Considerations on the medicinal use, and on the production of factitious airs / by Thomas Beddoes. Part II / by James Watt.

CONSIDERATIONS

ON THE

MEDICINAL USE,

AND ON THE

PRODUCTION

OF

FACTITIOUS AIRS.

PART I. By THOMAS BEDDOES, M. D.

PART II. By JAMES WATT, Engineer.

EDITION THE SECOND.

TO WHICH ARE ADDED COMMUNICATIONS

From Doctors CARMICHAEL, DARWIN, EWART, FERRIAR, GARNET, JOHNSTONE, PEARSON, THORNTON, and TROTTER; from Mr. ATWOOD, Mr. BARR, Surgeon to the Birmingham Dispensary, Mr. WALTER WILLIAM CAPPER, Mr. GIMBERNAT, Surgeon to the King of Spain, Mr. SANDFORD, Surgeon to the Worcester Infirmary, and others.

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1795.

CONSIDERATIONS

ON THE

MEDICINAL USE

AND ON THE

PRODUCTION

OF

EMOTIONS VIPS.

To Mr. WATT.

DEAR SIR,

YOU will probably be startled when you read your name on the page destined to dedication; but I cannot prevail upon myself to send these Considerations a second time abroad, without acknowledging my satisfaction in having had you for a fellow labourer. To establish a new department in Medicine, would have exceeded my single strength; and I do not know any person who could have afforded me such effectual assistance as you have done.

That the pneumatic practice is beginning to acquire the certainty of a genuine art, may be too bold a thing for me to assert; but if this should prove to be the case, I need not explain how much it is indebted to you for the rapidity of its progress, the means of judging being fully before the public. The zeal however with which you exerted your talents to do good, could be witnessed but by a few; and it is particularly incumbent on me to return thanks both to you and Mr. Boulton, *for so liberally consenting, at my earnest request, to manufacture your air-apparatus. The profits were never likely to requite any man—much less persons engaged in such extensive concerns—for the expence and vexation always occasioned by a new branch of business.*

Though you have succeeded so far as to enable any one, who chooses, to procure elastic fluids with perfect ease, and in the utmost abundance, I hope you will not entirely abandon the subject. By turning your thoughts to it from time to time, you will not fail to help us forward by some useful hint, or happy invention.

Of those members of the medical profession who have already made trial of factitious airs, the desire of certainty or the uneasiness of doubt would ensure the perseverance, even though they had met with no direct encouragement. Others will feel it their duty or interest to adopt the same practice. Nor will the sick or their friends be universally quieted by unmeaning objections or overawed by that authoritative tone which ignorance—and medical ignorance, more especially—is so apt to assume. Notwithstanding the times, a much more lively interest has been manifested by the public in this arduous undertaking than I could have expected. And should the pursuit, which I by no means apprehend, be abandoned here, it will be continued in other countries. I could prove by sufficient testimonies how favourably the proposal for the extensive employment of aeriform remedies, has been received in different parts of the civilized world. At present, I shall only remark, that a celebrated American physician is composing a work, to explain the most remarkable appearances of the yellow fever of PHILADELPHIA, *according to the principles stated in the following pages. Should his explanation be true to nature, the same principles will doubtless suggest effectual means for checking the ravages of this consuming disorder in future.*

No contingencies therefore, it should seem, can altogether put a premature end to these interesting researches. When the time for balancing success and failure shall arrive, the result, I trust, will not diminish the satisfaction you must have derived from cases within your certain knowledge.

I am, dear Sir,

Your's with sincere esteem,

THOMAS BEDDOES.

Clifton, March 30, 1795.

THE

THE former edition of this pamphlet, conſiſting of between 500 and 600 copies, appeared in the middle of October, 1794. The bookſellers had diſpoſed of moſt of the copies in a few weeks; and in leſs than four months a new impreſſion became neceſſary. As the Britiſh market for profeſſional publications is moſt diſcouragingly narrow, may not this briſk demand be regarded as the token of a riſing diſpoſition in mankind to take what belongs to their welfare into their own conſideration; and to emancipate themſelves ſtill further from the danger and ſervility of implicit confidence?--- Preſuming that the preſent edition will likewiſe fall into the hands of perſons, indifferent about medical literature in general, but anxious to form an opinion concerning the virtues of elaſtic fluids; I ſhall endeavour to obviate the effect of certain cavils, which will perhaps be urged with greater vehemence, as the projected improvement ſeems more likely to anſwer. In the paſt and preſent ſtate of medicine there are ſeveral circumſtances which may, in my opinion, be ſucceſsfully employed for this purpoſe.

I. Let the means by which alone it is poſſible for human ingenuity to improve this or any other art be firſt conſidered; and afterwards

the difficulties it has been neceſſary to ſurmount before the moſt powerful articles of the *Materia Medica* could be brought into train. To diſcover an efficacious method of adminiſtering quickſilver, without inflicting the moſt ſevere torture upon the patient, required the ſucceſſive efforts of many generations. Opium has been longer known and much more frequently exhibited; yet the number of thoſe, who underſtand its properties ſo as to employ it ſafely and with its full effect, is at this day incredibly ſmall. Nor would a ſtranger to the records of medicine ever conceive by what ſufferings and, to palliate nothing, by what ſacrifices our preſent knowledge of theſe two ſubſtances has been obtained. This is a melancholy retroſpect; but before you give way to your ſenſations, hear what the alternative would have been. We poſſeſs the moſt authentic documents; and from them we may collect that the number of miſerable lives and miſerable deaths would have been many million times greater, if our predeceſſors had not perſevered in their endeavours to maſter theſe active bodies. Such is univerſally the condition of human affairs; and the miſeries of the preſent age will work out the redemption of poſterity.

If you purſue this train of thought, you will, after ſome heſitation perhaps, be led to a concluſion oppoſite to that of the acute author of

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the work, entitled *Medicine pernicious to Society* (a); but if you limit the queſtion to the paſt and the preſent, and comprehend practitioners of all titles and of both ſexes, I dare not deny that for one pang that has been eaſed, an hundred have been inflicted; for one life that has been preſerved, twenty have been deſtroyed.

It would not therefore have been a ſufficient reaſon for abandoning elaſtic fluids in deſpair, if in caſes where there was no chance of other help, ſome ſuſpicious circumſtances had ariſen after their uſe.---They have however now been very frequently and largely adminiſtered; and ſometimes in a ſtate of debility but juſt compatible with life. My attention and enquiries have been particularly directed to bad conſequences. Yet I know only of three inſtances, where any inconvenience, more worth conſideration than the ordinary effect of an emetic, has been experienced. In the worſt of theſe I had the mortification to be concerned; it is the caſe of epileptic affection related in my *Collection of Letters*. The patient is now as before the inſpiration of the modified air; nor has any thing worth mentioning occurred in the mean time.-----Of the other caſes Dr. Carmichael gives an accurate report p. 69-72:

(a) Medecine nuiſible à la Societé; by Dr. Gilibert, a Medical Profeſſor of Montpellier.

There is not, I believe, the leaſt reaſon to ſuſpect that life has been ever once ſhortened in theſe attempts to relieve hopeleſs diſtreſs. Had ſuch an event fallen under my notice, I ſhould have deſcribed it as circumſtantially as the moſt brilliant cure. Of the obſervations I ſhould myſelf make, it was my original determination to relate ſuch as might inſpire caution rather than ſuch as might ſuggeſt too high expectations; and I ſuppoſe common ſenſe will dictate to every perſon in the ſame circumſtances the policy of watching and reporting effects in the character of an adverſary rather than of an advocate.

To imagine poſſibilities is one thing; to judge of realities is another. The imagination, I preſume, may very allowably range the unexplored receſſes of Nature in queſt of remedies for frequent and fatal diſorders. If any thing that appears capable of ſupplying ſo great a deſideratum ſhould occur, you muſt of neceſſity, in applying it to uſe, be guided by views or expectations, previous to direct experience. To frame analogical hypotheſes concerning the operation of untried agents (unleſs the hypotheſes be abſurd or contrary to well-eſtabliſhed facts) can, therefore, bring no man's judgment into queſtion, except with thoſe who feel it their intereſt to confound, or who want capacity to diſtinguiſh, things eſſentially different.

In

In the daily declamations againſt proceeding upon analogy in the practice of phyſic, there is ſo little meaning that the declaimers are continually endeavouring to avail themſelves of this reſource; they are only unconſcious of what paſſes in their own minds. But to adhere to ſpeculation in oppoſition to the evidence of experiment, is, I acknowledge, a degree of weakneſs, equal to the criminality of prevarication or direct falſhood, for the ſake of gaining a lucrative reputation. My coadjutors appear to have been actuated by the ſame ſentiments: and the impartial and intelligent may, I think, be ſafely challenged to determine how far their reaſonings are diſtinguiſhed by philoſophical ſcepticiſm, and their reports by the auſterity of truth.

In our clinical obſervations we muſt all be ſenſible that there is a degree of immaturity, which time only could remove. But it ſeems too obvious to require proof that the progreſs of the art and the advantage of patients are beſt conſulted by ſpeedy publication, provided the ſtatement of facts be accurate as far as it goes. This is certainly the quickeſt way of multiplying obſervers: and thus I expect the machinations of empirics and monopoliſts will be defeated.

II. No one will pretend that factitious airs are inert; and ſince they have been ſo freely uſed with ſo little injury, may we not ſafely perſevere, till their virtues be aſcertained? Is it too ſoon to conclude that the caution, at all times neceſſary in the practice of medicine, is ſufficient for the ſecurity of the ſick? and that any unfortunate event in future ought to be imputed to raſhneſs, to ignorance, or to one of thoſe miſtakes in conſequence of which the nobleſt remedies have ſometimes proved pernicious? It is beyond expectation fortunate that the time of natural death ſhould have in no inſtance coincided with the firſt adminiſtration of elaſtic fluids. For I ſaw Craft and Timidity, which formed a league to expel Peruvian bark from the ſhops, to oppoſe inoculation, and to decry the cool treatment of the ſmall-pox, ready to take advantage of any event that might bear an alarming interpretation.---- That ſo little oppoſition and ſo little pretext for oppoſition has ariſen, I impute to a variety of cauſes: to ſkill and care in individuals; to our ſuperior knowledge of the nature of animation; to inſtructive experiments upon animals; and, above all, to that power over inviſible and impalpable agents which we derive from mechanics and chemiſtry.

III.

III. By ſeveral who viewed this project with an evil eye, it was doubtleſs expected that it would be defeated by its own difficulty. But it has eſcaped this danger, and others, according to the courſe of medical tranſactions, await it. That which will ariſe from the following cauſe I regard as moſt to be dreaded. Unleſs the enemies to improvement ſacrifice their fees to their ſtubbornneſs, they will be compelled by the urgency of patients to employ the new method or to *make believe* they do. In what diſpoſition of mind they will ſet about the trial may be conceived by thoſe who recollect the occaſion on which the Jew in Shakſpeare demands

"On what compulſion muſt I, tell me that?"

Modern inſtances might eaſily be adduced where an active and well-recommended material has been preſented to the public, as unfit to be preſcribed, on the authority of caſes in which it had been converted by the enormity of the doſe into a poiſon. When factitious airs fall into the ſame hands, we ſhall, I dare ſay, be furniſhed with inſtances in plenty of their injurious effects; for I repeat what I have already taken ſome pains to inculcate, that like all efficacious remedies they are capable, when miſapplied, of producing the moſt fatal conſequences.

IV. Knowledge is never exact but when it involves abſolute or comparative quantity.

To perceive clearly in what eſtimation the general art of healing in its preſent condition deſerves to be held, we ſhould know

1. The number of caſes where it can effect a cure, though no ſpontaneous recovery would take place.

2. The number of caſes where we are helpleſs ſpectators.

3. The pain we can ſave patients whether ſpontaneous recovery will or will not take place.

Were theſe quantities aſcertained, the figures on the melancholy ſide of the account would, I fear, run tremendouſly high. But let us ſuppoſe that in a given diſtrict there are 10,000 patients, where the drugs in uſe can neither preſerve life, nor in any conſiderable degree mitigate pain. Of theſe 10,000 caſes let it be aſſumed that in 1000 or in half the number factitious airs are capable of re-eſtabliſhing health, and in 2000 others that they will prove better palliatives than we poſſeſſed before. That their efficacy will hold ſo high a proportion I by no means affirm; though facts ſeem to warrant very favourable expectations, and the ſignal virtues they have manifeſted in internal and external ulcerations, that is to ſay, in curing or relieving the moſt fatal and excruciating

ating of human maladies, is a moſt encouraging conſideration. But though their advantages ſhould require to be expreſſed in much lower terms, it is obvious that they may ſtill be an acquiſition to humanity ; and I have offered a numerical ſtatement merely to evince their value, if they ſhould prove ſerviceable in any ſpecies of diſeaſe, though they fail in all others. The habit of analyſing medical facts is ſo uncommon that the diffident and the uninformed might by a little management be led to infer general want of power from partial inefficacy. It was accordingly remarked to me by a phyſician, acquainted with the hiſtory of his art, the feelings of his brethren, and the ſpirit of the metropolis, " that ſome patients might poſſibly " be cured by breathing this or that air ; as " others are by ſwallowing this or that drug. " But the method, unleſs myſteriouſly practiſed, " cannot ſoon obtain credit ; perſons out of " the profeſſion are too indolent or ignorant to " concern themſelves about its pretenſions : it " appears troubleſome and would put the fa- " culty too much out of their way ; I think " therefore ſucceſs in twenty inſtances will not, " at preſent, be ſo likely to recommend it, as " one failure to bring it into diſcredit."----I acknowledge the ſhrewdneſs of theſe remarks ; and I am ſenſible that it is a thing of itſelf by no means deſirable *to put the faculty out of their way.*

way. But ſuperior conſiderations will eaſily occur; and it remains to be ſeen whether the public judgment, almoſt 200 years after the time of BACON, is ſo enfeebled by medical ſuperſtition, as to yield in a matter of ſuch moment to vague preſumptions and opinions of queſtionable origin.

To the former edition I prefixed a propoſal for a MEDICAL PNEUMATIC INSTITUTION. A *temporary* public eſtabliſhment might, I conceived, be ſo contrived as greatly to aſſiſt in deciding how far elaſtic fluids will be of ſervice in diſeaſes, which are a reproach to the art and mines of gold to its profeſſors.----Among the peculiar advantages of ſuch an inſtitution perſons of information appear to have been moſt ſtruck with the following. 1. To a complete trial of this practice it might be neceſſary to fill apartments with modified air: Even unfavourable concluſions ſhould be eſtabliſhed in ſuch a manner as to leave no regret behind; and perſons of enlarged views will, I ſuppoſe, aſſent to an obſervation of Mr. Thomas Wedgwood, "that it is worth while to expend "the ſpecified ſum in order to aſſure ourſelves "that elaſtic fluids will not be ſerviceable as "medicines." 2. It would be deſirable to have the means of applying this practice to animals ---as dogs and horſes---labouring under dangerous or fatal diſorders. 3. We might carry on

phyſiological

phyſiological inveſtigations of longer duration and greater extent than have ever yet been deviſed, with a view to diſcoveries, applicable to the practice of phyſic. 4. As all imaginable precautions would be taken to authenticate facts and give them publicity, a large quantity of matter for reflection, if not of knowledge immediately uſeful, would be thrown into circulation. 5. Obſervations on private patients may ſuggeſt modes of applying air, not eaſily practicable but in an appropriated building. 6. It may be expected that men of genius, having ſuch aſſurance that all reaſonable ſuggeſtions would be realiſed, would univerſally exert their inventive powers in behalf of humanity.

According to the common acceptation of the term *charity*, the propoſed inſtitution muſt be regarded as eſſentially different from ordinary charitable foundations. It is calculated for the benefit of the wealthy as well as of the indigent; in other words, to relieve the diſtreſs univerſally ariſing from the imperfect ſtate of medicine, and not from poverty in particular. It can ſcarce be ſuſpected as a private or party job; there are few individuals incapable of judging how far the undertaking is unneceſſary; for there are few who have not ſeen ſome friend tortured long or prematurely cut off by ſome diſorder, which has baffled the ſkill of thoſe in

whom

whom moſt confidence was placed, and from which they themſelves are furniſhed with no exemption.

The propoſal having been ſome months before the public, it may be expected that I ſhould ſay ſomething of its reception. It has incurred ridicule; that was in order. It has alſo been commended; indeed, if I may credit the reports of ſome correſpondents, and if *words* could procure workmen and materials, the preſent age might have conſecrated to humanity an edifice more ſplendid than the monuments of oriental ſuperſtition. Theſe commendations however might be mere civilities; but I can ſeriouſly affirm that no deſign has ever been ſanctioned by more reſpectable ſupport. The ſum at preſent ſubſcribed does not, I believe, exceed ſix hundred pounds. But among the ſubſcribers will be found a majority of the perſons, eminent in Great Britain and Ireland as improvers of medical and philoſophical ſcience. Their names ſhall ſpeedily be given to the public. But I think it due to departed worth to record on the preſent occaſion that the promotion of this deſign was among the laſt acts of the ingenious and public-ſpirited Mr. Wedgwood. In my former advertiſement I thought myſelf bound in juſtice to mention the liberality of Mr. William Reynolds, of Mr. Joſeph Reynolds,

Reynolds, and Mr. Yonge, ſurgeon, of Shifnal, Shropſhire. In 1792, when I pointed out the principles on which I imagined beneficial conſequences might reſult from the free uſe of elaſtic fluids as medicines, theſe perſons agreed with me to riſque a ſum not exceeding two hundred pounds each, in order to bring my conjectures to a proper trial. An apparatus was accordingly erected; an operator engaged, and in 1793 I made many of the following experiments. At the ſame time it was aſcertained that the practice might very ſafely be purſued: and a proſpect of advantage offered itſelf. Upon this firſt eſſay was expended no inconſiderable part of the ſum we had determined not to exceed.

I have obſerved of late certain expreſſions in print, from which ſtrangers to the real circumſtances might ſuppoſe that ſeveral other perſons had co-operated with me in attempting to improve Medicine, in conſequence of previous connexions in private life. But there has been in this proceeding nothing of narrow partiality towards an individual, nothing of colluſion or cabal. The real motives of thoſe who have ſtepped forward are ſo much more honourable to themſelves, and to the cauſe in which they engaged, that ſuch miſapprehenſion ought to be obviated. In truth, I have not even a perſonal acquaintance with the majority of thoſe

by

by whom I have been favoured with communications; nor had I the leaſt previous intimacy or correſpondence with any one among the number, excepting a phyſician eminent for the variety and energy of his talents; and our acquaintance was confined to an intercourſe of letters on ſubjects of medicine and philoſophy.

Advertiſing the propoſal and contributions in the London papers has been delayed longer than was intended. But the neceſſities of the poor during the late diſaſtrous ſeaſon were ſo urgent that it was thought the public would not pay much attention to other applications for ſubſcriptions. As ſoon as the contributions amount to fifteen hundred pounds, I ſhall propoſe to the ſubſcribers to proceed to the execution of the deſign, in hopes that the ſum, further neceſſary, will be afterwards raiſed.—I have ſometimes been aſked if it would not be better to defer the project till peace be reſtored? I think indeed that leſs difficulty would have been experienced in time of peace; but I have thought it not improper to reply by another queſtion: *If you admit the propriety of the measure at any time, should a nation like this defer a plan, requiring for its execution no more than* 3 *or* 4000l. *and calculated to rescue multitudes from suffering and death? Can you suspend the progress of disease, till you are at leisure from the pressing concerns of the war to contribute*

your

your mite towards the alleviation of diſtreſs, which is gnawing the boſom of innumerable families? Beſides, where is our ſecurity, that at the ceſſation of hoſtilities or ſhortly afterwards, we ſhall be better able or more willing than at preſent to execute ſchemes of beneficence? And would it not be a cauſe of juſt regret if we ſhould ſuffer to paſs away ſo noble an opportunity of deſerving well of mankind, at ſuch a trifling coſt?

