	Carb. acid. found.	Carb. acid per minute.	Time.
29,8	56°	1060 .	1061	1	53	,88	1 hr.

Experiment IV. *Oxygen Gas.*

The pig hitherto employed was put into the glass vessel A, which with the tube contained 60 cubic inches of atmospheric air; 250 cubic inches of oxygen, containing 5 per cent. of azote, were admitted into the gasometer communicating with B, and during a quarter of an hour were made to pass slowly through the vessel in which the animal was confined, to the empty gasometer communicating with C, where it measured exactly 250 cubic inches; a portion was preserved in the mercurial bath for examination, and the gasometer B was replenished with 250 cubic inches of the same oxygen; this was passed in about the same time as before, through A into gasometer C, when it measured 248 cubic inches.

250 cubic inches more of the oxygen were now admitted into gasometer B, and passed in the same manner through A into C, where they measured 249.

The gasometer B was for the fourth and last time supplied with 250 cubic inches more of the oxygen, which were passed as before, through A into C, during about a quarter of an hour, and then measured 249.

The pig had remained in the vessel one hour and twelve minutes; it did not appear to have suffered in the least; portions of the respired gas were saved from each of the gasometers, and examined as usual.

	Cubic Inches.		Contained in 100 parts.	Carb. Acid.	Oxygen.	Azote.
No. 1.	250	Carb. acid	8	20		
		Oxygen	66		165	
		Azote	26			65
			100			
No. 2.	248	Carb. acid	10	24,80		
		Oxygen	78		193,44	
		Azote	12			29,76
			100			
No. 3.	249	Carb. acid	10	24,90		
		Oxygen	80		199,20	
		Azote	10			24,90
			100			
No. 4.	249	Carb. acid	12	29,88		
		Oxygen	79		196,71	
		Azote	9			22,41
			100			
In Glass A, and tube C.	60	Carb. acid	12	7,20		
		Oxygen	79		47,40	
		Azote	9			5,45
	1056		100	106,78	801,75	147,52

Total, gas before experiment, 1060
after 1056

Deficiency, - 4

Calculation for Oxygen.

We do not calculate upon the tube from gasometer B, because it is always in the same state after the experiment as before.

1000 cubic inches of oxygen containing 5 per cent. azote, consisted of		950 pure oxygen
60 Atmospheric air with the pig, and in tube C, containing 21 per cent. oxygen		12,60
Total, oxygen before experiment,		962,60
Oxygen found after experiment,	801,75	
Ditto in carbonic acid -	106,78	
		908,53
Oxygen missing,		54,07

Calculation for Azote.

1000 cubic inches containing 5 per cent. azote - - -	50
60 Atmospheric air, containing 79 per cent.	47,40
Total azote before experiment,	97,40
Ditto found after experiment,	147,52
Increase of azote,	50,12

This increase of azote was much more than equal to the cubic contents of the animal's body, the deficiency of 4 cubic inches was doubtless oxygen absorbed.

Summary of the Experiment.

Bar.	Therm.	Oxygen, &c. inspired.	Gas after experiment.	Deficiency.	Carb. acid found.	Carb. acid per min.	Time.	Oxygen missing.	Azote added.
29,05	57°	1060	1056	4	106	1,48	1 h. 12 m.	54,07	50,12

Experiment V. *Oxygen.*

In this experiment we employed a smaller pig, which occupied the space of 33 cubic inches, and our object was to keep him for the same length of time in a smaller quantity of gas, we therefore only used 750 cubic inches of oxygen, beside the common air contained in the glass A, and tube, amounting to 66 cubic inches; the first 250 cubic inches were passed through the glass A into C in 24 minutes, where it appeared to have undergone no alteration of volume. 250 cubic inches more were passed during the next 23 minutes, and these measured 248 in C; the last 250 were passed in 24 minutes, and the volume remained unaltered. The animal did not appear to suffer the slightest inconvenience, except from the confinement.

State of the Gas before Respiration.

		Oxygen.	Azote.
66 cubic inches of atmospheric air,	=	13,86	52,14
750 oxygen, containing 5 per cent. azote,	=	712,50	37,50
816 total consisting of		726,36	89,64

The oxygen was tried before, as well as after the experiment, and both the results agreed perfectly with each other. We now examined portions of gas preserved from the three gasometers, with lime water, and the tests for oxygen.

		Time. min.	Contained in 100 parts.		Carbonic acid.	Oxygen.	Azote.
No. 1.	250.	24	Carb. acid	9,5	23,75		
			Oxygen,	60,5		151,25	
			Azote,	30			75
				100			
No. 2.	248.	23	Carb. acid,	9,5	23,56		
			Oxygen,	81		200,88	
			Azote,	9,5			23,56
				100			
No. 3.	250.	24	Carb. acid,	10	25		
			Oxygen,	82		205	
			Azote	8			20
				100			
66 with pig, as No. 3.					6,60	54,12	5,28
814		71			78,91	611,25	123,84

Calculation for Oxygen.

Oxygen before the experiment	-	726,36
Ditto after - - -	611,25	
In carbonic acid - -	78,91	
		690,16
Loss of oxygen		36,20

Calculation for Azote.

Azote found after experiment	- -	123,84
Ditto before experiment	- -	89,64
Increase of azote		34,20

Summary of the Experiment.

Therm.	Gas before Exper.	Gas after Exper.	Deficiency.	Carbonic Acid found.	Cubic Inches per Minute.	Time. h ′	Oxygen missing.	Azot added.
° 56	816	814	2	78,91	1,11	1 11	36,20	34,20

The quantity of azote added, of oxygen missing, and of carbonic acid formed, were smaller than in the last experiment; but the animal in this instance was smaller, as well as the quantity of oxygen passed through in a given time.

In this case, as in the human subject, the increase of azote takes place principally in the early periods. The whole azote contained in the 66 cubic inches, confined with the pig, was only 52,14, but supposing, which perhaps was not the case, that the 66 of common air were expelled by the first 250 cubic inches of oxygen, we should have 250

less 66

184 of oxygen,

containing 5 per cent. azote, or 9,20 cubic inches; these added to the 52,14, would make 61,34 of azote to be found in the first gasometer of respired gas, but we detected 75, so that even on this supposition 13,66 of azote were added in the first twenty-four minutes.

The azote contained in the second gasometer before respiration, was 12,50 cubic inches, but after it had been respired for twenty-three minutes, we found 23,75, or an increase of 11,25 azote. The azote contained in the third gasometer, before respiration, was, as before, 12,50 cubic inches; but after it had been respired for twenty-four minutes, we found 20, or an increase of 7,50 azote.

The azote contained in the 66 cubic inches, was 3,30, but we found 5,28, or an increase of 1,98 azote.

From the results of these experiments, it seemed that when the *usual proportion* of azote was not present in the gas respired, there was a disposition in the blood to give out a certain quantity in exchange for an equal volume of oxygen, and we resolved to try, whether this circumstance would occur when hydrogen was substituted for azote, we accordingly made a mixture containing 22 per cent. oxygen and 78 hydrogen.

Experiment 6. Hydrogen and Oxygen.

The pig employed in the last experiment, was placed upon the stand in the glass A, with 66 cubic inches of common air as usual.

250 cubic inches of the mixture were passed from the gasometer, communicating with B through the glass A into the gasometer communicating with C during sixteen minutes. The animal did not appear uneasy: a second quantity of 250 cubic inches was passed in seventeen minutes and three quarters: the animal did not seem to be in the least incommoded.

A third quantity of 250 cubic inches was passed, in about sixteen minutes.

And a fourth quantity of 250 cubic inches in eleven minutes and three quarters; but during this time, the animal became very sleepy, and towards the end of the experiment, kept his eyes constantly shut; he, however, appeared to suffer nothing, and was easily roused for a short time by rapping at the side of the glass. At the end of sixty one minutes and a half, he was taken out, and we found that during this time, he had produced 60,20 cubic inches of carbonic acid gas, or rather less than one cubic inch in a minute.

It appears, that less carbonic acid was evolved in this instance in a given time, than when oxygen was respired, but

some circumstances occurred to prevent us from discovering what change the azote had experienced: this point was, however, decided by the following experiment.

Experiment 7. *Hydrogen and Oxygen.*

Having mixed hydrogen and oxygen gases in such proportion as that the oxygen should rather exceed the quantity contained in atmospheric air, we placed the same animal in the glass A with 66 cubic inches of atmospheric air, 250 cubic inches of the mixture were admitted into gasometer B, from the large water gasometer, and gradually passed through the glass A into gasometer C, during fifteen minutes. The pig did not appear uneasy, and the respired gas measured 250 in C: a portion of this was preserved for examination, which we shall call No. 1.