The following Bankers in London have obligingly agreed to receive Subſcriptions for the Medical Pneumatic Inſtitution: Meſſrs. Coutts and Co. Sir J. Eſdaile and Co. Meſſrs. Pybus and Co. Meſſrs. Ranſom and Co. Meſſ. Smith, Payne, and Co. Meſſ. Staples and Co. ----Sir Benj. Hammett, Alexander Anderſon, Eſq. and John Grant, Eſq. have conſented to hold the money ſubſcribed, as Truſtees, till the execution of the deſign commences.

PART I.

EXPERIMENTS, CAUTIONS, *and* CASES, tending to illuſtrate the medicinal uſe of FACTITIOUS AIRS, and of other ſubſtances, of which the application to Medicine has been ſuggeſted by modern philoſophical diſcoveries.

I.—*Of the Atmoſphere.*

IT is proved, by ſatisfactory experiments, that the inferior region of the atmoſphere conſiſts of two kinds of air, quite diſtinct in many properties. One is the kind called VITAL, DEPHLOGISTICATED, or OXYGENE AIR, and by a variety of names beſides. The other has been named AZOTIC, PHLOGISTICATED, FOUL, or BAD AIR. Where the lower atmoſphere is not altered by the breathing of animals, the burning of fuel, by exhalations from ſubterraneous chemical proceſſes or putrefying ſubſtances, and ſuch local cauſes, if you confine and examine an hundred cubic inches, you will find twenty-ſeven or twenty-eight to be oxygene, and the remaining ſeventy-two or ſeventy-three azotic

air. The manner in which air may be analyſed, is deſcribed in the writings of Dr. Prieſtley, Mr. Scheele, Mr. Cavendiſh, and Mr. Lavoiſier. Theſe authors explain much of the nature of oxygene and azotic air. A candle burns in a veſſel full of oxygene air with dazzling brilliancy, and is conſumed with great rapidity. This air unites with various ſubſtances, and turns them ſour, as beer and milk. Blood taken from a vein is of a dark or livid colour; oxygene makes it bright, florid or ruddy. You may ſee this difference by breaking a clot of blood that has ſtood a little time in the air; the ſurface will be crimſon, the inſide dark, and the dark part, now become the ſurface, will turn ruddy, though covered with ſerum. When black blood is put into azotic air, it does not become ruddy. Azotic air extinguiſhes flame, does not burn when mixed, or in contact with common air, and is not abſorbed by lime-water.

Near the earth, theſe two airs are found mixed with ſurpriſing exactneſs. Take a cubic foot from ten different places, and you will find that a little more than a quarter of each is oxygene; the reſt azotic air. There is often likewiſe found a little carbonic acid air, as one part in an hundred, though no fires burn, or animals breathe near.—The nice balance of attraction between the two conſtituent parts of the atmoſphere, deſerves notice. Theſe two ſubſtances, when cloſely united, form nitrous acid: If, therefore, they were not, by ſome circumſtances, prevented from uniting cloſely, all the oxygene, with part of the azote, would be changed into an highly corroſive acid, and the

waters

waters of our globe would be converted into *aqua fortis*. Again, azotic is lighter than oxygene air; if, therefore, they had not ſome attraction, they might ſeparate, and any animals, that ſhould be immerſed in an atmoſphere of azotic air, would almoſt inſtantly expire: The undiluted oxygene remaining below, would, as we ſhall preſently ſee, occaſion violent diſeaſes in man, as well in many other animals.

II.—*Of the breathing of man and ſimilar animals.*

Fix a pipe to a bladder full of air, and, holding your noſtrils, breathe the air for ſome time, and your diſtreſſed feelings will inform you that it is no longer fit for breathing. If you transfer this breathed air into an inverted glaſs jar full of water, and turn up the jar ſo as to keep in the air, and admit none from the atmoſphere, you will find that it extinguiſhes a candle, and deſtroys the life of a ſmall animal, dipped into it. If you procure another quantity of ſuch air, and add to it a little more than one fourth of oxygene air, a candle will burn in it juſt as in the atmoſphere; and you may breathe it as long as ſo much freſh air, though it is not exactly the ſame; for it contains, after being breathed, ſome fixed or carbonic acid air, either thrown out from the blood, or formed in the lungs. Theſe experiments indicate, that breathing renders common air unfit for ſupporting life or flame, by depriving it of oxygene. Various other experiments ſhew further that this is the caſe. The blood, before it paſſes through the lungs, is dark; after paſſing, it is florid; dark blood in a bladder, expoſed to the atmoſphere, becomes florid ſuperficially; and in breathing, the blood

and air are only ſeparated by membranes not unlike a bladder. When dark blood is introduced into veſſels containing oxygene or common air, the blood becomes ruddy, and the air is reduced in quantity. Hence it appears, that the blood conſtantly drinks up a portion of the oxygene air received into the lungs; and from various conſiderations I conclude that it is conſumed in the contraction of the muſcles, and in the formation of ſeveral fluids, ſecreted from the blood; for the blood, after traverſing the body, comes back to the lungs dark, or without the oxygene, which it received in paſſing through them. In ſaying that this principle is *conſumed*, I mean no more than that it enters into new combinations; quitting the blood and muſcular fibres, and forming perhaps an ingredient in thoſe ſalts which the bones and fluids are found to contain.—It has been calculated, that, an healthy man requires about five cubic feet of air, or $1\frac{1}{2}$ cubic feet nearly of oxygene air, every hour.

So much is premiſed to render the following experiments and ſpeculations intelligible to ſome readers. —They will find more in Dr. Goodwin's *connection of life with reſpiration*, Mr. Coleman's *diſſertation on ſuſpended reſpiration*, Dr. Menzies' *Tentamen de reſpiratione* (*Annales de Chimie*, 1791, p. 211), in my three publications on the propriety of employing elaſtic fluids in various diſorders, and the chemical authors already quoted.

It appears that the ſkin imbibes and exhales air. It will imbibe various kinds; but, as it is found in equal times to take in three or four times as much oxygene

air

air as any other, it probably ſelects oxygene alone from the atmoſphere. Some philoſophers ſuppoſe the human ſpecies to have exiſted in a monkey ſtate; would the hair then ſo much prevent the cutaneous abſorption of oxygene as the cloaths at preſent?—From theſe experiments it has been alſo conjectured that immerſion of the naked body or limbs in different airs might cure diſeaſes. See Dr. Ewart on Cancer, Dilly, London. Monthly Review for November, 1794, p. 301.

III.—*Though the proportion of oxygene in the atmoſphere may be beſt adapted to the average ſtate of health, may the proportion not be ſmaller than is beneficial in ſome diſorders, and larger than in others?*

Conſiderate perſons will, I conceive, reply, that this is probable. I have made many experiments on animals, to illuſtrate the effect of atmoſpheres of various conſtitutions. I ſhould have made more, had I not been abſent from England, or otherwiſe occupied for a good part of the laſt 12 months. No inveſtigation of greater importance or extent, can be imagined. This is only a rude beginning. Others will aſſiſt in continuing the enquiry.

IV.—*The effect of breathing oxygene air little diluted.*

Dr. Prieſtley and Mr. Lavoiſier found animals either to die, or to become exceedingly ill in ſuch air, while it continues more oxygenated than the atmoſphere, and will ſupport the life of other animals. It is not then defect, but exceſs of oxygene, that is pernicious here. The heart and arteries pulſate more quickly and forcibly; the eyes grow red and ſeem to pro-

trude; the heat of the body is ſaid conſiderably to increaſe (a), ſweat to break out over the whole body, and fatal mortification of the lungs to come on. Theſe appearances denote violent inflammation: animals have always appeared to me to ſuffer extremely, ſoon after immerſion in unmixed oxygene air. The human ſpecies, I think, will be found to vary as widely in the manner in which this elaſtic fluid affects various individuals as in any quality whatſoever. Some, I have obſerved, not to be very ſenſibly affected by it when reſpired pure. To my own lungs, it feels like ardent ſpirits applied to the palate; and I have often thought I could not ſurvive the inſpiration of oxygene air as it is driven from manganeſe by heat many minutes. The production of inflammation is fully eſtabliſhed by diſſection, as others have found, and as appeared from the following experiment:—A large kitten was kept ſeventeen hours in a veſſel containing ſeveral cubic feet of air from manganeſe, of which about eighty parts in an hundred might be oxygene. This, and another kitten of nearly the ſame ſize, which had lived as uſual, were then diſſected in my preſence, by Mr. Guillemard, of St. John's College, Oxford, who immediately made the following minute of the appearances:—"The lungs were of a florid red colour in the "oxygenated kitten (A); in the other (B), they were "pale; the difference was very ſtriking, both in the "inflated and uninflated ſtate; the edge of one lobe "in A was marked with livid ſpots (as in mortifi-"cation). The pleura was likewiſe evidently inflamed. "The heart in A was of a florid red colour. The "liver,

(a) Girtanner Antiphlogiſtiſche Chemie, p. 263.

" liver, kidneys, ſpleen, and blood-veſſels of the me-
" ſentery and urinary bladder, were of a brightiſh red
" colour. In B, the heart was of a deepiſh colour.
" The liver, ſpleen, kidneys, and blood-veſſels in ge-
" neral, were of a bluiſh or purple colour. Both kit-
" tens had been ſucceſſively killed by immerſion under
" water. Upon opening the head of A, there was no
" appearance of inflammation.—The blood veſſels had
" rather a florid colour; but there was no ſign of ex-
" travaſation, or more than the uſual quantity of blood.
" In B, on raiſing the ſkull, there appeared a quantity
" of blood between the bones and the membranes of
" the brain, of which the blood-veſſels were turgid
" with dark-coloured blood.

" In A, the heart readily obeyed the ſtimulus of prick-
" ing: The ſpontaneous contractions of the right au-
" ricle and ventricle were frequent; they continued
" with little diminution of frequency and force for
" above half an hour. In about an hour, they had
" wholly ceaſed.

" In B, the irritability of the heart was at firſt equi-
" vocal. On opening the pericardium half an hour
" after the ſternum had been removed, the motions of
" the heart became very viſible; they continued more
" than an hour after the firſt expoſure of the contents
" of the thorax."

The univerſally diffuſed florid colour in A was par-
ticularly ſtriking; So was the dulneſs of one heart at
firſt, and the vivacity of the other: Of the latter, I
believe the ſpontaneous pulſations were in all many

times more frequent and forcible; though this circumſtance deſerves more particular examination than we beſtowed upon it. The kitten (A) had eaten ſome time after being put into the reſervoir, as appeared from food introduced at the ſame time. The air ſeemed to have ſuffered little diminution either in quantity or quality: The reaſon will appear from a ſubſequent experiment. On cutting the wind-pipe of A to blow up the lungs, a good deal of viſcid mucus flowed out. This was occaſioned by ſtrong action continued for ſome time, and was not ſeen in any thing like the ſame degree in B.

V.—*Experiments to aſcertain the condition of the venous blood in animals made to reſpire oxygene air.*

On comparing the experiments made upon blood out of the body, I was formerly uncertain what might be expected to be the effect of hyper-oxygenation of the ſyſtem upon the colour and other qualities of the venous blood. (See my Obſervations on conſumption.) Many ſubſtances, containing oxygene, brighten venous blood, but oxygenated marine acid, according to ſeveral foreign chemiſts of reputation, has an oppoſite effect. Mr. Guillemarde and myſelf often noticed the dark appearance of the veins in animals charged with oxygene, and of the blood they diſcharged when wounded. To inveſtigate this point more particularly, one of two equal half-grown rabbits was kept fifteen minutes in a mixture of three parts of oxygene air from heated manganeſe, and one part of atmoſpheric air. Both were killed by blows on the back of the head, and opened nearly at the ſame time. This experiment

periment was made in the preſence of Mr. William Clayfield, and Mr. Bowles, Surgeon, of Briſtol. In the oxygenated rabbit neither the *vena cava* itſelf, nor blood taken from it, appeared leſs dark-coloured; we thought (but were not certain) that it was rather more ſo. The blood of the oxygenated rabbit coagulated much more rapidly. The liver alſo was of a much leſs dark colour in this rabbit.

The blood of both gained its uſual florid colour on ſtanding expoſed to the air.

EXPERIMENT 2.—Of two equal and nearly full-grown rabbits, one was kept a quarter of an hour in undiluted oxygene air, prepared as before. Both were then killed and opened, as before, by Mr. Bowles. In the oxygenated the following were the appearances. The veins were certainly not of a lighter colour, nor the blood. A quantity from the *vena cava* of both rabbits was received in tea-cups. When it was ſpread thin on the ſides of the veſſel, we thought the oxygenated blood had a purple or claret colour, which was not perceptible in the other; Mr. Bowles likewiſe thought its general appearance rather darker; its coagulation, as in the former experiment, was more ſpeedy: and the coagulum, as I thought on examination afterwards, was firmer.—The liver was leſs dark.

On the margin of the lungs in the oxygenated rabbit, we obſerved florid ſpots in ſhape and ſituation like thoſe I had formerly ſeen on the lungs of animals long confined in oxygene air; and which I take to be points of inflammation.

We obſerved ſigns of much ſtronger irritability in the right auricle and ventricle, in the diaphragm and the

the intercoſtal muſcles of the oxygenated rabbit. They continued longer too in this. But conſidering the force and frequency of the contractions, the quantity of action would have been greater in the oxygenated, had the irritability continued five times as long in the other.

Theſe phænomena made me wiſh for an opportunity of oxygenating animals of large ſize, as horſes, and of drawing blood from their veins and arteries both before and afterwards. Such a train of experiments would form a very intereſting ſupplement to Mr. Hunter's reſearches concerning the *general principles of the blood. (See his Treatiſe on the blood, inflammation, and gun-ſhot wounds, p.* 11—100.) The ſpeedier coagulation of the oxygenated venous blood I think remarkable, and as it happened in three experiments, it probably was not accidental. The more vigorous action of the oxygenated muſcles too deſerves to be compared by a courſe of experiments with the tendency of oxygenated blood to coagulate ſooner. Several perſons, of whom all did not know the one rabbit from the other, found the boiled fleſh of the oxygenated, in both caſes, more ſtringy, harder, and leſs juicy. The difference was moſt ſenſible in the young pair. The greater ſtringineſs was apparent on both theſe occaſions to the eye.

We obſerved that the rabbits drank repeatedly during their confinement in oxygene air. The latter had been watered a ſhort time before; I could not learn whether the former had or not. Perhaps this thirſt (if ſuch it was) depends on the excitement produced.

The

The concluſion directly deducible from theſe experiments, is, that the blood parts with that exceſs of oxygene upon which its florid colour depends, before it gets into the large veins, or indeed into any of the viſible veins. The altered colour of the ſolids ſhews where the oxygene remains. But as we can never get to the end of our phyſiological enquiries, a further problem may be propoſed:—" If the oxygenation be " continued very long, will not the ſolids be ſo " highly charged as to be able to take no more oxy- " gene from the arterial blood? and will it not paſs " florid into the veins?"—If this does not happen, there muſt be ſome contrivance in the ſyſtem to throw this principle perpetually from the ſolids. Thoſe who do not think that oxygene combines with the blood during reſpiration, have only to change the terms of my concluſion. The fact remains.

VI.—*Experiments with air, containing ſomewhat more oxygene than the atmoſphere.*

In my letter to Dr. Darwin, I conjectured " that if " before immerſion divers were to breathe air of an " higher than the ordinary ſtandard, they would be able " to continue longer under water," (p. 13). I made ſeveral experiments to determine whether this ſuppoſition was juſt; in each two animals of the ſame litter were employed; and as ſeveral ſpectators were ſometimes preſent, they were deſired to fix upon the weakeſt for oxygenation. The following report I literally tranſcribe from my journal, as it was ſettled and ſubſcribed by the ſpectators: " Auguſt 20th, 1793. " Kitten C was placed in a mixture of nearly two- " thirds oxygene air from manganeſe, and one-third atmoſpheric

" atmoſpheric air; it was kept twenty minutes in the " veſſel, which was from time to time ſupplied with " oxygene air, ſo as to keep the air better than atmo- " ſpheric air; which was known by dipping a candle " into it, and obſerving that it burned with a brighter " flame. At the expiration of the twenty minutes, C " and D, which latter had breathed atmoſpheric air, " were immerſed in water till perfect aſphyxia came " on. At the inſtant they were taken out, there ap- " peared in both a motion of the lower jaw; C began " ſenſibly to recover, while D lay as dead: In a mi- " nute and half, C roſe, and began to walk about the " room, ſtaggering at firſt, D being ſtill motionleſs or " nearly ſo; in this ſtate it continued for fifteen mi- " nutes, when, for the firſt time, it raiſed itſelf, and " immediately afterwards fell on its ſide.

" Christopher Machell.
" Richard Lovell Edgeworth.
" J. Guillemard.
" Jas. Sadler.
" Thomas Beddoes.

" Kitten D died the next day."

Of many ſimilar experiments, it is ſufficient to obſerve, that the reſult was always in ſome degree the ſame; ſometimes the unoxygenated animal failed to recover; it was generally noticed that the oxygenated ſhewed ſigns of life under water the longeſt; and ſometimes that it ſtruggled as much as ever after its unoxygenated fellow had ceaſed to move. Thus, in an experiment (September 28) a whelp, which had reſpired atmoſpheric mixed with one-third of oxygene air for thirty-four minutes, is regiſtered to have been as much alive as before immerſion under water, another puppy

of

of the ſame litter unprepared, and immerſed at the ſame time, having become motionleſs. Theſe facts illuſtrate the query concerning divers. To obviate any miſtake from difference of conſtitution, the experiment was ſometimes repeated upon the ſame pair of animals, one being oxygenated one day, and the other the next, or the day following. The water in which they were drowned, was ſometimes heated to the temperature of the body.

But as unequal quantities of liquid have been found to get down the wind-pipe of drowning animals, it ſeemed proper to repeat the experiment in another manner.—Accordingly, of two greyhound puppies of the ſame litter, ten days old, E the weaker was kept an hour and fifty minutes in a mixture of two-thirds of atmoſpheric air, and one-third of oxygene air from heated manganeſe. F was left as uſual: Both were then immerſed in hydrogene air. F ſoon appeared much agitated, and expreſſed much uneaſineſs. E moved very little, and ſoon placed itſelf in the couchant poſture, with the head between the fore-legs and the muzzle reſting on the bottom of the veſſel. In five minutes, F was lying on its ſide, now and then breathing, which it did leſs and leſs frequently and more feebly. In ten minutes, this effort was ſcarce perceptible: In two minutes more, it was not once repeated. For the laſt ſix out of the twelve minutes, E was ſo perfectly ſtill, that we were diſpoſed to believe it dead; and a perſon preſent ſaid, "this experiment will turn out ill for oxygene." During theſe laſt ſix minutes, E had not inſpired at all; and from the firſt, the reſpiration was very infrequent.

At

At the end of the twelve minutes, both puppies were taken out of the hydrogene air; E immediately cried and ſtruggled, F being quite motionleſs. They were laid before a fire; E cried, moved, and ſoon walked as uſual; F ſeeming quite dead. In ſixteen minutes, a ſtream of oxygene air was blown into F's mouth, but no ſign of life appeared. The animal was afterwards opened; upon irritating the pericardium with a pointed knife, ſo as to preſs upon the heart, no movement followed; the pericardium being removed, the heart began to contract ſpontaneouſly; a ſtream of oxygene air being directed upon the heart, its action became more ſtrong and frequent; the number of ſtrokes was about ſeventy in a minute. The colour of the heart (probably from the filling of its own blood veſſels) changed from pale to red. The difference of colour in the tongues of theſe puppies was ſtriking, after the experiment, even by candle light, that of E being much more ruddy. The following variation ſeems worth tranſcribing from the journal: Of two puppies of the ſame litter, the weaker G was kept in atmoſpheric air mixed with one-third oxygene, and H for an equal time in atmoſpheric air with one-third hydrogene. Both were plunged into tepid water. H became motionleſs, while G moved with force, cried on being taken out, and ſeemed little affected.

The effect of oxygene air was very ſtriking in recovering H. It began to move, and reſpire the moment it was put into a veſſel containing this air.

It was ſometimes obſerved, that the movements of very young puppies under water, did not entirely ceaſe in leſs than fifteen minutes.

VII.—*Neceſſity of oxygene air to muſcular exertion.*

The blood in the veins is dark; in the arteries it is bright. When the reſpiration is ſtraitened, the arterial blood becomes darker; when acceſs of oxygene air is prevented, all the blood becomes dark. In drowned and ſtrangled perſons, the face, lips, the ſkin under the nails, and ſome other parts, are of a violet or dark blue colour. Here the blood can receive no oxygene.—There are a number of caſes on record, where, from bad conformation of the heart and adjacent great blood veſſels, part of the blood only traverſed the lungs; the reſt paſſed into the arteries again in the dark diſoxygenated ſtate in which it returns from the veins. Such perſons are always blue or livid. They are extremely feeble; in walking, are ſometimes obliged to ſtop every third ſtep, nor can they make any exertion of the muſcles without inſtant panting and wearineſs. They commonly die ſuddenly; you will find an account of ſuch individuals in *the Commentaries of the Inſtitution at Bologna*. Vol. 6, p. 64. *Philoſoph. Tranſactions*, vol. 55, p. 72. *Medical Obſervations and Enquiries*, vol. 6, in my *Medical Obſerv.* p. 62. *Abernethy's Surgical Eſſays*, part 2.—Perſons ill of ſea-ſcurvy, often drop down dead in making a ſudden effort, and from ſurprize. There is reaſon to believe, that either living in confined air, or on ſalted food, occaſions a deficiency of oxygene in the fluids and ſolids.

Hence, if a perſon were to keep quite ſtill, a given quantity of air ſhould ſerve him to breathe longer than if he exerted himſelf. Thus ſhould any perſons find themſelves again in the ſituation of Mr. Holwell and

his

his fellow-ſufferers in the Black-hole priſon at Calcutta, their beſt chance of ſurviving would probably be to forbear vehement ſtruggles. The fever of the ſurvivors appears to have been occaſioned by the great ſtimulating power of freſh air, and of the ſenſations their eſcape muſt have occaſioned.

The following experiments render probable the expenditure of oxygene in muſcular exertion. They do not, however, abſolutely prove this poſition; nor did their immediate reſult appear to me ſo certain as of my other experiments. Of two half-grown kittens of the ſame litter, one was teazed tō make efforts for half an hour, and then put into an air-tight veſſel, in which it lived 48 minutes; the other lived 56 m. in the ſame veſſel; it would require more ſuch cruel experiments to decide whether ſpeedier death here aroſe from previous conſumption of oxygene by ſtrong muſcular action, and the ſubſequent neceſſity of a ſupply. It ſhould be obſerved, that the firſt animal was not reſpiring more deeply than the ſecond, at the time they were incloſed.

The following fact is remarkable, and countenances, but does not rigorouſly prove, the hypotheſis. A grown cat was incloſed in an air-tight glaſs veſſel. She immediately became furious to a degree beyond what I ever obſerved in any animal under experiment. The violent agitation continued for 20 minutes. In 5 minutes more—25 minutes in all—ſhe appeared dead; ſhe was left in the veſſel two minutes longer, and proved to be quite dead. A lighted candle was immediately extinguiſhed on being introduced into the veſſel.

Into the ſame veſſel another cat of the ſame ſize and age nearly, to which a ſmall glaſs of white wine had been given half an hour before, was introduced. This cat ſat almoſt perfectly ſtill during the whole experiment. It lived 47 minutes, or nearly twice as long as the other.

In order to vary the experiment, half a glaſs of ſherry was given to a kitten nearly grown. It was *immediately* put into the ſame receiver; and ſet to *ſtruggle very violently*. It ſoon appeared to reſpire with difficulty. In 15 minutes the reſpirations were 98 or 100 in a minute. It did not reſpire after the 34th minute, and in 2 minutes more was taken out inſenſible.

A fellow kitten, no way prepared, was placed in the ſame receiver, and remained *very tranquil* for above a quarter of an hour; its reſpiration was never ſo frequent as that of the former; and it raiſed its head and breathed at the end of 41 minutes.

We have then

	Minutes.	Minutes.
An haraſſed kitten living	48	Difference 8.
Its fellow, not previouſly harraſſed,	56	
A grown cat not prepared, but furiouſly agitated, - - -	25	Difference 22.
Another perfectly tranquil, having drank wine, - - -	47	
A large kitten immediately after wine, and violent, - -	34	Difference 7.
Its fellow tranquil without wine,	41	

In theſe ſix experiments the ſame veſſel, that is, the ſame quantity of air, was uſed. It may be ſaid, by a

perſon unuſed to accuracy of terms, " no wonder the moſt exhauſted animals ſhould periſh ſooneſt." By conſidering a moment, he will perceive, that it is deſirable to know preciſely in what this exhauſtion conſiſts. I formerly conjectured that oxygene is conſumed faſter by an animal under the firſt operation of wine or other ſuch ſtimulants; and Dr. Withering afterwards adduced the experience of Mr. Spalding in confirmation of this conjecture. It is not ſo eaſy to make the experiment upon animals; the efforts of ſome under confinement being ſo much more violent than of others. The laſt experiment was made with a view to this queſtion, but the two preceding incline me to refer ſpeedier death in this inſtance to the violent ſtruggles, rather than to the wine.

VIII.—*Another comparative experiment with an Animal charged with oxygene.*

Of two half-grown rabbits (K and L) of the ſame brood, colour, ſize, and apparent ſtrength, K was put into a large reſervoir containing atmoſpheric air with a little oxygene. After ſome hours it was taken out, and placed for an hour longer in a mixture of nearly equal parts of oxygene and atmoſpheric air. It did not ſeem to ſuffer in its reſpiration; K and L, which latter had remained at large in the ſame apartment, were then incloſed in a veſſel, and placed in a freezing mixture. In 20 minutes ſome of the cold brine was poured upon the bottom of the veſſel in which the rabbits were: in 30 minutes L ſeemed affected, in 45 was ſcarce alive, and in 55 was quite lifeleſs, and frozen ſtiff. K ſeemed ſufficiently lively, only its feet were frozen ſtiff. They were dipped in cold water, and the animal recovered perfectly. I obſerved many convulſions and much tremor of the limbs during recovery.

very. It was between 8 and 9 o'clock in the evening when the rabbits were taken out of the veſſel. K, by 12, had recovered the uſe of its forelegs, and being left not far from a dying fire within the fender, was found in the morning running about the room, when it eat cabbage leaves freely. It was kept alive for a week, when the legs appeared diſeaſed from too quick application of heat at firſt.

The experiment being repeated without admitting liquor into the receiver, the reſult was ſimilar. Would opium and wine enable an animal to reſiſt the freezing mixture, as oxygene does?

IX.—*Experiments with oxygene and other airs, largely diſtributed through the cellular ſubſtance.*

Dr. Maxwell, aſſiſted by Dr. Goodwyn and ſome other friends of accuracy and genius, forced different airs under the ſkin of animals, whence every perſon in any degree acquainted with anatomy, knows they would inſinuate themſelves far and wide through the body, in conſequence of the free communication between different portions of the cellular ſubſtance.—I. 4½ pints of *atmoſpherical air* were forced under the ſkin of a bitch, weighing 20lb. the inciſion was cloſed by a ſuture: the animal appeared uneaſy and indiſpoſed for 36 hours; the puffing did not begin to ſubſide before the 9th day; on the 20th, no air was left except a little about the lower part of the belly.—II. 3 pints of air, in which a light had burned out, were forced under the ſkin of a dog weighing 13lb. For ſome hours the animal appeared ſtupid. The emphyſema or puffing ſeemed to decreaſe during the 3d

day; on the 16th convulſions came on and frequently returned; on the 20th the dog died, much debilitated. In three other experiments nearly the ſame phænomena were obſerved.—III. 4 pints of oxygene air were infuſed in the ſame manner into another dog; ſlight uneaſineſs was obſerved for the firſt hour, and afterwards the animal appeared exceedingly lively *(maxima alacritas)*. Next day the emphyſema began to leſſen; by the 10th all the air was abſorbed. In another dog of 19lb. $3\frac{1}{2}$ pints of this air diſappeared in 8 days; in a third of 21lb. 3 pints in 8 days; in a 4th of 20lb. 3 pints nearly in 7 days. The 2d and 3d were affected as the firſt dog; the 4th was in no way affected. —IV. Carbonic acid air was infuſed into ſeveral dogs and rabbits. A large quantity (as much as 2 pints in a dog of 17lb.) diſappeared during the operation; the reſt was gradually abſorbed in 4—14 days. No inconvenience followed, except in one caſe where a pint of air infuſed into a rabbit 3 months old, occaſioned uneaſineſs from diſtention; but even here the animal eat with a good appetite in half an hour. The inſtantaneous diſappearance of ſo much air in theſe experiments, was probably owing to its combination with the moiſture in the cellular ſubſtance.—Inflammable air (from metallic ſolutions, I ſuppoſe) occaſioned heavineſs and ſhivering in two dogs; 3 pints in one, $2\frac{1}{2}$ in the other. Some detumeſcence was obſerved on the 4th day in both; in 13 days the air was all gone in the 1ſt, and in the 2d in 9 days.—VI. $2\frac{1}{2}$ pints of nitrous air were infuſed into a dog of 28lb. It howled as if in exquiſite pain: in 15 minutes it ſtaggered as if drunk; then convulſions came on, and vomiting with involuntary excretions. In 30 minutes it lay enfeebled on the ground, making deep and laborious

rious inſpirations, in 54½ it died, the convulſions continuing to the laſt.—The heart had all its cavities full, and was quite inirritable. The lungs were of a pale ſaffron colour, and ſhewed no veſtige of red blood. Brain in a natural ſtate. In another experiment 1½ pint of nitrous air produced the ſame effects, and death in 45 minutes. In neither caſe were the external muſcles inirritable. Rabbits died juſt as theſe dogs, and the ſmell of nitrous acid was perceived when the lungs were inflated and left to collapſe. In this theſis (Edinburgh 1787) Dr. Maxwell relates other experiments, in which airs were thrown into the blood-veſſels. By one (p. 22) he ſhews that elaſtic fluids do not prove fatal till they get into the cavities of the heart. But as theſe latter experiments ſuggeſt no concluſion concerning the medicinal power of elaſtic fluids, I need not conſider them at preſent. Mr. Achard of Berlin, was the firſt who publiſhed experiments with different airs injected into the cellular membrane. But Mr. Achard is a writer whom you can ſeldom quote with confidence.

X.—*Experiments with hydrogene and other mephitic airs.*

Dr. Prieſtley, (*Exp. on Air, N. Ed.* I. 229), ſays, " Inflammable air kills animals as ſuddenly as fixed " air, and as far as can be perceived, in the ſame " manner, throwing them into convulſions, and there- " by occaſioning preſent death." Dr. Prieſtley does not ſay how he aſcertained the former part of this aſſertion, and I apprehend, it will be found erroneous, if it regard pure hydrogene. Mr. Scheele could make 20 inſpirations without inconvenience; and I have ſeen ſeveral perſons breathe ſtill oftener from a tube

through which a current of this air ſet, their noſtrils not being cloſed (*Letter to Dr. Darwin, p.* 44). Hence I concluded that this bland air might with impunity be breathed unmixed, longer than any other mephitic air, except perhaps azotic. Dr. Macdonald of Belfaſt, whoſe abilities and ſkill in phyſiological reſearches muſt be well remembered by all who ſtudied medicine at Edinburgh ten years ago, confirms me in this opinion. "I have tried, (he informs me in a letter dated Auguſt 13, 1794), "hydrogen air in five pulmonary caſes, in "two of which it had a very ſudden and a very fa- "vourable influence. In one of the others the "meaſles ſupervened upon phthiſis, and ſeemed to "decreaſe the firſt diſeaſe.—My patients ſometimes "reſpired hydrogen air for a minute and half at a "time; the more frequently they repeated the expe- "riment, the more eaſy did it become; but after 15 or "20 inſpirations I always obſerved the face to grow "dark and livid. I am aſtoniſhed at the length of "time which man can breathe, and animals live in, "hydrogen air."

Dr. Gilby of Birmingham noted the following appearances, and immediately afterwards drew out this minute.

"*Hydrogene Air.*"

"A mouſe immerſed in hydrogene air—from wa- "ter and heated malleable iron—continued 30 ſeconds "without ſhewing any mark of diſtreſs; reſpiration "then became laborious; one minute 33 ſeconds "from the time of immerſion it inſpired: but it "moved no more, and when taken out, proved to be "quite dead.

"*Fixed,*

" *Fixed, or Carbonic acid Air.*"

" Another mouſe, immerſed in this air, was inſtantly " affected; and in 15 ſeconds was completely dead." A young wood pigeon, in hydrogene air, ceaſed to gape and move in 2 minutes 35 ſeconds. For 10 or 15 ſeconds it did not appear incommoded. Its fellow, in carbonic acid air, ceaſed to gape and move in 43 ſeconds. It ſhewed diſtreſs inſtantly on immerſion.

Very young animals do not drown ſo ſoon as old.— Imagining, therefore, that young animals would afford a more ſenſible ſcale on which to meaſure the power of different mephitic airs to extinguiſh life, I made the following experiment. A puppy, four days old, was put into a veſſel of hydrogene air from heated iron and water. It ceaſed to breathe and move twenty two minutes afterwards.—Another puppy, of the ſame litter, was put into carbonic acid gas: it ceaſed to breathe and move in one minute and an half.—Comparative experiments of this kind require repetition; two apparently ſimilar animals may be tenacious of life in different degrees, from cauſes not yet diſcovered; moreover, if immediately before immerſion, one ſhould have inſpired, and the other expired, this might occaſion a wrong inference: nor ſhould dependence be placed on a ſlight difference. By keeping animals, ſeemingly equal, in different unreſpirable airs, till all appearances of life in one or the other had ceaſed; then taking the ſurvivor out, ſuffering it to recover, and after ſome days drowning it again in that air in which its fellow had periſhed before, I hoped to determine this queſtion certainly for the ſubjects of experiment, and by analogy for all animals of the ſame claſs.

Accordingly, three rabbits of the ſame litter, ſeven weeks old, nearly half grown, and weighing one pound and an half each, were ſucceſſively immerſed in three different kinds of air. Dr. Gilby being preſent at this experiment alſo, noted the appearances at the moment they occurred.

EXPERIMENT I.—RABBIT X.

" *In hydrogene from water and heated malleable iron.*

	Minutes,	Seconds, after immerſion.	
" In	1	20	Moved about, in appearance little diſtreſſed.
	1	50	Began to breathe ſhort.
	2	0	Viſibly diſtreſſed.
	4	15	Much agitated.
	7	0	Taken out, breathing very ſhort and thick.
" In leſs than	17	0	Completely recovered.
" In	40	0	(that is, as ſoon as food was offered) began to eat.

" EXPERIMENT II.—RABBIT P.

" *In hydrocarbonate air from hot charcoal and water, twice paſſed through water.*

	Minutes.	Seconds.	
" In	0	25	Breathed ſhort, diſtreſſed.
	0	35	Violently agitated, continued ſo 15 ſeconds; inſpired at long intervals for ſome ſeconds: ſcarce alive.

" After

	Minutes.	Seconds.	
" After	1	30	No inſpiration or movement ſeen.
" In	4	0	Taken out for dead—did not recover.

" EXPERIMENT III.—RABBIT Q.

" *In carbonic acid air, from heated chalk.*"

	Minutes,	Seconds, after immerſion.	
"	0	20	Strongly convulſed.
	0	35	Gaſped at intervals.
	0	49	Has continued gaſping.
	1	0	Nearly dead.
	1	15	Quite dead.
	2	0	Taken out, perfectly inanimate, did not recover.

EXPERIMENT IV.—RABBIT R.

At the time of making theſe experiments I had not pure azotic air at command, and had neglected to uſe it when I had; the following obſervation makes it highly probable, that this air is not more ſuddenly deleterious than hydrogene. A candle having burned out in a veſſel full of atmoſpheric air in contact with lime water, a very ſmall kitten (about 14 days old) was put into the ſame portion of air; after the death of this kitten, which did not happen in leſs than 3 hours,

hours, the fellow of the three preceding rabbits was introduced; the following were the appearances:

Minutes.

1 Breath ſhort—turns round.
3 In no great diſtreſs, breath ſhort.
5 The ſame.
7 Breath ſhorter.
10 Reſpiration apparently more laborious.
12 Taken out—very ſoon recovered—a candle plunged into the veſſel was immediately extinguiſhed.

EXPERIMENT V.—RABBIT X *again, at the interval of ſeveral days in hydrogene air.*

Min.	*Sec.*	
——	——	At firſt very tranquil.
2	0	Snuffs for air round the ſide of the veſſel.
4	0	Reclined almoſt on its ſide.
5	30	Breathes thick—very weak.
6	10	Taken out, breathing thick.
7	10	Could ſit.
8	0	Could move, tho' ſtill weak.
9	30	As uſual.

EXPERIMENT VI.—RABBIT X *a third time.*

At the interval of two days—recent hydrocarbonate, prepared without ſuperfluous ſteam.

——	——	Diſtreſſed the moment of immerſion.

Min.

Min.	*Sec.*	
0	20	Scratched the veſſel furiouſly.
0	25	Fell on its ſide.
0	35	Motionleſs and inſenſible—taken out.
——	——	Lay as dead ſome time; finally recovered.

Another rabbit of the ſame brood, (before immerſion in water, viſibly much affected with fear) ſtruggled with ſtrength for a minute and an half. At the end of two minutes, forty ſeconds, it moved; in three minutes was taken out, but did not recover.

Should theſe experiments be repeated by a perſon, careful to procure his elaſtic fluids free from offenſive acid fumes, the diſtinctneſs of the phænomena I obſerved, perſuades me that their general reſult will be confirmed. Of ſome readers, whom the importance of the ſubject may lead to take up this pamphlet, the curioſity will, I fear, be repreſſed by ſenſations, ariſing from the idea of pain endured by the animals. In a few caſes, the torture which was inflicted was exceedingly repugnant to my own feelings; and for this reaſon, I have left one ſeries of experiments (SECT. vii.) more incompleat than I could eaſily have rendered it. Againſt drowning, an imputation of cruelty will hardly lie: Animals, deſtined to this death, may juſt as well drown for the inſtruction of the phyſician. Beſides, did not accuſtomed acts of outrage and injuſtice daily paſs uncenſured, I know not how he who feeds upon the fleſh of a ſlaughtered animal can conſiſtently condemn

demn inveſtigations, ſeriouſly tending to reſtore or preſerve health, though conducted at the expence of the life and eaſe of animals, unable to reſiſt the power of man. I wiſh, with all my heart, I could prove that moroſe writer in the wrong, who has called the Earth A VAST FIELD OF BATTLE, where creature, for preſervation, preys upon creature, or tortures its fellow in purſuit of pleaſure.

Two kittens immerſed, one in carbonic acid, the other in hydrogene air, afforded a ſimilar reſult; that is, the carbonic acid appeared full three times as deleterious as hydrogene.

Finally, to render the difference again more diſtinct, two equal quantities of atmoſpheric, were ſucceſſively mixed with an equal bulk of carbonic acid, and of hydrogene, air. A rabbit (S) being put into the mixture of atmoſpheric and carbonic acid air; the following obſervations were made.

	Minutes.	
In	2	Appeared weak.
	4	Has been couchant for 2 minutes.
	6	Very ſtill.
	11	Reſpiration more laborious.
	26	Extremely weak; ſeems ready to fall on one ſide; ſcarce alive.
	43	Quite dead.—After the 2d minute it never roſe—death very lingering.

A fellow rabbit, T, in atmoſpheric and hydrogene air, ſeemed much leſs diſtreſſed at firſt; rubbed its fore-feet after it had continued in the veſſel 40 minutes,

nutes, and performed ſeveral other actions; much of the time it ſat, that is, it continued erect before. Even at the laſt, no diſtreſs, except quick reſpiration, was obſervable.