250 cubic inches more of the mixture were admitted into B, and gradually passed, as before, during thirteen minutes; it measured 250 in C; and a portion No. 2 was preserved for examination.

The animal did not seem to suffer any inconvenience. 250 cubic inches more of the mixture were admitted into B, and gradually passed, as before, through A into C during seventeen minutes. The animal now become quite sleepy, but did not appear to suffer any thing. He was taken out at the end of forty-minutes.

At the close of the experiment, the remains of the mixture, which had stood about an hour in the large water gasometer, being examined was found to contain 22 per cent. of oxygen and no carbonic acid; of the residual 78 parts, 20 were mixed with 10 of oxygen, which had been previously found to contain

3 per cent. azote; these 30 parts being detonated in DAVY's improved VOLTA's eudiometer, by the electric spark, were reduced to 3 parts, and these 3 parts being treated with the tests for oxygen, were reduced to 2 parts, *a proof that all the hydrogen had been consumed;* but the 10 parts of oxygen contained, 3 of azote; this deducted from 2, leaves 1,7 for the azote contained in 20 parts of the residuum 78.

20 : 1,7 : : 78 : 6,6

The mixture employed, therefore, contained in every 100 parts

22 oxygen
6,6 azote
71,4 hydrogen
100

We next examined the gas which had been respired,

No. 1. 250 cubic inches respired during fifteen minutes.

100 parts, subjected to the action of lime water in PEPYS's eudiometer, were reduced to 93,5, and this by the tests for oxygen was farther diminished to 77: 20 parts of this 77, mixed with 10 of oxygen and detonated, the residuum treated with the tests for oxygen, left 12 parts which were azote,

From these 12 parts
Deduct ,3 for the azote in the 10 parts oxygen
Leaves 11,7 for the azote contained in 20 parts of the residual 77.

20 : 11,7 : : 77 : 45

No. 1, therefore consisted in 100 parts of

6,5 carbonic acid
16,5 oxygen
45 azote
32 hydrogen
100

No. 2. 250. Respired during thirteen minutes; 100 parts were reduced by lime water to 92,5, and these by the tests for oxygen to 77. Of these 77 parts, 20 being mixed with 10 of oxygen, and detonated, were diminished to 4, and these 4 being examined for oxygen left 3, which must be azote:

From these	3	
Deduct	,3	for azote in the 10 parts oxygen,
Leaves	2,7	for the azote contained in 20 parts of the residual 77.

20 : 2,7 : : 77 : 10,4

No. 2. therefore consisted in 100 parts, of

7,5	carbonic acid,
15,5	oxygen,
10,4	azote,
66,6	hydrogen,
100	

No. 3. 250. respired during seventeen minutes; examined as above, consisted in 100 parts, of

6	carbonic acid,
17	oxygen,
6,5	azote,
70,5	hydrogen,
100	

the 66 remaining with the animal at the close of the experiment, may be considered as very nearly the same as No. 3.

In this, as in the former experiment, we observed that the evolution of carbonic acid was greatest at the middle of the time, but was considerably diminished toward the end, as the pig became sleepy; it is not improbable therefore, that dur-

ing sleep, less carbonic acid is evolved than when the animal is exercising all its faculties.

When atmospheric air alone is respired, we have uniformly found, that the carbonic acid evolved, added to the oxygen remaining, exactly equalled the oxygen existing in the air before it was respired, but in the present instance it was one per cent. more, a circumstance which we are at present unable to account for, but it was constantly the case in all the three trials.

Calculation for Azote.

From the foregoing statement we are enabled to ascertain the quantities of azote, both before and after the experiment.

Azote before the Experiment.

66 cub. inches atmospheric air, with the animal contained $\frac{79}{100}$ or - - -	52,14
750 ——— of the mixed gasses contained $\frac{6,6}{100}$ or	49,50
816 total gas employed	101,64

The total azote before the experiment was therefore 101,64 cubic inches.

Azote after the Experiment.

		Respired during.		
No. 1.	250.	15 min.	100 : 45 : : 250 :	112,50
2.	250.	13 min.	100 : 10,4 : : 250 :	26
3.	250.	17 min.	100 : 6,5 : : 250 :	16,25
	66.		100 : 6,5 : : 66 :	4,29
	816	45 min.	Azote after experiment	159,04
			Ditto before	101,64
			Increase of azote	57,40

Calculation for Hydrogen.