In 48 minutes it was taken out; it now ſtood firm; and though unwilling to move; was capable, when urged forward, of advancing, without ſtaggering, or any ſign of great debility. In appearance it had ſuffered leſs in 48 than its fellow in 15 minutes.

XI.—*How hydrocarbonate air affects venous blood.*

Two fowls were ſtrangled and a rabbit was drowned while their fellows were immerſed in hydrocarbonate air. In all theſe laſt the veins appeared of a brightiſh red colour! the liver and heart (which was perfectly irritable) were alſo of a bright colour. In the others the liver was dark as uſual; and the heart pale. In the hydrocarbonated rabbit the fleſh was univerſally of a light lively red. The blood from the *vena cava* had the ſame brightneſs; it coagulated about as ſoon as the livid blood of the ſtrangled fowls and drowned rabbit. The boiled fleſh of all the fowls had much the ſame taſte and toughneſs. The muſcles of the lower extremities of the hydrocarbonated fowls were of a lively red. The boiled fleſh of the h. rabbit had a pink hue.—Of two equal fowls one was put into hydrocarbonate and one into carbonic acid air; the former was ruddy throughout, as was well ſeen in the heart cut acroſs. In the fowl put into c. acid air nothing of this bright red colour appeared. The liver I thought paler than in ſtrangled fowls: but I had not one at hand for immediate compariſon. Of this laſt h. fowl the wings and breaſt were brown, and the thighs reddiſh.

XII.—*Reflections*

XII.—*Reflections on the preceding facts.*

The attentive reader muſt have ſeen, even in the reſult of theſe ſimple extemporaneous experiments, indubitable proofs of the power of factitious airs variouſly to affect the living frame. It appears that oxygene air, when inſpired pure, or nearly ſo, increaſes the motions ſo as to produce dangerous or mortal inflammation ; that by reddening the blood, it brightens the colour of the ſolid parts ; even that of the liver, which anatomy ſhews to be the leaſt likely of all the ſolids to be affected by any change of the arterial blood : that it renders animals leſs capable of being drowned or deſtroyed by cold ; that it is expended in muſcular motion, ſince animals that have exerted themſelves violently, immediately before confinement in a given quantity of atmoſpheric air, or during confinement, ſooneſt exhauſt it of oxygene ; and that, when it is blown into dogs, in the manner veal is blown up by butchers, it produces a remarkable degree of vivacity. Theſe facts, compared with ſome of the obſervations, which will be given in the next paragraph, will prove of uſe in directing us how to apply this air properly as a remedy ; eſpecially as they will appear to have been confirmed ſince their firſt publication by obſervations on the ſick.

Between unreſpirable airs, there ſeems a remarkable difference in their power to produce inſenſibility and death. Hydrogene appears the leaſt noxious, both when inſpired alone, or mixed with atmoſpheric air. Azote probably differs little from hydrogene. Hydrocarbonate ſeems extremely deleterious ; Mr. Watt gives evidence of this in the human ſpecies. I can add a ſimilar obſervation. A perſon in con-

firmed

firmed conſumption breathed a quantity of hydrocarbonate, mixed with 4 times its bulk of atmoſpheric air: he became very ſick, or rather vertiginous; the pulſe was much quickened, and the extremities became very cold. The patient finding an abatement of pain in his ſide, and of dyſpnoea, returned for another doſe. The operator, a chemiſt of great ſkill, thinking the former doſe too ſtrong, mixed 50 c. inches of hydrocarbonate with 600 of atmoſpheric air. This was reſpired without any ſenſible effect. In a quarter of an hour, 100 c. i. of hydrocarbonate were mixed with 600 of atmoſpheric air. The patient breathed at twice about two-thirds of this mixture, when he was deſired to deſiſt. Soon afterwards he became vertiginous and nearly inſenſible, his pulſe at one period being nearly imperceptible; the ſphincter of the bladder was relaxed; after his recovery, he was again very cold—" intenſely cold to his own feelings" was his expreſſion—as well as to the touch. After getting into his carriage, he fainted; and his pulſe for ſeveral hours continued quicker and weaker than before. The operator having obſerved, that when much water is added to red-hot charcoal, carbonic acid air is copiouſly produced, in the preparation of this laſt portion of air, had added ſo little water, that no ſuperfluous ſteam at all came over; hence it was as pure as can be made: being alſo newly prepared, it retained all the charcoal it had carried up; of which it is well known to depoſit part on ſtanding. This might lead to conjecture, that the greater deleterious power of heavy inflammable air from water and hot charcoal (hydrocarbonate) compared with that of light inflammable air, depends on

the

the facility of its combination, or at leaſt of the charcoal it contains with the oxygene of the blood; in conſequence of which, it ſpeedily diſarms the ſyſtem of its moving principle. This opinion ſeems countenanced by the effect of nitrous air, which more quickly deſtroys life than any of thoſe above-mentioned, and which is well-known very readily to combine with oxygene. Death, in this caſe, might be more inſtantaneous, from the inſtantaneous production of an highly corroſive acid (nitrous acid) and its application to the whole ſurface of the lungs. But for the rapid effect of carbonic acid air, and the appearances in XI I can aſſign no plauſible reaſon; nor does the above hypotheſis ſuit the facts in XI; which with thoſe in X refute thoſe eminent philoſophers, who have of late ſuppoſed that water and ſeveral bland unreſpirable airs occaſion death, ſimply by excluſion of the oxygene of the atmoſphere. Their action is certainly unequal; and I preſume, recovery from aſphyxia in water (when but little goes down the wind-pipe), hydrogene air, azote, or from ſtrangulation (where no material organic injury is produced), will be much more eaſy than from aſphyxia, occaſioned by other unreſpirable mediums.

Experiments to diſcover the effects of the long continued action of aeri-form ſubſtances, would be much more curious than ſuch as I have made. They would thus, in all probability, more deeply and permanently affect the living ſyſtem. If, for inſtance, an animal were kept in an atmoſphere containing $\frac{20}{100}$ $\frac{24}{100}$ of oxygene or ſtill leſs, it would perhaps be affected by the ſea-ſcurvy. The muſcular fibres, at leaſt, and the ſolids in general would in all probability be found weak,

tender

tender, or eaſy to be torn. Again, if three equal growing animals were kept, one in the atmoſphere, the other in air of an higher, the third of a lower, ſtandard, and in all other reſpects treated alike; ſome conſiderable difference would perhaps be obſerved in their growth and vigour.—By frequent immerſion in water, the aſſociation between the movements of the heart and lungs might perhaps be diſſolved; and an animal be inured to live commodiouſly for any time under water. If ſome plan, ſimilar to that which I have ventured to propoſe, ſhould be executed, ſuch proceſſes of inveſtigation ought to be carried on in the Inſtitution.

XIII.—*Some effects of the inſpiration of hydrogene, to elucidate the reſult of the foregoing experiments.*

"When an animal is immerſed in water, *his pulſe becomes weak and frequent*, he feels an anxiety about his breaſt, and ſtruggles to relieve it: in theſe ſtruggles, he riſes towards the ſurface of the water, and throws out a quantity of air from his lungs. After this, *his anxiety increaſes, his pulſe becomes weaker;* the ſtruggles are renewed with more violence; he riſes towards the ſurface again; throws out more air from his lungs, and makes ſeveral efforts to inſpire; and in ſome of theſe efforts, a quantity of water commonly paſſes into his mouth; *his ſkin then becomes blue, particularly about the face and lips; his pulſe gradually ceaſes; the ſphincters are relaxed;* he falls down without ſenſation, and without motion." (*Dr. Goodwyn, l. c. pp* 3, 4.) This deſcription of drowning in water applies, as far as the circumſtances admit of compariſon, to the effects occaſioned by the reſpiration of pure hydrogene. I have remarked them in a num-

ber of healthy perſons, who were curious to try how long they could breathe this air. The frequency and debility of pulſe, blueneſs of the lips and coloured parts of the ſkin, were always obſervable in a minute, or a minute and an half. Beſides, dizzineſs was felt, and the eyes have grown dim; in animals, the tranſparent cornea has appeared ſunk and ſhrivelled. Several individuals agree in deſcribing the incipient inſenſibility as highly agreeable. One conſumptive perſon loved to indulge in it; for this purpoſe, contrary to my judgment, he uſed to inſpire a cubic foot of hydrogene at a time. This quantity moſt commonly produced little change in his feelings. Sometimes it brought on almoſt compleat aſphyxia. During this proceſs, I have felt the pulſe nearly obliterated. Afterwards, as he recovered, it was ſenſibly fuller, and ſtronger than before the inſpiration. This fact belongs to a general principle now beginning to be underſtood; when the ordinary powers have been, for a certain time, withheld from the body, they act with greater effect, as holding the fingers to the fire after handling ſnow, occaſions ſevere aching. For this reaſon, whenever air with leſs oxygene is to be inſpired, it would ſeem more advantageous to employ for a long time an atmoſphere little reduced, than one ſo low that it can only be breathed for a ſhort time.

An obſervation the patient juſt mentioned made upon himſelf, ſeems to ſhew the neceſſity of oxygene to muſcular action. Judging from his feelings, that he was perfectly recruited after his doſe of pure hydrogene, he has riſen from his ſopha with an intention to walk about his apartment, but has been ſurpriſed on riſing, to find himſelf incapable of advancing three

ſteps,

ſteps, till he had reſted ſome time longer. In this caſe, was not the ſtore of looſely combined oxygene, laid in before, expended during the inſpiration of the hydrogene, by thoſe motions which are perpetually going on in the ſyſtem? Did it not require ſome time to replace the neceſſary portion in the muſcles, remote from the heart and lungs?

XIV.—*Some particulars relative to oxygene, ſupplemental to the preceding experiments.*

The celebrated Dr. Ingenhouſz in a letter dated Auguſt 4th, 1794, mentions to me a very curious experiment, "which," ſays he, "if it be a real fact, "throws a great deal of light upon your ſyſtem; it is "this:—Bliſter your finger, ſo as to lay bare the na- "ked and ſenſible ſkin. The contact of air will pro- "duce pain: put your finger into vital air, and this "will give more pain; introduce it into fixed or azo- "tic air, and the pain will diminiſh or ceaſe." Dr. Webſter, he adds, was informed of theſe circumſtances, by a Frenchman, whoſe name does not appear; I had often heard them indiſtinctly related; and it is rather ſurpriſing that the fact has not been aſcertained. Much of the art of modern ſurgery conſiſts in keeping the air from wounds and ſome kinds of ulcers: and this fact, if the account be true, pretty deciſively ſhews which ingredient of the atmoſphere is injurious.

I applied a bliſter an inch long, and half an inch broad, to the back of the third finger of the left hand. When the pain from the action of the cantharides had entirely ceaſed, I cut away the ſcarf-ſkin of the veſication; and was ſenſible, the moment the air was admitted, of a ſharp ſmarting pain. This did not continue

ſo ſevere ; but the expoſed true ſkin ſenſibly ſmarted. Upon tying the neck of a bladder, containing carbonic acid air from heated chalk, round the root of the finger, the pain very ſoon ſubſided. While I kept my finger in carbonic acid air, which was near half an hour, I ſhould not have known it had received any injury. On taking it out, the ſurface had a whitiſh appearance—Was this from the beginning of the formation of epidermis ?—In the air—the experiment was made in a warm temperature—the ſmarting returned ; in an hour the expoſed ſkin was painful and looked angry, as the expreſſion is : I again encloſed it in carbonic acid air ; in ſix minutes I felt no more pain. After ſeveral hours I again removed the bladder, and ſoon felt the ſmarting return.

During the hour after my finger had been for the firſt time taken out of the bladder, I had introduced it into a phial of oxygene air, for a few minutes, but was not ſenſible of increaſe of pain ; nor can I ſay that the redneſs and angry appearance was owing to this circumſtance.

The following experiments were made on three different perſons :—1. The raiſed epidermis of a bliſtered finger, after all action of the cantharides had ceaſed, was cut away in carbonic acid air. No pain was felt. The atmoſpheric air ſlowly mixed with the other in the glaſs cylinder, as I found by the dull manner in which a candle after ſome minutes burned in it ; and now ſome ſlight pain was felt. The finger being put into oxygene air, a ſmarting came on, and laſted 20 minutes ; but then became leſs. The finger was next put into air containing alkaline fumes ; and the pain was much ſeverer than ever.—2. A ſecond

bliſter

bliſter being opened in the air, ſmarting pain came on. In a bladder of fixed air it ſoon went off.—3. The epidermis was cut off from a bliſter on my own finger, which I inſtantly plunged into oxygene air; it felt as when ſalt is ſprinkled on a cut: and the pain was, I am pretty ſure, more ſevere than when my former bliſter was opened in the atmoſphere. In carbonic acid air the pain in two minutes quite ſubſided, and returned when I expoſed the bare ſkin to the atmoſphere.

At Oxford, in 1790, I had propoſed to a diſtreſſed negro, to try to whiten part of his ſkin with oxygenated marine acid air. He was to exhibit the appearance, if it ſhould be curious, for the relief of his family. His arm was introduced into a large jar full of this air, and the back of his fingers lay in ſome water impregnated with it at the bottom of the veſſel. It was perceived that he had ulcerations from the itch between his fingers; and this made me very cautious about the experiments. In 12 minutes he complained of ſevere pain from the ulcers, and the arm was withdrawn. The back of his fingers had acquired an appearance as if white lead paint had been laid upon them, but this did not prove permanent. A lock of his hair was whitened by this acid.—Next day the ulcers became extremely painful, and the hand ſwelled from the inflammation; this deterred him from a continuance of the experiment after he was cured of his complaint. You cannot ſafely impute the effect of this powerfully ſtimulating acid to its oxygene alone.

But the fact ſtated by Dr. Ingenhouſz is very agreeable to the common phænomena preſented by wounds. Moreover, I have lately ſeen cancerous patients treated by the application of unreſpirable air, with the moſt

 aſtoniſhing

aſtoniſhing ſucceſs. In mentioning to Dr. Black the introduction of factitious airs into the BATH hoſpital, as a ſource of hope, I did not ſo ſoon expect an event which ages and nations have deſired in vain. Obſervations, extremely analogous to the experiments juſt related, were there made during the courſe of the treatment. See Dr. Ewart's pamphlet. Should it be invidiouſly obſerved by any reader of his narrative, that ſomething ſimilar had been tried before, it may be truly replied, that theſe trials were rather diſcouragements to the new application of elaſtic fluids; and that failure in former inſtances enhances the merit of the recent method. Mr. Magellan's caſe ſeems never to have been much known in England.

It ſeems not improbable, that on certain ill-conditioned ulcers, oxygene externally applied has a ſalutary effect, by occaſioning greater action, both of the veſſels which throw out the copious thin diſcharge, and of the abſorbents. Many ſubſtances, uſually applied to ſuch ulcers with ſucceſs, as metallic ſalts, contain much oxygene, and ſome are moſt highly charged with this principle, as the red oxyds of metals. The following intelligence, if authentic, adds confirmation to this opinion, and may prove uſeful. A few months ago, I was ſtruck with the frequency of ſcrophulous tumours among the poor of the county of Longford, in Ireland. Suppoſing that neceſſity might have occaſioned the trial of many methods of cure, I enquired whether the people there had not ſome peculiar domeſtic practices in ſuch complaints. A phyſician referred me to a ſimple but very reputable old farmer, as remarkably ſucceſsful in ſcrophulous ſores. With this perſon I had an interview. In his practice, he had no view to gain; and that, in his principles, he had nothing of empirical impoſture, he convinced me,

by

by at once diſcloſing his whole ſecret. He had himſelf, many years ago, an ulceration of the ſubmaxillary glands : This, after various unſucceſsful applications, was healed by a ruſtic practitioner like himſelf. He obtained a knowledge of the remedy, by which, during a long life, he aſſured me he had himſelf healed many ſuch ulcers of the glands about the jaws. He was ſo little ſpeculative, as never to have attempted the cure of an obſtinate ſore in any other ſeat. That he might effectually inſtruct me, he brought ſpecimens of his ſimples. They were the leaves and ſtalks of wood-ſorrel (*oxalis acetoſella*), and the root of meadow-ſweet (*ſpiraea ulmaria*). The ſorrel he prepares by wrapping it in a cabbage leaf, and macerating it by its own juices in warm peat aſhes. This pulp is applied as a poultice to the ulcer, and left 24 hours ; the application of ſorrel is four times repeated ; then the roots of the meadow ſweet, bruiſed and mixed with the ſour head or efflorescence that appears on butter-milk, left in the churn, are uſed in the ſame manner till the ſore heals, which I was told always ſpeedily happens ; often in two or three weeks.

The following extract of a letter from Mr. Edgeworth of Edgeworthſtown, contains ſome ſupplementary information, and will probably add ſo much to the credit of my information, as to obtain a trial for the remedy.

" I have learned from Mr. Mills, that when he was about eight and twenty, he had two large ſcrophulous ſwellings in his neck, one under each ear, near the jaw ; the marks they had left he ſhewed me. He was attended by a ſurgeon in the neighbourhood for ſome weeks, without receiving any benefit. A farmer, with

whom he was acquainted, recommended the application he mentioned to you, by which he was completely cured. The man told him the names and quantities of the ſeveral ingredients, when he applied them, but did not till ſome years afterwards (when he was leaving this country for America) apprize him that the *myſtery of the cure* (this was his expreſſion) depends entirely upon the ſorrel. This perſon had predicted to Mills, that one of the ſores, which had been lanced, would not heal ſo ſoon as that which had ſuppurated of itſelf; and he found this to be true. Whilſt he had ſcrophulous ſwellings, he was weak and unhealthy; from the time the wounds were healed, he has been ſtrong and active; he is now eighty; and whilſt he was relating theſe circumſtances to me this evening, he kept pace with my horſe up hill for half a mile, without any apparent effort. I mention this, becauſe it is a common opinion (I ſuppoſe a vulgar error) that healing ſuch ſores is prejudicial to the general health. He has applied this remedy to upwards of an hundred different perſons, every one of whom have been cured.—Seven years ago I remember having ſeen his ſon, who rents a conſiderable farm from me, with an enormous ſcrophulous ſwelling on his neck; he was in great pain, was weak, and emaciated; he was too impatient to wait for a ſuppuration of the ſwelling, and would have the plaiſter applied to it whilſt it was unbroken: the cure was protracted, but it was effectual; he has had no return of the complaint; a ſlight inequality of ſurface ſtill remains on his neck; Mr. Mills has communicated his recipe to ſeveral, and in particular to a very intelligent perſon in this neighbourhood, who has employed it with unfailing ſucceſs. All the patients complain of the ſeverity of the application;

cation; and in every ulcer to which it is applied, there takes place a remarkable change from a dead pale to a bright ſcarlet colour." *July* 17, 1794.

This change of colour indicates communication of oxygene, which perhaps the oxalic acid of the ſorrel contains in ſuch a ſtate of combination as eaſily to part with a portion. Now Dr. Darwin, in his ZOONOMIA, attributes ſcrophulous ſwellings of the glands to inirratibility, which, as I have conjectured, may ariſe from a certain deficiency of oxygene. Theſe principles would ſupply an obvious theory, were we but certain of our facts. If however, as the preceding account implies, ſorrel produces detumeſcence of the glands before ſuppuration, its application will be, I ſuppoſe, a more eligible practice than any now in uſe. Writers in the Materia Medica may have applied *deobſtruent*—their word of courſe—to this plant, but I remember no particular commemoration of its virtue in ſcrophula. Murray, a compiler of extenſive reading, has nothing to this purpoſe.—(*Apparat. Medicam.* III. 492-9).

XV.—*Of the preparation of atmoſpheres of different ſtandards.*

Perſpicuity in the directions, which cannot for all readers be attained in *reaſonings*, being a principal object in the preſent pamphlet, it may be uſeful, before I proceed, to exhibit a view of thoſe mixtures which furniſh atmoſpheres of an higher or lower ſtandard, than the common air. By *an higher ſtandard*, I mean more than 28 parts of oxygene in 100; by *a lower ſtandard*, leſs. For the ſake of brevity, we might

ſay,

ſay, *air of the ſtandard of thirty-ſix*, inſtead of "air containing thirty-ſix parts of oxygene in an hundred parts."

Mr. Watt's hydraulic bellows furniſh the means of throwing any proportions you pleaſe of the different airs into the common reſervoir. I have found a ſmall ſpare hydraulic bellows—of the contents of a gallon for inſtance—highly uſeful in adjuſting the proportion of atmoſpheric air. It may be larger; but when ſmall, it is very *handy*. The effect, as far as can be ever uſeful in practice, is ſhewn in the following tables:

Change of the ſtandard of atmoſpheric air, by addition of other airs.

The ſtandard of atmoſpheric air being 28 oxygene, 72 azote, it is altered in this manner, by the addition of ſucceſſive equal parts of atmoſpheric to one of oxygene: Small fractions are neglected.

	Oxygene.	*Azotic.*
1 part of atmoſpheric to 1 of oxygene	64	36
2 of atm. to do.	52	48
3 do. to do.	46	54
4 do. to do.	42	58
5 do. to do.	40	60
6 do. to do.	38	62
7 do. to do.	37	63
8 do. to do.	36	64
9 do. to do.	35	65
10 do. to do.	$34\frac{1}{2}$	$65\frac{1}{2}$
11 do. to do.	34	66
19 do. to do.	$30\frac{1}{2}$	$69\frac{1}{2}$

The

The ſtandard is altered in the following manner, by addition of ſucceſſive equal parts of oxygene to one of atmoſpheric air:

		Oxygene.	*Azotic.*
2 oxygene - -	to 1 atmoſpheric	76 -	24
3 oxygene - -	to do. - -	81 -	19
4 do. - -	to do. - -	85 -	15
5 do. - -	to do. - -	88 -	12

Reſpecting theſe two tables, it is to be obſerved, that the moſt ſkilful chemiſts have never been able to obtain oxygene air quite pure; it may therefore be allowed, that in ſuch as will commonly be prepared, not more than 85 parts in 100 will be pure oxygene; unleſs it be prepared from good manganeſe and rectified vitriolic acid; of this, waſhed in lime-water, not 10 parts in 100 will be unreſpirable. The unreſpirable air, with tolerable care, will be obtained free from oxygene. The following proportions, therefore, will be more exact than the foregoing:

Effect of the addition of different portions of atmoſpheric to one of unreſpirable air.

		Oxygene.	*Unreſpir.*
1 atmoſpheric -	to 1 unreſpirable	14 -	86
2 do. - -	to do. - -	19 -	81
3 do. - -	to do. - -	21 -	79
4 do. - -	to do. - -	22 -	78
5 do. - -	to do. - -	23 -	77
6 do. - -	to do. - -	24 -	76
7 do. - -	to do. - -	24 -	76
8 do. - -	to do. - -	25 -	75
9 do. - -	to do. - -	25 -	75
10 do. - -	to do. - -	$25\frac{1}{2}$ -	$74\frac{1}{2}$

Effect

Effect of the addition of different portions of unreſpirable airs to one of atmoſpheric.

1 atmoſpheric	-	to 2 unreſpirable	9	-	91
1 do.	-	to 3 do.	7	-	93
1 do.	- -	to 4 do.	$5\frac{1}{2}$	-	$94\frac{1}{4}$
1 do.	- -	to 5 do.	5	-	95

XVI.—*Of the method of procuring elaſtic fluids.*

To procure a doſe of factitious air by means of Mr. Watt's apparatus will, I think, be found more eaſy than to dreſs a joint of meat. In ſeveral inſtances under my eye, a ſervant of plain underſtanding has managed the apparatus perfectly: in one a maid ſervant has proved quite equal to the taſk. When inexperienced operators have failed, it has been from ſetting the water to drop before the charge in the furnace was red-hot, or letting it drop too faſt afterwards. Hence they get ſteam inſtead of air. When the joints are made tight, and the heat is proper, and the water does not drop too faſt, the operation proceeds perfectly. Mr. Watt gives a ſufficient variety of lutes. A ſtrip of oiled ſilk bound faſt round a joint, alone makes a good lute; ſo does a ſtrip of bladder.

I was for ſome time anxious concerning oxygene air. Expecting this would be full as extenſively uſeful in medicine, as any unreſpirable air, I wiſhed for a method equally ſimple of procuring it. The manganeſe from the Mendip hills gives 1. azotic, 2. oxygene, 3. azotic with carbonic acid air; ſo that the whole product is not much ſuperior to the atmoſphere. I feared leſt it ſhould be found difficult to catch the beſt part of the produce. At the ſuggeſtion of Mr. Hermbſtaedt and Mr. Chaptal I turned my attention to the

ſolution

ſolution of manganeſe in vitriolic acid. Mr. Hermbſtaedt had found a pound of either the Ilefeld or Ilmenau manganeſe, with ſtrong vitriolic acid, to yield 3384 cubic inches of "the beſt oxygene air."—(*Harmbſtaedt's Verſuche*, B. II. p. 49.) Mr. Chaptal obtained full as much from French manganeſe. I procured 150---200 c. i. of oxygene air (which by the nitrous teſt proved excellent) from oil of vitriol and 1 oz. Exeter manganeſe. But when I came to make experiments with a view to diſcover a proper method for common practice, I perceived that this proceſs was highly objectionable. The firſt portions of air procured by means of the oil of vitriol of commerce contained much oxygenated marine acid air—a ſpecies of elaſtic fluid exceedingly deleterious and irritating to the lungs. This happened becauſe ordinary oil of vitriol is contaminated with muriatic acid. Beſides, as the acid of vitriol will itſelf be carried up by the heat neceſſary to extricate the air by this operation, the veſſels will ſuffer from corroſion, unleſs troubleſome precautions are employed. The air itſelf too will not eaſily be totally freed from the pernicious acid fumes. Hence, contrary to my firſt intention, I ſhall omit directions for procuring oxygene air from oil of vitriol and manganeſe; they are fortunately become unneceſſary, ſince Mr. Watt's apparatus anſwers incomparably for this alſo, according to his laſt directions. Exeter manganeſe is in no reſpect preferable to any other, that does not contain much calcareous earth, or ſome noxious mineral, which latter is not the caſe with any manganeſe I know. To impregnate hydrogene air with zinc, I have thought it ſufficient to put a few ounces of zinc (which in the ſhops is called *ſpeltre*) into the pot, the reſt of the charge being of iron.

It

It may be well to ſuffer oxygene air to ſtand ſome hours before it is uſed, that it may depoſit the ſuſpended particles of manganeſe; which however, as far as I have ſeen or heard, have never been in the ſmalleſt degree hurtful.—As to the hydro-carbonate, I fully agree with a very judicious correſpondent, that it will be moſt powerful when freſh.

As there can be no reaſonable doubt but the ulcers of the lungs were healed by air from chalk and acids in the caſe of the lady deſcribed by Dr. Ewart, and as other reſpectable obſervers have ſeen the ſymptoms of conſumption alleviated by the ſame practice, I have added to this edition the figure of an apparatus for effervefcing mixtures, leſs objectionable in one reſpect than I remember to have ſeen deſcribed. It may be uſed as an auxiliary to Mr. Watt's apparatus, but ought in no caſe to be depended on alone. The lower veſſel B, *fig.* 1, *pl.* 4, is to contain vitriolic acid or ſpirit of ſalt (muriatic acid) and chalk for carbonic acid air; and either acid with zinc for hydrogene air. The former of theſe mixtures foams much; and the apparatus ſhould be placed on a large pewter diſh. The oil of vitriol ſhould be mixed with 16 or 20 times its bulk of water; and the chalk ſhould be pounded and made into ſauſages with water. The veſſel ſhould be filled only to a 4th or 5th part of its height with the materials. It may be made to hold from three to five gallons. Into the ſmall bucket C of the capital may be put ſpirits of hartſhorn to the depth of an inch, the bucket itſelf being four inches deep. The fumes of the ſpirit of hartſhorn will arreſt the acid ſpray, and prevent its paſſing down the long tube. The capital A is to be ſet in the groove at the top of the veſſel B,

which

which is to be filled with water. This groove ſhould be more than an inch deep. The tube may then be turned towards the patient's face. Spirit of ſalt diluted juſt enough to diſſolve the chalk with moderate briſkneſs is better than vitriolic acid for a continued efferveſcence; but it is more expenſive; for this acid the chalk need only be broken into lumps of the ſize of a walnut. The ſpirit of hartſhorn ſhould be renewed whenever it has conſiderably loſt of its pungent ſmell.

If hydrogene air be wanted, the veſſel B may be filled to a greater height, becauſe the ingredients do not foam ſo much. The oil of vitriol in this caſe is not to be ſo much diluted; from 5 to 7 times its bulk of water is ſufficient. But it may always be tried in a glaſs with a bit of zinc beforehand. You will eaſily judge whether your mixture wants acid or the other material according as it begins to act anew when you add a little of one or the other. If you drop in a roll of chalk, for inſtance, and no hiſſing is perceived, it wants acid. The whole apparatus ſhould be japanned, and the inſide alſo be anointed with melted bees wax. I have directed, when it could be done, that the vitriolic acid and water ſhould be boiled together. The management of this apparatus is troubleſome, as of every other where you want a continued efferveſcence. In pouring theſe acids from veſſel to veſſel, it is difficult to avoid ſome ſplaſhing, by which holes will be burned in the cloaths. The fumes of muriatic acid ſoon ſpoil poliſhed iron furniture.

XVII.—*Caſes in which oxygene air was inſpired.*

The cleareſt directions for the uſe of factitious airs in medicine will be afforded by a faithful account of the

effects

effects they have been already found to produce. I ſhall therefore diſpoſe the clinical obſervations I have to lay before the reader in the beſt order I can deviſe. To theſe obſervations I ſhall ſubjoin a brief recapitulation; in hopes it may furniſh a more preciſe idea of the progreſs already made, and contribute towards the accumulation of further knowledge.

Letter from Dr. THORNTON.

Feb. 27, 1795.—*Great Ruſſel-ſtreet.*

DEAR SIR,

I am very happy to hear your propoſal for a *pneumatic inſtitution* meets with the ſupport of ſo many eminent phyſicians and men of ſcience. I wait with the utmoſt impatience for its eſtabliſhment, firmly believing that the experience reſulting from it will be of the greateſt public utility. The ſubjoined caſes will be a great inducement for extending pneumatic remedies in the propoſed inſtitution to ſurgery; they will, I truſt, operate ſomewhat with the public in promoting a ſubſcription ſufficient for that benevolent purpoſe.

The firſt caſe will appear to great advantage, as the patient has obligingly permitted me to encloſe to you his journal, which is the faithful picture of his own feelings; he aſſures me, he had not the leaſt knowledge of any part of your *theory* of the operation of vital air, but was induced from ſeeing ſomewhat ſimilar cures performed, to confide himſelf to Mr. Hill, an ingenious ſurgeon who has been among the firſt to apply theſe new powers to the purpoſes of his profeſſion.

Journal

Journal of the Rev. Mr. ATWOOD, *Rector of Saxlingham and Sharrington.* Part. I. *Statement of the caſe, and of the effect of the common means of cure.*

" December, 1779.—The left leg has felt for ſome time paſt very heavy ; is now much ſwelled ; upon preſſure the indentation continues. This was wholly removed in about nine weeks by means of a very tight bandage on the leg, exerciſe, ſpirituous lotions, fumigations, and frictions.—October, 1780. The conſtitution much impaired by the hot climate of Spain ; was attacked with jaundice, which yielded to ſlow journies on mules and to oranges.—January, 1785. My health was much deranged during this month, with great debility.—1786 and 1787. The habit much relaxed.—December 1788. Had violent night ſweats. —January, 1789. Theſe continued to the latter end of this month.—May, 1789. Had a violent inflammatory fever.—Auguſt, 1790. Had an eruption on the ſurface of the body.—1791. During this whole year experienced great debility.—March, 1792. Was ſeized with an inflammatory fever, attended with delirium.—May, 1792. Had a third attack. My phyſician ordered me ſea-bathing to remove the extreme debility which ſucceeded to this fever.—From Auguſt 1792, to February 1793, bathed in the ſea. During this time I had many dreadful ſpaſms in the ſtomach and bowels, accompanied with nauſea and vomiting. Theſe were the forerunners of the diſeaſe, which has ſince affected my left leg.—January, 1793. There appeared a *mahogany coloured* ſwelling in the left ancle of the left leg, which kept up an inceſſant gnawing pain. —July, 1793. This hardneſs was attemped to be eat away with cauſtic ; but it produced only an ulcer of a

very unfavourable aſpect.—September, 1793. I placed myſelf under a moſt ſkilful ſurgeon at Norwich, who applied fomentation, unguents, &c. but without any material benefit.—November, 1793. Though a cripple, was enjoyed regular exerciſe. The ulcer, however, ſtill continued increaſing.---January, 1794. A *new enemy* more formidable than the other made its appearance. It had the ſame *dark mahogany colour*, and the ſame *unconquerable hardneſs*. By degrees this formed into a dreadful ulcer, which increaſed daily.—March, 1794.—Came to London, and placed myſelf under a ſurgeon of great eminence. Was attended by him daily with unremitting attention. Twice did he employ the lapis infernalis, but theſe ulcers ſeemed to reſiſt every application. My conſtitution being extremely debilitated, with loſs of appetite; want of ſound ſleep; and the mind exceedingly irritable, ſea-bathing was once more enjoined.---From June 14, to October 18, bathed in the ſea.---June 27. Mortification took place. The uſual methods, bark in great quantities, port wine, and yeaſt poultices, were had recourſe to.---October 25. Returned to London. The pains in the leg were exceſſive; the fœtor intolerable; the ulcers had made great encroachments; frequent nauſea at the ſtomach; the bark and other medicines were frequently rejected, the breakfaſt ſometimes, and now and then the dinner; the nights were exceſſive bad; ſtrength impaired; in ſhort every thing was unfavourable.---December. A friend who had ſeen the whole progreſs of the caſe, aſked my ſurgeon "what proſpect there was of ſaving the limb." He made no reply, but very gravely ſhook his head.

The following letter is here introduced as eſſential to a compleat idea of the caſe.

Barnet,

Barnet, Feb. 25, 1795.

DEAR SIR,

Being accidentally preſent at the firſt interview between you, Mr. Hill, and Mr. Atwood, I cannot help expreſſing my great *aſtoniſhment* on finding ſo ſpeedy a cure has been actually effected in ſo deſperate a caſe.

The wound, I mean what particularly called my attention at the time, appeared to me to extend *four* inches in longitudinal direction of the muſcles of the leg, and about *three* inches tranſverſely. It was ſo *deep* that not only the whole thickneſs of the adipoſe membrane was deſtroyed, but a conſiderable loſs of ſubſtance had taken place in the muſcular parts themſelves.

The ulcer was in appearance as *ill-conditioned* as I remember to have ſeen, either in the London hoſpital, or in my own practice of near thirty years, affording an ichorous fœtid diſcharge, which appeared to inflame the ſurrounding parts, and which muſt therefore have gone on increaſing the evil.

The gentleman's habit of body, from his own account, was ſuch (for he had tried bark, ſea-bathing, &c. without benefit) that I confeſs I had not the moſt diſtant idea, that any cure could have been performed, much leſs, in ſo ſhort a ſpace of time.

Indeed I think it a great happineſs to mankind in general, that ſuch a remedy as the vital air has been diſcovered, and that men of ſcience are employing it; I am rejoiced to have ſuch proof, that the blood and juices of our fellow creatures can be ſo changed, that we need not *now* deſpair of our patients even in ſituations truly deplorable. I have the honor to be, &c. &c.

[*To Dr. Thornton.*] JOHN CORP.

PART II. *of Mr.* ATWOOD'S *Journal, beginning the day before the inhalation of vital air.*

December 13. Got up with a peculiar ſenſation of weight and pain in the leg; a ſenſe of nauſea at the ſtomach; and no inclination for breakfaſt; ſpirits oppreſſed; and the mind irritable; when endeavouring to walk, felt great pain; the large ulcer in the leg looked of a blackiſh hue in places; a probe being thruſt into one part of the ulcer, I had not the leaſt ſenſation in that part; yeaſt poultices were talked of; had no appetite for dinner; felt very much indiſpoſed towards the evening; no inclination for ſupper; had a ſenſe of chillineſs on firſt getting into bed, ſucceeded by hot palms; paſſed as uſual a bad night, with perturbed ſleep; awoke at two o'clock with ſharp and burning pains in the leg, which continued until five in the morning; doſed till nine.——December 14. Got up with nauſea at the ſtomach; and a ſenſe of languor; no appetite for breakfaſt; ſpirits exceedingly oppreſſed; for the firſt time inhaled the VITAL AIR diluted with a portion of atmoſpheric; had a pleaſurable glow at the time; felt an appetite for dinner, and my friends obſerved my cheeks did not fluſh after dinner, as heretofore; my ſpirits, which were ſomewhat better during the day, ſunk towards evening; no inclination for ſupper; paſſed a very indifferent night.——December 15. Got up but without a ſenſe of nauſea; had a ſlight inclination for breakfaſt; perfect eaſe in the leg; inhaled again the vital air; felt a great appetite for dinner, and a peculiar pleaſurable lightneſs after dinner, as if no ſuſtenance had been thrown in; with a flow of ſpirits; and a ſtrange idea

of

of being able to mount a horſe, and ride as faſt as people in health; appetite for ſupper; paſſed the ſweeteſt night! ſuch as I am ſure I have not enjoyed theſe four years.——December 16. Got up quite refreſhed without the leaſt ſenſe of nauſea at the ſtomach; a great inclination for breakfaſt; ſpirits unuſually elated; took the vital air; felt a genial glow during the whole day; great appetite for dinner; walked with agility and without pain; the wound however appeared unfavourable to day; appetite for ſupper; a good night; awoke with a thick clammy perſpiration.——December 17. Spirits much depreſſed; no inclination for breakfaſt; mind very irritable; much pain in the wound; inhaled the vital air; the wound threw off *nine ſloughs* this day; a ſlight appetite for dinner; the ſpirits recovered towards evening; inclination for ſupper; had a ſound night's reſt.——December 18. Appetite for breakfaſt; inhaled the vital air; a ſenſe of glow, which extended even to the fingers ends; the muſcular powers were evidently increaſed; walked with ſlight, or no pain.——December 19. The wound for the firſt time diſcharged *real pus*; had the *ſenſation*, if the expreſſion can be allowed, of *perfect health*, never experienced before this week; ſleep very ſound; pains in the leg towards morning.——Dec. 20. Got up with great ſpirits; inhaled the vital air; the wound diſcharged a great quantity of real pus; a craving for dinner; felt no longer an inclination for much wine, and after four glaſſes, had the ſame ſatisfaction, as three pints uſed formerly to produce; porter was now rather coveted; ſpirits elevated in an extraordinary degree, which together with a genial ſummers warmth continued from four to nine in the evening, and then ſubſided to humbler ſpirits; ſlept profoundly

from ten to four, which, with the morning doze, made me get up ſufficiently refreſhed; tranſitory pains in the leg.——December 21. A fine appearance of *white edges* in the wounds; great appetite for dinner; an univerſal glow in bed, accompanied with perſpiration; ſharp twitching in the leg.——December 22. Appetite for breakfaſt; inhaled the vital air; the wound ſtill kept on a great diſcharge of laudable pus; no appetite for dinner; in the evening a peculiar ſenſe of weight and uneaſineſs in the leg; a great liſtleſsneſs in the evening; much irritation in the leg; particularly in the ulcer, with much *itching* round the part; but an indifferent night.——December 23. Spirits oppreſſed; inhaled the vital air; returned home without much inclination for dinner; ſpirits rather mended towards evening; enjoyed a good night's reſt. ---December 24. Eat a hearty breakfaſt; ſpirits elevated; walked with eaſe and vigour; a ſurpriſing change for the better had evidently taken place in the wound; appetite for dinner; had a good night. ---Chriſtmas day. Still the ſame happy appearance in the wound to day.---December 27. The ulcer looked wonderfully well; was evidently decreaſed in ſize; the diſcharge very favourable; but leſs in quantity; great pain was felt in the ulcer for a quarter of an hour in bed; afterwards fell into a refreſhing ſleep.--- December 28. All the appearance of healing; the wound much decreaſed; ſome parts filled up; and the borders of a fine white; the whole leg, which before exhibited a dark purpliſh appearance, wore now the livery of health.---December 29. The cavity of the wound was almoſt filled up; the effects of the vital air operating together with my amendment, produced a conſtant gaiety, as if I had been drinking champagne;

champagne; enjoyed a profound night's reſt.---December 30 and 31. The ſame ſenſation of perfect health; elevated ſpirits; great appetite; and comfortable ſleep.—New-year's day. Every thing in a good train. My toaſt after dinner was, "*May the introducers of aerial remedies meet with that recompence from their country, which they ſo amply deſerve.*"

[This toaſt from motives of delicacy I would have omitted, but I thought it my duty to tranſmit you the journal entire as written by the author, R. I. T.]