Hydrogen before Experiment.

The mixture before the experiment was found to contain 71,4 hydrogen.

100 : 71,4 : : 750 : 535,50

therefore the total quantity must be 535,50 cubic inches.

Hydrogen after Experiment.

No. 1. 250	100 : 32	: : 250 :	80
2. 250	100 : 66,6	: : 250 :	166,50
3. 250	100 : 70,5	: : 250 :	176,25
66 in A	100 : 70,5	: : 66 :	46,53
Hydrogen found after experiment			469,28
Hydrogen before the experiment			535,50
Ditto after - - -			469,28
Loss of hydrogen, - -			66,22

In this experiment, as well as in those with oxygen, the proportion of azote evolved, was greater in the early than in the later periods, and it becomes interesting to contrast them: thus we know that 52,14 cubic inches of azote were in the vessel with the animal at the beginning of the experiment, and that, of the 250 cubic inches of mixed gases passed in the first fifteen minutes, only 184 could be expelled into gasometer C, (100 : 6,6 : : 184 : 12,14.) which contained only 12,14

making together 64,28 of azote, which was all that

could have been expected in the first gasometer of 250 after respiration, supposing the *whole* of the common air had been expelled, but we detected 112,50, or an increase of 48,22 cubic inches in fifteen minutes.

The second gasometer before it was connected with the glass A, contained but 16,50 cubic inches of azote; we found however about 26, and what is remarkable, in the last gasometer there was no increase at all.

Calculation for Carbonic Acid.

No. 1.	250.	15 min.	100	:	6,5	: : 250	:	16,25
2.	250.	13 min.	100	:	7,5	: : 250	:	18,75
3.	250.	17 min.	100	:	6	: : 250	:	15
	66.	-	100	:	6	: . 66	:	3,96
		45						53,96

The quantity of carbonic acid evolved in 45 minutes was therefore 53,96 cubic inches, or at the rate of 1,19 cubic inches per minute.

The foregoing experiments seem to prove,

1. That when atmospheric air alone is respired, even by an animal subsisting wholly upon vegetables, no other change takes place in it, than the substitution of a certain portion of carbonic acid gas, for an equal volume of oxygen.

2. That when nearly pure oxygen gas is respired, a portion of it is missing at the end of the experiment, and its place supplied by a corresponding quantity of azote; the portion evolved in a given time, being greater in the early than in the later periods.

3. That the same thing takes place when an animal is made to breathe a mixture of hydrogen and oxygen, in which

the former is in nearly the same proportion to the latter, as azote to oxygen in atmospheric air.

4. That an animal is capable of breathing a mixture of 78 parts hydrogen, and 22 oxygen for more than an hour, without suffering any apparent inconvenience.