It was applauded and unanimouſly drank.---Jan. 1, 2, 3, 4, 5, 6, 7. As on the preceding days, with evident and progreſſive amendment in the wound.---January 8. Went to a private concert; before, muſic was diſguſting to me, having no ſpirits to enjoy it; was ſurprized to find myſelf ſtanding, at I was playing on my violin, without leaning on a chair, at ſeveral different times during the evening, and without the leaſt ſenſation of fatigue or pain.---January 9. The ſmaller ulcer, which of late I have not much noticed, was *healed*.---January 10, 11, 12. Nothing peculiar.---January 13. The old ulcer was this day rubbed hard with a flannel, and the larger ulcer appeared nearly healed.---January 14. Walked with great vigour; the larger ulcer was rapidly *ſkinning over*; appetite good; ſpirits good; and ſleep the ſame.—January 17. Notwithſtanding the ſeaſon the moſt inclement I remember, the ulcer was completely *ſkinned over*; and my body ſeemed fortified againſt cold."

Here ends the journal. I have to add that on the 25th of February, the family received a letter from Mr. Atwood from on board the Stately, of which ſhip he was made chaplain. He was then in perfect health and ſpirits.

There are two other cures, which deſerve your particular attention, as the perſons were previouſly in the beſt hands, and as they ſerve in ſome degree to confirm your ideas reſpecting *herpes*, as depending upon a deficiency of the oxygenous principle.

John Patterſon, aged 45, married, has five children; he was formerly a ſailor. He had endured much hardſhip, and at one time lived for nine months wholly on ſalt proviſions. He was ſubject from the age of fourteen to eruptions on his face. When he came under Mr. Hill's care, I ſaw him, with a face encruſted over with humours, ſeveral purple blotches on his body, many hard ſcales or ſcurfs about his arms, and a dark-coloured deep ulcer in his leg, which gave out an ichorous and fœtid diſcharge. He had alſo loſt his ſight near eighteen months. Theſe complicated evils had reſiſted the well-known abilities of Meſſ. Weſt, Carr, Turnbull, Wathen, Phipps, and others. This caſe being recommended to Mr. Hill by the laſt named gentleman, he gave him the vital air blended with atmoſpheric air, as an alterative of the blood, ſtrengthening his conſtitution with chamomile tea and bark, and Mr. Phipps continued thoſe applications to the eyes, which before the purification of the blood, proved unſucceſsful. After a few weeks inhalation of the modified atmoſphere, I had the ſatisfaction of ſeeing him with a face perfectly clear and ſmooth, large white ſcales fell from his hands and arms; the dark purple ulcers on his body, and the vitiated ulcer in his leg were healed, and he had ſo far recovered his ſight, that he had at firſt a blue, then a brighter light before him, and after a regular attendance during four months, he was able to diſcriminate different objects in the ſtreet.

The ſubject of the next caſe is a widow lady. She had a humour in her right leg, which deprived her of exerciſe, and had produced a painful and diſcoloured ſore in that part of above 18 years ſtanding; 4 years of which time, ſhe was attended by Pott, and twenty-ſeven months, by Sharp; but neither of theſe eminent ſurgeons were able to effect a cure. After only three weeks inhalation of the vital air a violent itching came on, and in another week this leg was rendered as ſound as the other. Mr. Sharp ſaw this patient at Mr. Hill's, and examined her leg, and was very much delighted. This lady has now continued well near ſix months.

I need not take up your time with Mr. Hill's ſucceſs in other leſs conſpicuous caſes. What I have already related is ſufficient to ſet forth the advantage that will probably ariſe to ſurgery from the introduction and proper application of the pneumatic practice.

I am, &c. &c.

R. I. THORNTON.

P. S. Nothing is ſaid of dreſſings in the above caſes; the uſual modes having been practiſed. The body too was kept open, as occaſion required.—It may be intereſting to add that the young lady, related to an eminent ſurgeon in London, whoſe caſe is mentioned in a letter of mine which you publiſhed ſome time ago, is now perfectly well. The violent ſpaſmodic ſeizures yielded compleatly to oxygene air. In the ſame collection I mentioned the caſe of a gentleman far gone in pulmonary conſumption, whoſe ſymptoms were ſurpriſingly mitigated by a lowered atmoſphere. Finding himſelf recruited, he undertook a journey of 140 miles. The hectic fever returned, perhaps in conſe-

quence

quence of his breathing the purer air of the country; and in a week after his arrival among his friends, he paid the debt to nature.——R. I. T.

It would be deſirable that Dr. Thornton ſhould fully ſtate the caſe of the lady afflicted by ſpaſms. The cure, I underſtand, was ſo compleat, that it gained the good will of ſeveral medical friends of the patient to the pneumatic practice. The caſe, if I conceive it rightly, was ſimilar to thoſe deſcribed in Zoonomia, p. 26.

Letter from Mr. BARR.

Birmingham, 14th March, 1795.

DEAR SIR,

Having a very high opinion of the effects to be expected from the practice which you have ſo benevolently promoted; and wiſhing to encourage farther experiments upon a ſubject ſo intereſting to humanity, I take the liberty to communicate to you ſome obſervations which I have made on the effects of different factitious airs in the cure of ſcrophula.

About four months ago, a gentleman of this neighbourhood applied to me for advice in the management of a ſcrophulous ulcer of conſiderable extent. He had tried various remedies, but had derived no laſting advantage from any of them. When I firſt viſited him he was worn down by a long courſe of night watching. The deep-ſeated pain of the arm was ſo conſtant and ſevere, that it had in a great meaſure deprived him of ſleep. His countenance was pale and ſickly; his limbs were continually afflicted with aching pains; every exertion, even the moſt gentle, ſeemed beyond the meaſure of his ſtrength, for his body had loſt much of

its

its active power, and his mind much of its wonted energy. The discharge from the ulcer was copious, thin, bloody and corrosive; and besides, the whole surface of the sore was so exceedingly irritable that the mildest dressings, applied in the gentlest manner, produced very severe and lasting pain. During the first six weeks of my attendance he regularly took as much Peruvian bark in substance as his stomach and bowels could bear; and the ulcer was dressed with various emollient, sedative, and astringent applications, but without any permanent advantage. I then recommended a trial of oxygene air, which was readily complied with. He began by inspiring four ale quarts diluted with sixteen of atmospheric air twice a day, and gradually increased the quantity of oxygene to a cubic foot and a half in the day; by pursuing this plan for about a month, his health was wonderfully improved, but the ulcer shewed no disposition to heal. The deep seated pain was now entirely removed, but in the space of a few days more, he complained of a burning sensation over the whole surface of the sore, similar to the pain arising from erisepelatous inflammation. This unpleasant sensation first commenced after inspiring the whole quantity of oxygene in the space of two hours, which before had been taken in equally divided portions morning and evening. We still pursued our plan, thinking that this new pain might be owing to some accidental circumstance, and that it would soon pass away. But it every day continued to increase, and the ulcer began to spread wider and wider. The edges became thick and were turned outwards, and the discharge became more thin and acrid.

In this ſituation, a local application ſeemed proper. I wiſhed to have applied hydrocarbonate externally to the ulcer, but this from ſome circumſtances of the caſe was not practicable. I then thought to moderate the ſtimulus of the oxygene by a mixture of hydrocarbonate, which Mr. Watt told me would occaſion no chemical change in the two airs. Accordingly a mixture of three parts of oxygene, and one of hydrocarbonate was preſcribed. Four quarts of this mixed air were added to about ſixteen of atmoſpheric, and this quantity inſpired morning and evening. In leſs than a week the burning ſenſation was much diminiſhed, and the ulcer put on a more healing appearance. The mixed air was then increaſed to five quarts, and uſed as before, which produced an increaſe of all the pleaſant ſymptoms. After a few days trial of this proportion of the mixed air, ſix quarts were preſcribed. This is the quantity now inſpired morning and evening.

My friend, at preſent, enjoys good health and a good appetite, and feels himſelf as ſtrong as at any former period of his life. The ulcer is now reduced to leſs than half its original ſize, and healing rapidly. There is neither ſuperficial nor deep ſeated pain remaining, and the motion of the joint, and the action of the contiguous muſcles are free and eaſy.

I am, dear Sir, &c. &c.

JOHN BARR.

P. S. The event I will take care to communicate, not doubting but you will find an opportunity of laying it before the public at no great diſtance of time.

Extracts

Extracts of Letters from Dr. CARMICHAEL.

SIR,

I take the liberty of ſending you the following lines, wherein I ſhall briefly ſtate the effects produced by oxygene upon a perſon affected with amauroſis. My patient I. B. aged 45, began 15 months ſince gradually to loſe his ſight, ſo that about 5 weeks ago he could ſcarcely diſtinguiſh a bright fire, or even the glare of the noon day ſun. The right ſide of his face, and half of his tongue, are affected with numbneſs, coldneſs, and loſs of feeling. No other complaint, P. 84. In this ſtate he began on the firſt of December, 1794, to breathe a mixture of 1 part of oxygene obtained by heat from manganeſe, and 9 parts of atmoſpheric air, for about the ſpace of 5 minutes.—2d December. Has paſſed rather a reſtleſs night, and complains much of heat and itching of his neck and ſhoulders.—P. 90. Breathed a mixture of 1 to 7.—3d. A very reſtleſs night. Complains much of pain in his temples and forehead.—P. 98. I directed 8 ounces of blood to be taken from his arm, and afterwards to breathe as yeſterday.—4th. The blood drawn was remarkably dark in appearance, and after ſome time contracted a thin ſuperficial florid cruſt.—P. 88. Paſſed a very reſtleſs evening and night. Head-ach not quite ſo ſevere. Breathed a mixture of 1 part ox. to 4 atm.—7th. Very ſevere head-ach, with temporary loſs of the uſe of his lower extremities.—P. 100. T. white. I directed the venæſection to be repeated to 12 ounces. This day I was afraid to give him any of the modified air.—8th. Has paſſed a better night, but feels himſelf low and feeble.—P. 92. Blood dark; but ſooner than formerly

merly aſſumed a florid cruſt. Inhales as before. 10. Has paſſed two reſtleſs nights, head-ach ſevere, but to uſe his own expreſſion, he feels himſelf "lightſomer." Breathed equal parts.—12th. Both nights he has had very ſevere head-ach; and on the 11th was for ſome little time deprived of the power of motion. Numbneſs and coldneſs of his cheek and tongue continued. The irritability of the pupils is not at all increaſed. Here I thought fit to give up the uſe of the oxygene, as by a continuance of it, I muſt confeſs I had fears of inducing a more ſerious diſeaſe than that I was endeavouring to remove or alleviate.—14th December. As I did not think it prudent to perſiſt longer with the ox. I determined to make trial of the hydro-carbonate. I directed for him a mixture of containing 1 quart of that ſpecies of factitious air, and 19 of atmoſpheric air, which he inhaled in about ten minutes, reſting at intervals. The ſame quantity was repeated for four ſucceſſive mornings, but no advantage attending this mode, and the vertigo occaſioned by it being troubleſome, I did not wiſh to continue the uſe of it for a longer time. From its diſcontinuance till the evening of the 27th December he continued much in his uſual way, when he was attacked with apoplexy, from which however, he gradually recovered.

Another caſe of Gutta Serena has afforded me an opportunity of trying the virtues of oxygene. This patient, about 40 years of age, and of a very irritable habit, has been gradually loſing her ſight for two years paſt; that of one eye is nearly gone, that of the other very indiſtinct. The nerve of the right eye has almoſt entirely loſt its irritability, but the pupil of the left ſtill contracts pretty readily on the approach of light.

On

On inſpection the ſlighteſt degree of cloudineſs towards the external canthus of the left eye may be perceived; and ſhe deſcribes objects as ſeen by the edge of a wall, or of any other interpoſing medium. Every other day, objects appear to her tinged with a yellow hue, and on the intermediate ones of a dark purple. She has the ſame ſenſe of colours in the dark and when the palpebræ are ſhut: thoſe appearances have ſucceeded each other at the interval of 24 hours, with the utmoſt regularity for ſome months paſt. At times ſhe is ſubject to a total loſs of ſight, which, however, continues but for a few minutes, and ſeldom longer than an hour at a time. Its return is in general accompanied by a conſiderable diſcharge of flatus from the ſtomach, to which ſhe is at all times ſubject. She has tried many remedies, but her ſight, ſhe ſays, has been getting gradually more imperfect.

14th January, 1795, I directed her to inhale a mixture containing 6 quarts of ox. procured from Exeter manganeſe by heat only, and about 18 of common air, which ſhe did in the ſpace of 5 or 6 minutes; and repeated it daily till the 22d.—22. No perceptible change. It was ſuggeſted that it might be better to divide the doſe and repeat it twice a day, which was accordingly done. I directed her to take 3 quarts of ox. diluted with 18 of atmoſpheric air forenoons and evenings. As ſhe was rather coſtive, ſhe took occaſionally of the Edinburgh ſtomachic pill.—2d Feb. No advantage attending this method, the doſe was increaſed to 6 quarts of ox. diluted as above, mornings and evenings. On the morning of the ſixth ſhe awoke completely blind, and continued ſo with the exception of a few momentary intervals during the day; ſhe however paſſed a good night, and on the morning of

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the 7th found her ſight much in the ſame ſtate as it had been on the evening of the 5th. She was a good deal alarmed at the deprivation of ſight for ſo long a period; and as ſhe had not derived any advantage from the uſe of the modified air, I deſired her to diſcontinue it. Her viſion became gradually more imperfect, her pulſe, during the time ſhe inhaled the modified air, in my opinion rather acquired tenſion, and the irritability of her ſyſtem was not quite ſo apparent.

S. P. Æt. 17¼.—Complains of univerſal languor and debility, palpitation and difficulty of breathing on the ſlighteſt exertion, eſpecially in going up ſtairs; ſhe is much emaciated, and her ſkin is univerſally pale; her feet and ancles for ſome months paſt have become œdematous toward evening, but more particularly after uſing exerciſe; ſhe complains of pain of her ſtomach, and of frequent cough, attended at times with pain of her ſide. B. regular; app. impaired; pulſe 112. She has never menſtruated, nor had any of the ſymptoms uſually preceding that evacuation. She firſt began to complain about 2½ years ago; ſince which time ſhe has taken different medicines, but without advantage.—Feb. 14, 1795, I directed her to inhale daily a mixture of oxygene and atmoſpheric air, in the proportions of 3 to 17.—18. Modified air produced no evident effect. I directed her 6 quarts of oxygene diluted with 14 of common air.—23d. Since the proportion of oxygene was augmented, her nights have been reſtleſs, and ſhe has complained of general heat. Cough more frequent; p. 125.—26th. Her evenings and nights are ſtill reſtleſs; cough increaſed; pain of her

her ſtomach not abated; p. from 120 to 125. I directed her to uſe the modified air in the proportions at firſt preſcribed.—March 1. Sleeps better, and in the evenings ſhe thinks that ſhe is leſs hot. Cough leſs frequent, pain of her ſtomach not abated; p. 110.---6th. Pain of her ſtomach leſs troubleſome, appetite mended; thinks that her ſpirits are higher than uſual: and that ſhe feels leſs fatigue and dyſpnœa on motion, p. 100.---The appearance of her countenance is evidently more healthy; cough much leſs frequent; dyſpnœa and palpitation on motion much relieved; p. 98; ſleeps well; œdema of her feet and ancles ſeldom returns in the evenings, excepting after more than uſual fatigue.—15th. Continues to recover in every reſpect; cough nearly gone; no return of pain of her ſtomach for ſome days; complains ſo little of dyſpnœa and palpitation on motion, that ſhe can walk a mile and upwards without being particularly affected by either, and without much fatigue; p. 89.—20th. Her general health much improved; the univerſal paleneſs of her ſkin has given way to the natural appearance; and her cheeks, lips and nails have acquired a roſy tinge; p. 81. She has not yet menſtruated, nor has ſhe hitherto had any ſigns indicative of ſuch a change; but as that diſcharge depends upon a certain tone of the arterial ſyſtem in general, I have little doubt but that it will be eſtabliſhed with the complete reſtoration of her health; which deſirable event there is every reaſon to believe is at no great diſtance.

I am, &c. &c. JOHN CARMICHAEL.

28th. Has uniformly mended in appearance, ſtrength, and in reſpect to her own feelings.—J. C.

Birmingham, March 1795.

Extract of a letter from Dr. Pearson.

Dear Sir,

In my little publication, I can ſcarcely call any thing my own, but the obſervations on the *vapour of æther*, of the probable uſe of which in phthiſical caſes, your conſiderations on Factitious Airs firſt gave me the idea. As the number of conſumptive perſons in this large manufacturing town is deplorably great, I have had frequent opportunities of trying the inhalation of æther in ſuch caſes; and I have the ſatisfaction to ſay that I have found it very beneficial. It abates the hectic heat, relieves and often removes the dyſpnœa, and promotes and improves the expectoration. It ſeems to have ſuch an effect as a mixture of inflammable and fixed air (duly diluted with common air) would have; and where the factitious airs cannot be had, it may be uſed in their ſtead with great advantage.

My trials with inflammable air upon conſumptive patients at the hoſpital here, have, as yet, been too few, and thoſe too much interrupted, to admit of any certain concluſion; but I have lately had a proof of the ſalutary operation of oxygene air in the caſe of a chlorotic girl, Mary Rider, 22 years of age, who has had her menſes ſuppreſſed for the laſt 12 months. After ſhe had taken for many weeks the uſual emmenagogue medicines without experiencing the ſmalleſt benefit, I ordered her, at the end of December, oxygene air, of which ſhe took a large doſe, immediately after it was expelled from oxygene, and before it had time to make any depoſit. Her pulſe, which before was very languid, was conſiderably raiſed by it; and ſhe ſaid ſhe felt a warmth in her cheſt, which continued

tinued throughout the day, accompanied with head-ach and an uneaſy ſenſation at the ſtomach. At the 2d application, about a fortnight afterwards, ſhe inhaled a ſmaller doſe, (viz. 2 quarts) largely diluted with common air. (This oxygene air muſt have been purer than that which ſhe had breathed before, as it had ſtood by a long time in the air-holder, in which ſome water was purpoſely left to abſorb the fixed air, from which I have reaſon to think it was not thoroughly freed during its paſſage through the refrigeratory.) At this and the ſubſequent repetitions of the application, the ſtrokes of the artery in the wriſt were ſtronger and fuller than before the inſpiration. On account of pain of the ſide, head-ach, and uneaſineſs at the ſtomach, of which ſhe complained the next day, the application was ſuſpended, and was not again repeated till the 22d of January, when ſhe breathed only a quart of oxygene. In the interval no other medicine was given but Rochelle ſalts, to keep the belly open, and take off the fulneſs and quickneſs of the pulſe.—23d. A quart more.—24th. The ſame quantity. Mr. Taylor, the apothecary to the hoſpital, ſuperintended the laſt mentioned applications, as I was prevented from being preſent myſelf. When I ſaw the patient the day after the laſt inhalation, I found her pulſe, appetite, ſpirits and countenance much improved. An accident having befallen the apparatus, and the ſtock in the air-holder being exhauſted, we were obliged to diſcontinue the application. The girl was diſcharged on the 31ſt of January, much better as to her general health, and particularly with more colour and more animation in her countenance; but in reſpect to the menſtrual evacuation, the ſame as before. When ſhe left the hoſpital, ſhe had directions to come again after 5 or 6

weeks; when, if the ſuppreſſion of the menſes ſhould ſtill continue, I intend to repeat the pneumatic application.——I have likewiſe given oxygene air to another patient affected with epilepſy joined with amenorrhæa; but as I have not, in this caſe, repeated the application ſufficiently, I do not yet think myſelf warranted to ſpeak of its effects.

I am, dear Sir, with great regard, your's,

RICHARD PEARSON.

Birmingham, Feb. 2, 1795.

P. S. From what I have ſeen of the effects of oxygene, I think it ſhould at firſt be applied in more diluted doſes than thoſe in which you ſeem to have given it. In my little pamphlet I have ſaid, (p. 4), that "at the firſt time of uſing it, it ſhould be mixed with 8 or 10 times its bulk of atmoſpheric;" but I think it will in moſt caſes be prudent to dilute it with as much as 12 or 15 times its quantity of common air.

Extract of a Letter from Dr. THORNTON.

A gentleman, Mr. T———d, was recommended to me by Mr. Baker; he had been afflicted with aſthma for the laſt 13 years. Having loſs of appetite, great muſcular weakneſs, cold extremities, and a languid pulſe, I directed him to inhale a ſuper-oxygenated air. After ſix weeks trial of the efficacy of this new means, accompanied with medicines, his aſthma was not diminiſhed, which ſurpriſed me, as I had in this way relieved and cured ſeveral aſthmas this winter and the preceding, but on the contrary it ſeemed ſomewhat increaſed. This gentleman was now ſeized with a violent cold; fearing the recent oxygenation might increaſe the inflammatory ſymptoms, I directed him to

inhale

inhale hydrogene gas, diluted with atmoſpheric air. The heat and foreneſs at his breaſt were immediately taken off. He repeated this, and he is himſelf fully perſuaded, from the knowledge he has of his own conſtitution and the laſting effects of a cold with him, that the hydrogene gas prevented, or rather cured this catarrhal attack; upon a more particular inquiry, I found he was in the habit of relieving his aſthmatic fits by going to the play, which ſucceeded if he went into the upper gallery, but not if he ſat in the pit, and that a ſharp eaſterly wind was ſure to bring on a paroxyſm, if he walked in the face of it; and that he was never ſo well as in crowded rooms, and in foggy damp air.

When Mr. T——d inhaled an oxygenated atmoſphere alone, he was accuſtomed, though the oxygene was very conſiderably diluted, to awake early with difficulty of breathing, a long fit of coughing, the breath hot, and the tongue parched. When he began to inhale the hydrogene air, he fell aſleep ſooner than before, ſlept compoſedly, and had none of the above ſymptoms. Since the catarrh was cut ſhort by the hydrogene, I have ventured to give him a little oxygene by day, with hydrogene at night. He is going on well; falls aſleep ſoon after taking the hydrogene, and is quite exempt from the above-mentioned diſagreeable complaints.

I cannot help adding, that I had lately an opportunity of obſerving a fact, which ſeems to favour your idea of muſcular motion, as dependent upon oxygene. An aſthmatic patient after going up ſtairs was always obliged to remain quiet in her chair near ten minutes, before ſhe could enter into converſation. The progreſs of her recovery not being ſo ſpeedy as ſhe could wiſh, ſhe

fancied the vital air in a ſtate of dilution did her no ſervice.—After inhaling the quantity I judged prudent, I have begged her to go down ſtairs, and walk up as quick as uſual, or rather more ſo, which ſhe obligingly did, and was able then to converſe the moment ſhe entered the room.

Ever your's,

R. I. THORNTON.

The Rev. Mr. F———, at Briſtol Hotwells, much troubled with dyſpnœa, and mucous expectoration, uſed to aſſure me, that after inhaling diluted oxygene air, he could walk up the ſteep hill to Clifton with much greater eaſe than at other times. He made the experiment innumerable times. This air, however, rendered him no permanent benefit; his diſorder depending upon mal-confirmation.

We may admit theſe facts, as they ſeem clearly aſcertained, and ſupported by many analogies. But would not æther or other drugs have done the ſame? And was the effect produced by the *ſpecific* power of oxygene? A good reaſoner ought not to admit ſuch power till there ſhall have been made a number of comparative experiments, of which no man has perhaps conceived the idea. It is, for inſtance, poſſible for any thing we know to the contrary, that certain ſubſtances introduced into the ſtomach ſhall prevent an animal from drowning ſo ſoon as its unprepared fellow, without communicating oxygene to the ſyſtem, and thus, to a certain degree, rendering reſpiration ſuperfluous. In this caſe it would be doubtful whether oxygene acts

on

on the ſame principle as the bodies, producing an effect ſo far equivalent, or on a principle peculiar to itſelf. When we are acquainted with the reſult of theſe more extenſive reſearches, we ſhall not be in ſo much danger as at preſent of being ſeduced by narrow views into wrong concluſions.

In November 1794, Mr. James Tobin of Briſtol, informed me he had heard of inſtances of amauroſis, in which benefit had been derived from inhaling oxygene air. From my own experience I could not give him any encouragement, except as to the probable ſafety of the trial; but as he had loſt the ſight of one eye entirely by this diſeaſe, and had that of the other exceedingly impaired, he determined upon the experiment. He ventured upon the quantities ſpecified in the following note, with which he favoured me from memorandums made at the time. Not the ſmalleſt difference for the better or the worſe was experienced at the time or ſince as to his viſion.

"Mr. James Tobin for fourteen days in December, "1794, took of atmoſpheric mixed with equal "parts of oxygene air, from five to ſix of Mr. "Watt's ſmaller cylinders daily; having diſcontinued "it for a fortnight, he began again taking of the ſame "proportions five cylinders for nineteen days; four "minutes are more than ſufficient for the breathing of "one cylinder (i. e. $\frac{1}{3}$ of a cubic foot) of this air. Mr. "J. T. has occaſionally breathed the pure oxygene "without any inconvenience, nor could he abſolutely "aſcertain any effect from the mixed air, though he "ſometimes thought he derived from it the power of "reſiſting cold. The proportion of oxygene is ſo

" great in this mixture as to add brilliancy to the " flame of a candle after it has paſſed through the " lungs."——*March* 23, 1795.

I have received general information concerning ſeveral other patients, to whom oxygene has been adminiſtered. Compleat reports will, I hope, be publiſhed in due time. In ſome of thoſe patients ſcrophulous tumours have diſappeared during this treatment. In one a combination, which I had recommended ſeveral months ago in ſuch caſes of cancer as ſhould reſiſt the external application of carbonic acid or other unreſpirable airs, has been employed with great advantage, and will probably effect a complete cure. Carbonic acid air having been applied for three months to a cancerous ulcer of the breaſt without mending its ſtate, it was conceived that the inhalation of oxygene air, together with the continuance of the external application of the c. acid, might produce an effect to which the latter alone was not equal. In leſs than a fortnight after this alteration in the treatment, good pus was diſcharged, healthy granulations appeared, and the ulcer was much diminiſhed. There has ſince been a gradual progreſs towards recovery, and the cancer, I am well informed, " is all but healed."

XVIII. *Caſes in which different unreſpirable airs were adminiſtered.*

Letter from Dr. FERRIAR.

Mancheſter, Jan. 23, 1795.

SIR,

It would afford me ſincere pleaſure if I could furniſh you with any deciſive proofs of the efficacy of Pneumatic Medicines; but my trials of them have not yet been numerous, and my patients have not been ſo regular and perſevering as I could have wiſhed. I began to uſe hydrogene about two months ago, with an elderly man, who had every ſymptom of confirmed phthiſis, and whoſe complaints had been uſhered in by hæmoptoe. His pulſe was 120, and very quick; on that day when he firſt breathed the mixture, there was $\frac{1}{4}$ of hydrogene. He remarked that he did not cough during the reſt of the day; and the next morning, his pulſe was only from 60 to 70. By adminiſtering a doſe of the air morning and evening, and increaſing the proportion of hydrogene to $\frac{1}{3}$, he obtained ſeveral eaſy nights, though the weather was froſty, and a thick fog prevailed for ſeveral days. Theſe favourable appearances are now over; for the air no longer gives him relief, owing, I apprehend, to the period of the diſeaſe. When the hydrogene loſt its efficacy, I gave him the hydro-carbonate, and afterwards oxygene, without benefit.

The next caſe in which I uſed hydrogene was that of a lady who had been haraſſed with a ſpaſmodic aſthma upwards of 11 years. During the laſt two years and half, ſhe had ſeldom been free from a paroxyſm above four days together. After breathing the

mixture

mixture with a third of hydrogene, ſhe complained of a ſenſation of fulneſs in the lungs, and of ſevere coldneſs. I prevailed upon her to uſe the medicine twice a-day for ſome time; and ſhe has certainly been more free from the aſthma than ſhe had been at any time for the laſt three years. In the courſe of two months, ſhe has had only two paroxyſms, and they have been ſhorter than uſual. I have attempted to relieve her during the paroxyſm, by giving oxygene, but without effect.

I made a patient at the Infirmary inſpire a mixture, with the common proportion of oxygene, in my preſence, a few days ago. The man has had a ſevere aſthma during ſeveral years, which only quits him in the middle of ſummer. He had been once free from his complaint for a conſiderable time, by taking bark and opium under my direction. After inſpiring the air, he ſaid he felt himſelf perfectly eaſy, and that if he could continue ſo, he ſhould think himſelf well. He has neglected, however, to return as I deſired, for another doſe.

I have found no inconvenience reſult from the exhibition of the airs; on the contrary, the conſumptive patient whom I firſt mentioned, thought his appetite and ſpirits improved by the uſe of the hydrogene.

I hope, in a ſhort time, to acquire more facts on this ſubject; in the mean time I ſhall be very happy if theſe ſlight obſervations can be of any uſe to you.

I am, Sir, &c.

J. FERRIAR.

To Dr. Beddoes.

Letter

Letter from Dr. CARMICHAEL.

DEAR SIR,

The Hydro-carbonate, ſo far as my obſervation goes, has never failed to afford very ſenſible relief in Phthiſis Pulmonalis. Conſumption occurs very frequently in this place; but it rarely happens that a phyſician is applied to early in the diſorder, when much advantage may be expected to be derived from the uſe of modified air. The perſons affected with Phthiſis, whoſe caſes are detailed below, were reduced to the brink of the grave, and cannot therefore be conſidered as favourable ſubjects. I have however the ſatisfaction to inform you that the hydro-carbonate has hitherto reprieved one of them, and that the ſufferings of the two others were uniformly and greatly alleviated. No medicines having been uſed at the ſame time, the effects produced are to be attributed entirely to the virtues of the factitious air.

J. A. applied for my advice Dec. 1, 1794 : has very frequent cough, attended with copious expectoration, pain of his ſide, dyſpnœa on the ſlighteſt bodily exertion, colliquative ſweats and diarrhœa, very reſtleſs nights, ſtrength much impaired, p. 115. Theſe complaints originated about five months ſince without any evident cauſe, and notwithſtanding many remedies uſed have continued to increaſe. I prepared a mixture of hydro-carbonate and common air, in the proportion of one quart to nineteen, which he inhaled at intervals as directed below in J. T.'s caſe (p. 87).—2. The vertigo produced was conſiderable and from which he did not completely recover for upwards of an hour. Has had a very comfortable night, cough relieved and he expectorates

torates with more eaſe, p. 108; breathing leſs difficult. —6. Pain of ſide and dyſpnœa gone, cough not ſo frequent, fœtor of the matter expectorated not ſo offenſive, diarrhœa leſs frequent, perſpiration much leſs profuſe, p. 104; ſleep has been uniformly good ſince he began the uſe of the modified air. Vertigo produced ſtill conſiderable, and after having once gone completely off continues to return at intervals during the day.—13. All his ſymptoms better except in point of ſtrength, which ſeems gradually to decay. His mother requeſted me to inform her whether or not it was my opinion that her ſon could recover; I replied that I had little expectation of ſo favourable an event, but that his life might be prolonged and rendered more comfortable by the uſe of the modified air. From this time, however, for five days, I ſaw no more of him.—18. He returned to-day, and earneſtly entreated me to ſuffer him to inhale the modified air as formerly. All the ſymptoms were greatly aggravated, the fœtor of his breath was intolerable, and his diarrhœa had returned with increaſed violence, p. 120; he breathed the ſame mixture as at firſt preſcribed for him.—19. Hydro-carbonate occaſioned conſiderable vertigo, has paſſed the night comfortably and ſeems much refreſhed by his ſleep, cough leſs urgent, p. 108.—24. Cough leſs frequent, dyſpnœa leſs urgent, fœtor of his breath leſs offenſive, ſleeps well, body regular, p. 104. Notwithſtanding the relief of his ſymptoms, his ſtrength is evidently declining.—30. Continues the ſame.—Jan. 12, 1795. Since the laſt report, owing to the ſeverity of the weather, he was prevented from attending. I am this day informed that his diarrhœa returned with great violence and carried him off on the tenth inſtant.

S. C.

S. C. æt. 32, was about nine months ſince, in conſequence of expoſure to cold and wet, ſeized with cough and pain of his breaſt, which ſymptoms were ſoon after attended with conſiderable expectoration. I firſt ſaw him towards the end of July. His cough was then ſevere and attended with copious expectoration of a whitiſh ropy fluid, he complained of flying pains of his thorax, dyſpnœa on any ſlight exerciſe, reſtleſs nights, and ſtrength much impaired, p. 100. He was at that time engaged in buſineſs, but as his ſtrength was but ill adapted to the attendance required, and his mind ſeemed little at eaſe, I recommended to him to leave ſuch ſcenes for the preſent, and if he conveniently could, to retire for a few months into the country. With this advice he readily complied, and I ſaw no more of him until the middle of October. His mended appearance beſpoke the benefit he had derived, he had had no pain in his breaſt for ſome weeks, and could uſe conſiderable exerciſe without any return of dyſpnœa, his appetite was much better, and he in general ſlept pretty well, his cough and expectoration continued in a leſs degree. But this glimpſe of hope was only of ſhort continuance, he gradually loſt the ground he had acquired, to his former ſymptoms new ones were added, ſo that at the end of November, when I again ſaw him, it was but too evident that he could not much longer ſtruggle with ſo formidable a diſeaſe.—Dec. 4. Cough very ſevere, copious expectoration of a ropy whitiſh phlegm, dyſpnœa urgent on the ſlighteſt exertion, nights very reſtleſs notwithſtanding he is in the habit of taking a grain and half of extract of opium at bed-time, profuſe perſpirations, p. 110, body regular, appetite and ſtrength much impaired. I directed him to inhale a mixture

containing

containing one quart of hydro-carbonate and nineteen of common air, once a-day, and desired him to omit the opiate at bed-time.—5. Considerable giddiness produced by the hydro-carbonate, and he complains that to-day he feels himself more languid than usual. Slept better than he has been accustomed to do for some weeks past.—10. Cough much abated, expectorates with more ease, pain of his side gone, dyspnœa on motion less urgent, continues to enjoy very comfortable nights, perspirations much less profuse, p. 90.—15. Continues to find relief from the modified air.—20. For the two last days his cough has been rather worse, and his nights restless, p. 100, body costive. I directed him to take a little rhubarb occasionally.——25. Body regular, cough relieved, and he has slept better; for some time past no perspirations, p. 90.—30. He is evidently more emaciated, his voice has become more feeble, and his step is less firm. Cough variable, expectoration rather more copious.—Jan. 4, 1795. Considerably affected by the severity of the weather, cough increased and attended with a sense of tightness in his breast, and at times with pain under his sternum.—27. I heard nothing of him for some days subsequent to the last report. Finding himself getting worse, he was advised to apply elsewhere, but medicine was of no avail, and I am informed that he sunk under his complaints two days since.—Had it been possible for me to have supplied this patient, and him whose case is before detailed, with modified air at their own houses, during the unusually severe weather, might they not have recovered?

J. T. æt. 40, has for two years past been affected during the winter and spring months with cough and expectoration,

expectoration, and at times with pains in his breaſt, accompanied with ſlight dyſpnœa. Theſe ſymptoms in general left him during the ſummer months, and never at any time aroſe to ſuch a degree as to prevent him from following his uſual occupation. In the beginning of October laſt, he was ſeized with pain of his ſide, cough, dyſpnœa, and after ſome time with copious expectoration. He applied for my advice in the beginning of November. At that time he had an almoſt inceſſant cough, attended with copious expectoration, he complained of a ſenſe of tightneſs acroſs his thorax, and much dyſpnœa on the ſlighteſt exertion, his pulſe was in general from 110 to 120, his nights were reſtleſs and attended with profuſe perſpirations, his body was irregular, his appetite much impaired, his frame much emaciated. I ordered for him at different times emetics, ſquils, ammoniacum, bliſters, &c. but from none of them did he derive more than a very temporary relief. —Nov. 27. He began the uſe of the hydro-carbonate. I directed him at firſt to inhale a mixture containing a quart and an half of this ſpecies of factitious air, and nineteen of atmoſpheric air. This quantity he uſed in about twenty minutes, breathing it for twenty ſeconds together, and then reſting for one, two, or three minutes according to the degree of vertigo produced.—28. The vertigo produced by yeſterday's inhalation was very ſevere, and returned at intervals during the evening. He has paſſed a much better night than uſual, and ſays that the dyſpnœa and ſenſe of ſtricture on the thorax are much relieved. The quantity of hydro-carbonate diminiſhed to one quart, diluted as above.—30. Cough much relieved, ſenſe of ſtricture gone, dyſpnœa leſs troubleſome on motion, has had better nights, and his perſpirations are leſs profuſe, p. 106, appetite rather

better.

better.—Dec. 7. Cough evidently better, expectoration conſiderably diminiſhed, p. 95, body for ſome days paſt regular, breathing ſo much improved that he can with eaſe walk up ſtairs to his chamber and undreſs himſelf, without return of dyſpnœa, which he could not before accompliſh without the greateſt difficulty, ſleeps better than he has done for months paſt, perſpirations entirely left him, appetite mended.—15. Continues to recover in every reſpect, has at times ſome return of tightneſs of his breaſt, but which is uniformly relieved or completely carried off by the hydro-carbonate. His countenance is evidently altered for the better, and he is of opinion that his ſtrength returns. Notwithſtanding that the modified air ſtill continues to produce conſiderable vertigo, I increaſed the quantity to two quarts, diluted as before.—27. Cough very much relieved, expectorated matter reduced to one-third of its former quantity, p. from 84 to 90. He has evidently acquired fleſh, and he is of opinion that his ſtrength continues to improve.—Jan. 6, 1795. Cough rather more frequent and attended with ſome degree of dyſpnœa. On account of the ſeverity of the weather, which evidently affects him, I ordered him not to ſtir from home. At this time he began to breathe the modified air of the ſtrength directed above, twice a-day.—16. Cough relieved, quantity of expectorated matter much the ſame as reported on the 27th ult. in other reſpects the ſame.—Feb. 1. On account of the unuſual ſeverity of the weather, no advance has been made ſince laſt report. Cough more variable, and at times attended with ſome degree of dyſpnœa, expectotorated matter rather increaſed, he does not however emaciate.—12. Cough much abated, quantity of expectoration reduced to one-fifth of its former quantity,

his

ſtrength is ſo much recruited that it is with difficulty I can reſtrain him from returning to his occupation. In every reſpect he is much better.—March 1. Continues to gain ſtrength, cough leſs frequent, and expectoration ſtill diminiſhing in quantity, appetite good, ſleeps well. As I could not prevail with him to remain longer at home, I adviſed him, before he returned to his uſual occupation, to walk out a little daily.