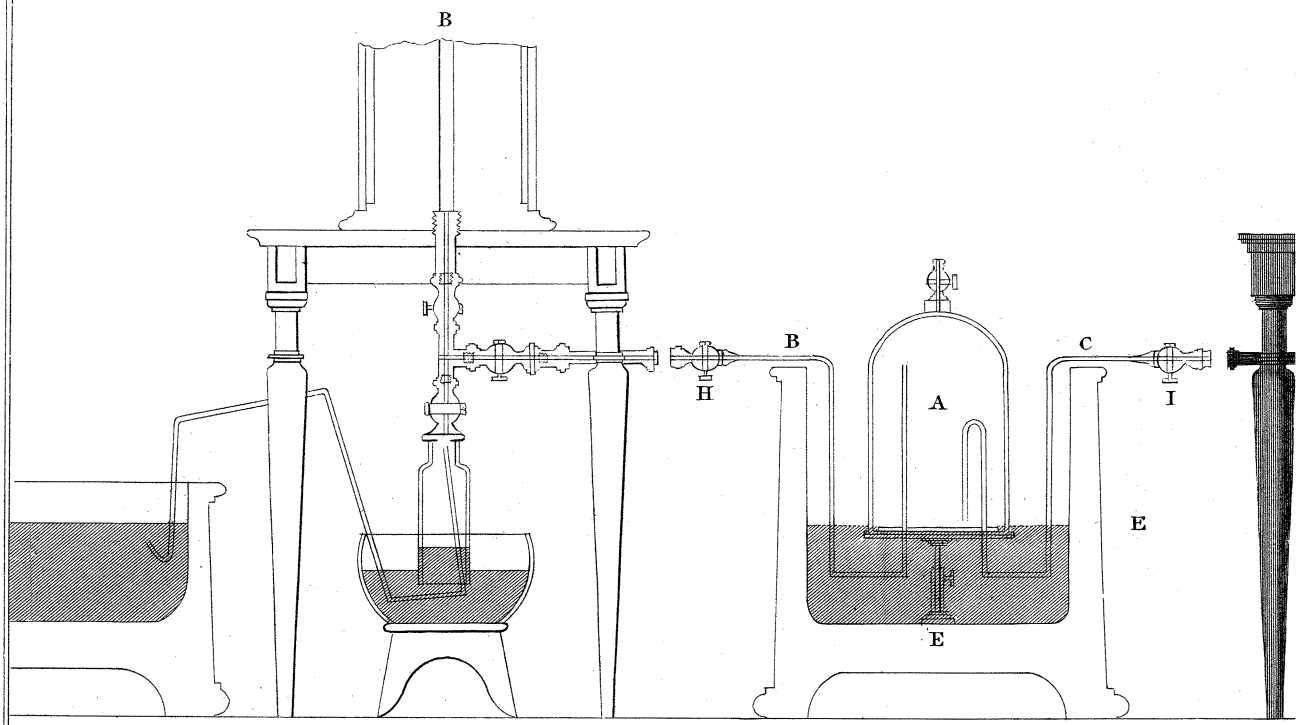
5. That the excitability of an animal is much diminished when he breathes any considerable proportion of hydrogen gas, or that it at least has a tendency to produce sleep.

6. That there is reason to presume an animal evolves less carbonic acid gas during its sleeping, than in its waking hours.

7. That the lungs of a middle sized man contain more than 100 cubic inches of air after death.

These experiments have been conducted without reference to any particular theory, and indeed some of the results were so contrary to our preconceived opinions, that we have been induced to bestow more than ordinary attention on the subject. Confident, however, that all those who repeat the experiments with the same care will arrive at the same results, we shall rest satisfied with stating the facts, not without a hope that those brilliant discoveries of Professor DAVY, which have already given us new views of the operations of nature, will in their progress furnish us with that explanation which it is in vain to expect at present.

Azote or nitrogen, for instance, has been considered as a simple or elementary substance; it is recognised, however, principally by negative properties. Every gaseous fluid which will not support life or combustion, which is not absorbed by water, nor acted upon by the tests for oxygen, nor capable of being detonated with oxygen gas, is generally pro-



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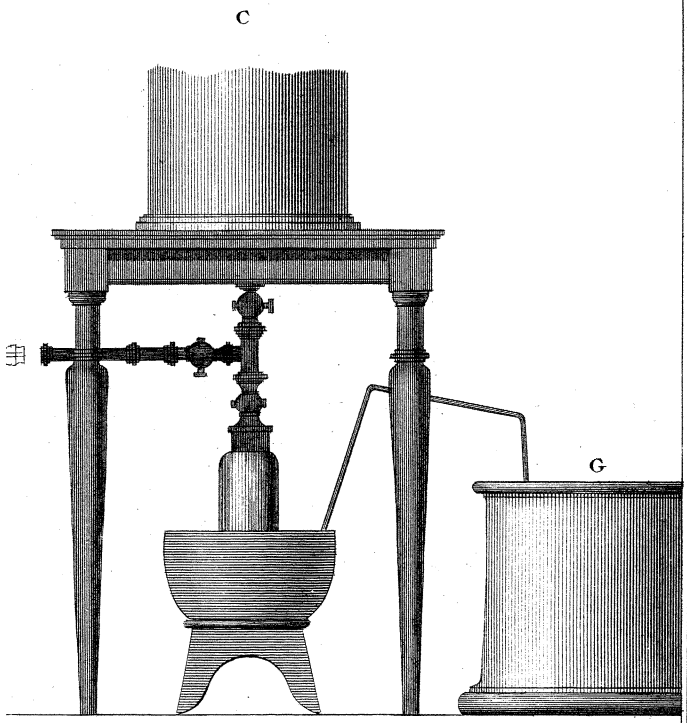

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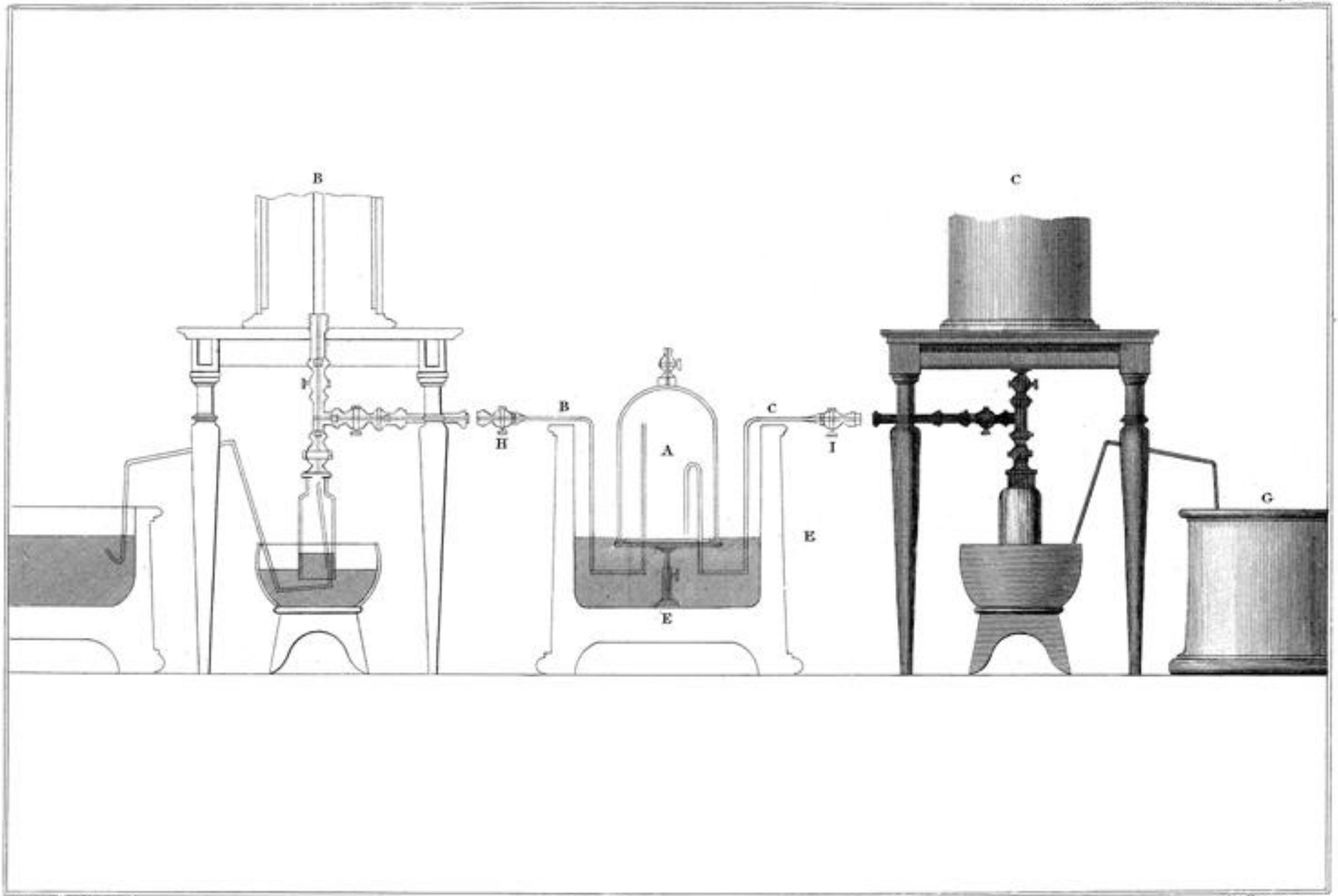
nounced to be azote: it is the constant residuum in almost all our experiments upon gases, but who shall say whether this residuum is a simple substance or a compound?

The experiment of Professor BERZELIUS, leads us to suspect it of metallic properties; and those of DAVY make it probable that it is an oxydated body; the subject is still under discussion. But we may fairly indulge more than a hope that the ardent zeal, and well directed labours of the philosophers just mentioned, will throw a new and important light upon this obscure and difficult subject.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