[It is much to be regretted that this patient would not be perſuaded, or could not afford to devote himſelf entirely to the care of his health. His return, however, to his uſual occupation, and conſequent expoſure to the ſeverities of ſuch a ſeaſon, form an æra in his caſe; and Dr. Carmichael has promiſed me a continuation of his hiſtory. I ſhall not fail to communicate the event to the public in the courſe of the preſent year: caſes now in progreſs, beſides thoſe mentioned in this pamphlet, will enable me in a few months to add a ſmall appendix. T. B.]

In preſcribing the uſe of this ſpecies of factitious air, ſuppoſing my patient to be 19 years of age or upwards, I begin by directing 1 quart of hydro-carbonate to be mixed with 19 of atmoſpheric air. In this proportion it may be inhaled for fifteen or twenty ſeconds together, without producing much uneaſineſs of the head or vertigo; it is then prudent to deſiſt until ſuch time as any feeling occaſioned by it goes off, which will in general require from one to five minutes. Vertigo univerſally accompanies the uſe of the hydro-carbonate, even in much ſmaller doſes than thoſe which I have above directed. At firſt the patient is ſenſible of a tightneſs acroſs his forehead, and a ſenſe as of ſomething creeping round his ears and back part of his

head. Theſe ſymptoms gradually increaſe, until they are loſt in vertigo, or if imprudently too much has been given, in a ſlight degree of apoplexy. I have made uſe of ſpirits, water, and volatile effluvia, to reſtore patients overcome by this ſpecies of modified air, but nothing ſeems to anſwer the purpoſe ſo well as expoſing them freely to a current of the atmoſphere. I in general make uſe of incipient vertigo as a teſt how much of the mixture patients may breathe at a time, and unleſs it produces more or leſs of this effect, I do not find that the advantages derived are ſo conſpicuous. The proportion of the hydro-carbonate may be increaſed as the ſyſtem becomes habituated to its operation. J. T. at this time takes a gallon of hydro-carbonate diluted with four gallons of atmoſpheric air twice a-day, and without producing much diſturbance in the ſyſtem. The other two patients never inhaled the modified air ſtronger than in the proportion of two to eighteen, nor oftener than once a-day.

In preparing the hydro-carbonate, I find it to be of the utmoſt conſequence to ſuffer water to paſs from the water-pipe in the moſt gradual manner. By doing ſo the air comes over much ſlower, but its purity compenſates for a little loſs of time. If much water is uſed a conſiderable quantity of hepatic and aerial acid airs are generated. The latter is of little conſequence, as it may be abſorbed by quick-lime put into the refrigeratory, but the former being inſeparable from the hydro-carbonate, increaſes dyſpnœa when preſent, and I have ſuſpected it ſometimes of occaſioning pains in the breaſt.

The hydro-carbonate loſes much of its activity by keeping, it does not produce vertigo in the ſame degree,

gree, and I have not obſerved the ſame beneficial effects reſult from its uſe. On recurring to freſh prepared air, it is neceſſary to begin again with a very ſmall doſe.

I am, dear Sir, &c. &c.

JOHN CARMICHAEL.

Birmingham, Feb. 12, 1795.

The collection of letters from Dr. Withering and others being out of print, and not likely to be ever republiſhed, I ſhall extract the following important obſervation. Whatever opinion be formed concerning the nature of the caſe, the patient clearly appears to owe her life to the pneumatic treatment:

Extract from a letter from Dr. EWART, *dated November* 14*th*, 1793.

The other caſe in which I employed the inhalation of mephitic air, was that of a lady (Mrs. P.) aged about 22 years; who nearly two years and a half ago, was ſeized in Ruſſia with ſymptoms of a violent pleuriſy, after incautiouſly eating iced cream when over-heated. Notwithſtanding blood-lettings and other evacuations, the inflammatory ſymptoms ſeem to have run into a rapid ſuppuration; for eight or ten days after the firſt attack, and after a ſevere fit of coughing, almoſt immediate relief followed the ſudden expectoration of a large quantity of what was deemed pure pus, ſlightly intermixed with blood. But though the pain and dyſpnœa now abated, ſtill a frequent cough and a very

copious expectoration of a ſimilar matter to that diſcharged at firſt, remained; and ſoon her fever aſſumed a hectic form. She was in this ſituation recommended to come to England, but experienced no benefit either from the ſea voyage or from the uſe of the Briſtol hot waters, which ſhe drank during ſome months. So much of her caſe I give from her own report. From Briſtol ſhe came to Bath in the beginning of laſt January, when I firſt ſaw her, eighteen months after the commencement of her illneſs. The ſtate of circumſtances then was, very conſiderable and *progreſſive* emaciation, an almoſt conſtant hectic fluſh on the countenance, the pulſe always quick, with regular and ſtrong exacerbations of fever towards evening, which again abated before morning, and were ſucceeded by profuſe ſweats; the cough was very frequent, and the expectoration ſo profuſe as completely to wet many handkerchiefs daily. She began now to inſpire mephitic air, pretty nearly in the ſame manner as Colonel Cathcart had formerly done. She not only repeated, however, the inhalations from the machine oftener, and continued them longer each time than was done in his caſe, but even while ſhe was not inſpiring through the tube, the machine generally remained on a table near her, emitting the fixed air which was continually extricated from the mixture of calcareous earth and vitriolic acid it contained, ſo that I ſeldom entered her apartment without perceiving mephitic fumes in a greater or leſs degree. The apartment being cloſe and of no great extent, I ſometimes thought it prudent to have a window opened for the purpoſe of clearing it of theſe fumes.—Particular circumſtances rendered it neceſſary that I ſhould inform the lady's relations without reſerve, what chance I ſaw of her recovery;

and

and in the beginning of my attendance I did not heſitate to expreſs my deſpair of doing her any good, or of ever ſeeing her better. Such however was ſoon the abatement of all her ſymptoms under the above treatment; ſo entirely for ſome weeks did the hectic fever diſappear; and ſo evidently did ſhe gain during the ſame period both fleſh and ſtrength, that not only her relations acquired new and ſanguine hopes of her recovery, but I began ſeriouſly to flatter myſelf with a diſappointment of my predictions, although I durſt not venture to avow it. The firſt check given to this amendment, which proceeded for four or five weeks, was occaſioned by an over exertion of her lately recovered ſtrength, during a fatiguing walk, the latter part of which was up a pretty ſteep aſcent. A return of pain in the breaſt and dyſpnœa, a tinge of blood in the expectoration, together with an accelerated pulſe, made me have recourſe to blood-letting, bliſters applied to the cheſt, &c. which greatly relieved theſe ſymptoms, but at the ſame time reduced the general ſtrength. The inhalation of mephitic air was interrupted during the period of this inflammatory attack, from an uncertainty how it might act rather than from any obſervation of its diſagreeing; but it was repeated as before, after the ſymptoms of inflammation had abated, and again ſeemed to produce the ſame beneficial effects. A ſecond relapſe however occurred ſome weeks afterwards from a ſlight indiſcretion, the throwing off part of her accuſtomed garments. This was removed much in the ſame way as the former one, and the mephitic air was again reſorted to with ſimilar ſucceſs. After each of theſe inflammatory attacks, and after one or two others which happened ſubſequently, there remained for ſome time a conſiderable

increaſe of cough and expectoration, and a permanent hectic, which however gradually abated under the uſe of the mephitic air. But theſe repeated relapſes from ſlight cauſes, notwithſtanding the conſtitution rallied aſtoniſhingly afterwards, and ſoon ſeemed to regain all it had loſt, renewed my fears that the diſeaſe would ſoon run the uſual and rapid courſe of confirmed phthiſis. The patient left Bath in the month of May laſt, to take advantage of the ſummer ſeaſon for trying another voyage by ſea, ſtill bent on continuing the inhalation of mephitic air. I deſpaired of hearing much longer any favourable accounts of her; but have been repeatedly and agreeably diſappointed, in learning that her health has ſince gained inſtead of loſing ſtrength. By a letter received within theſe few days from Peterſburgh, where ſhe has paſſed the ſummer, it is reported to me "that ſhe is wonderfully recovered by the Balſam of Mecca, which ſhe got from the Turkiſh Ambaſſador." Whether ſhe has all along continued the mephitic air, I cannot undertake to aſſert; but I believe in the affirmative, from her intentions at the time of leaving this country. To whatever cauſe her preſervation is owing, it is the firſt caſe of ſo fully formed, and ſo far advanced a phthiſis that I have met with, in which the progreſs to diſſolution has been ſo long reſtrained, or ſo ſucceſsfully repelled.

I remain, dear Sir, &c.

JOHN EWART.

——Accounts from Peterſburgh of a late date ſtate the amendment of this lady to be more conſiderable than I ventured in my laſt letter to repreſent it. It was her intention to paſs the winter in the South of Ruſſia, but

but ſhe now thinks herſelf ſo well as to be able to remain with impunity at Peterſburgh. The expreſſions of her father in a letter to her ſiſter are, "She has recovered progreſſively ever ſince ſhe returned here, "regains fleſh and ſtrength, is free from fever, and "ſuffers very little from her cough, but continues to "ſpit immoderately, though with eaſe." No mention is made in this letter whether ſhe perſiſts in reſpiring fixible air.

Your's, &c.

Bath, Dec. 15, 1793. J. E.

Bath, March 25, 1795.

My Dear Sir,

In the beginning of the winter Mrs. P. was found to be pregnant, and has been delivered of a healthy child. Lady H. from whom I had an account within the laſt fortnight, mentions no particular ſymptoms, but only ſays her ſiſter is vaſtly well. She has not breathed any factitious air ſince her return to Ruſſia; ſo that all which can be inferred from her caſe, applicable to your ſubject, is the evident amelioration of ſymptoms which firſt began to take place here under the caſe of the carbonic acid air. I have ſince adminiſtered the ſame air in a conſiderable number of caſes of phthiſis. I can ſay with confidence that in moſt of them it relieved the cough; but in none of them, where the diſeaſe was fully formed, could it be ſaid to produce beneficial effects in any degree equal to thoſe obſerved in Mrs. P's. caſe. In two caſes of apparently incipient phthiſis, the ſymptoms entirely

diſappeared under its uſe ; but the difficulty of diſtinguiſhing certain ſtates of ſimple catarrh from the firſt ſtage of genuine phthiſis, leaves it with me ſtill a matter of doubt, whether theſe two caſes were ſtrictly of the latter deſcription or not.

One remark on Mrs. P's. caſe is likewiſe obvious, that although her diſeaſe had proceeded to a very formidable length, with every ſymptom which characterizes the laſt ſtage of phthiſis, yet as it originated in a pleuriſy, brought on by a ſudden cauſe, and without evidence of any particular prediſpoſition to phthiſis, it may have been a ſimple impoſtume in the lungs, unattended by tubercules.

Your's, &c. &c.

J. EWART.

Dr. Pearſon has lately given from Dr. Bergius an intereſting experiment on the celebrated remedy of *cows-breath* in conſumption. A Swediſh lady, who had been ſubject to ſpitting of blood, was affected with cough, great expectoration and night ſweats. She was exceedingly emaciated; difficulty of breathing rendered it neceſſary to bolſter her up : ſhe had conſtant diarrhoea and ſwelling of the feet. In this laſt ſtage of conſumption, when the phyſicians had relinquiſhed all hope, a large hall was provided with ſtalls for four cows, and with a ſtage on a level with the heads of the cattle, upon which the patient's bed and chairs were placed. She took poſſeſſion of this ſtation in September: in a month ſome amendment had taken place; and by Chriſtmas all her ſymptoms were ſurpriſingly mitigated. Her fever was abated ſo much that her pulſe had become natural. In ſummer ſhe was able

to

to quit her habitation; ſhe gained fleſh; the cuta- a/
menia returned; and ſhe had to complain only of a ſlight cough and quickneſs of breathing when ſhe walked. The enſuing winter ſhe would not ſubmit to paſs her days in the hall with her cows. In the ſpring ſhe caught cold, and ſuffered much from inflammation of the lungs. The phthiſical ſymptoms returned in autumn; but ſhe now refuſed even to paſs her nights near the cows; ſhe died at the end of winter. The progreſs of this caſe during the firſt winter differs ſo totally from the conſtant courſe of conſumption, eſpecially when the patient is ſo far reduced, that we can ſcarce heſitate to aſcribe efficacy to the plan purſued, Dr. Pearſon thinks the patient's eſcape from imminent death may be imputed to the lowered atmoſphere and the carbonic acid produced by the reſpiration of the cattle. I do not ſuppoſe much will be attributed to the balſam of their breath.

If nothing was owing to the fumes of volatile alkali; with which the atmoſphere of the hall muſt have been loaded, we may at leaſt conclude that no injury is likely to ariſe from the ſpirit of hartſhorn in the apparatus repreſented in Pl. IV.

In the pamphlet whence this obſervation is taken, the beneficial effect of the atmoſphere of the Weſt India ſugar-houſes in conſumptive caſes is noticed. Carbonic acid abounds in theſe places. I have received intelligence of the compleat recovery of a conſumptive patient who conſtantly breathed the air of an American tar-houſe, which I ſuppoſe may be of much the ſame quality as that of the ſugar-houſes.

The following fact I ſhall not attempt to force into the ſervice of my ſpeculations. I leave it, as the re-

later

later has judiciouſly done, to be determined by others whether the kind of atmoſphere the patient breathed for ſo long a continuance had any ſhare in the ultimate effect. That much was owing to another obvious cauſe I do not pretend to doubt, and it ſeems worth preſerving as an inſtance of the good effect of long-continued nauſea and repeated vomitting. Moreover, the narrative may ſuggeſt the trial of complicated powers where the ſingle fail. Turn and twiſt our means how we can, we may eſteem ourſelves happy when we ſucceed at laſt.

Letter from Mr. CHISHOLM *to* Dr. EWART.

Bath, February 16, 1795.

DEAR DOCTOR,

The caſe which you deſired I would ſend you an account of, was as follows :—A negro man, a ſervant of mine, aged 28 years, of a ſtrong muſcular make, a bricklayer, in December 1787, after ſpending ſome days in hard drinking, and dancing in the open air, was ſeized with a violent pleuriſy, attended with ſtrong fever, and all the uſual ſymptoms; he was ſeveral times let blood and bliſtered; he alſo took a good many doſes of James's fever powder; by which the ſymptoms of general, as well as topical inflammation, were much abated, and it was expected he would ſoon recover. He however continued to complain, and in a few days it became evident, that matter was forming in the right lobe of the lungs; ſome weeks thereafter he ſuddenly brought up a conſiderable quantity of ill-digeſted matter, mixed with much blood. I immediately on this had him removed to my own houſe, where,

where, during two months, both food and medicine were adminiſtered to him with the greateſt attention. During all that time, however, he continued to be afflicted, with a moſt inceſſant cough, expectorating conſiderable quantities of very ill digeſted matter, always much tinged with blood, a great degree of hectic fever, and at laſt profuſe colliquative ſweats, with great loſs of ſtrength. I was perfectly ſatisfied he muſt ſoon die, of which he himſelf was ſo much convinced, that he requeſted I would ſend him home, as his wiſh was to die in his own houſe. I then propoſed he ſhould try the effects of a ſhort voyage at ſea, to which he conſented; he was accordingly ſent in a chaiſe to our neareſt ſhipping place, diſtant about 20 miles, with directions to have him put on board of one of the ſmall veſſels employed in the coaſting trade of Jamaica. He was accordingly put on board of a ſingle decked veſſel, about ſixty tons burden, the only one at that time about to ſail from our port, and I heard no more of him for ſix weeks; at the end of that time I received a letter from the perſon who had the care of the wharf, informing me he was landed there in a dying condition, and deſiring I would ſend a chaiſe for him; which I accordingly did, with directions to make very ſhort ſtages. At the end of four days he was brought to me, and to my aſtoniſhment appeared in good ſpirits, and ſeemed convinced he ſhould recover. On examining I found his pulſe good, the hectic fever having entirely left him, and although he had ſtill a ſhort teazing cough at times, there was nothing expectorated. From that time he took no medicine whatever, but was plentifully ſupplied with nouriſhment, conſiſting principally of panada, rice, and milk, in three months was perfectly reſtored to health and ſtrength, and went to work as

uſual;

uſual; he is ſtill alive, and in good health, and has never had any return of his pulmonary complaints.

The account he gave of his voyage was this :— Immediately on the veſſels ſailing, he was ſeized with a violent vomiting, occaſioned by ſea-ſickneſs, which continued with ſhort intervals, during the whole time he was on board; that being unable either to ſtand or ſit up much, he ſpent the greateſt part of the time, under the deck of the veſſel, lying on the top of the cargo, where the air is neceſſarily very bad, as theſe veſſels are generally loaded either with hogſheads of raw ſugar and puncheons of rum, or barrels of ſalted beef and pork, and I believe are very ſeldom ventilated. The only nouriſhment he took was ſhip biſcuit, pounded and mixed with water; he was, in conſequence, when firſt landed, reduced to ſo great a ſtate of debility and languor, he imagined he was dying, but after a night's reſt, and having taken a good deal of wholeſome nouriſhment, his ſpirits were reſtored, and he found his original complaints had in a great meaſure left him.

My own opinion at the time was, that his cure had been effected by the frequent vomiting, not having ever heard any thing of the beneficial effects of ſowered air. What ſhare that might have in the cure, you are a better judge; the caſe was ſimply as above ſtated, on the truth of which you may rely, every part having paſſed under my own daily obſervation, excepting during the time he was on board the veſſel; and of the truth of his account of that, I have not the ſmalleſt reaſon to doubt.

I am, your's, &c. &c.

To Dr. Ewart. JAMES CHISHOLM.

Extract

Extract of a letter from Dr. CARMICHAEL.

Birmingham, March 1795.

I. B. æt. 45, was attacked about four months ſince with difficulty of breathing, attended at times with pain under the ſternum, and commonly with a ſenſe of tightneſs of the thorax, frequent cough, with copious expectoration of a tough whitiſh fluid, p. 96, body regular, appetite variable. He has ſeldom paſſed four and twenty hours without a material aggravation of all his ſymptoms. Was firſt attacked with this diſorder ſix years ago, and has regularly ſuffered very ſeverely from it every winter ſince that period; it has always left him about the beginning of May, and he has kept free from complaint during the ſummer and autumn months. He has tried many remedies, but never with more than very tranſitory relief.

February 14, 1795, I directed him to inhale daily a mixture of hydrocarbonate and atmoſpheric air, in the proportion of 1 to 19.—15. No ſenſible effects from the uſe of the hydrocarbonate; the ſtrength of the mixture was therefore increaſed in the proportion of 2 to 18.—16. No vertigo, nor any other ſenſible effect produced by the uſe of the modified air. The proportion ſtill farther increaſed to 4 to 18.—17. Conſiderable vertigo produced by yeſterday's doſe, which returned at intervals, attended by head-ach during the day. Breathing much relieved, even during the act of inhaling the modified air, and has ſince continued tolerably eaſy. Slept better laſt night than he has been accuſtomed to do for ſome months.—22. Hydrocarbonate continues to produce conſiderable giddineſs,

breathing,

breathing, except ſome ſhort intervals of ſlight return, continues much eaſier. Cough leſs frequent, expectoration much diminiſhed. Continues to enjoy comfortable ſleep.—27th. Had a conſiderable return of difficulty of breathing on the afternoon of the 25th, which, however, abated ſo much before his uſual bed-time, as not to prevent him from paſſing the night comfortably. Cough infrequent, and rarely attended with expectoration. Has for ſome time paſt had no pain under his ſternum, and rarely any ſenſe of tightneſs of his thorax.—March 4. He is in every reſpect ſo much better, that he intends to return to his uſual occupation (making moulds in a caſt-iron foundry) on the 9th inſtant. Modified air continues to produce vertigo.—March 9. He continued without any return of his complaint, and returned to his employment as he intended; but after working for a few hours only, he was obliged to deſiſt, by a return of the ſenſe of tightneſs on his thorax, and conſiderable difficulty of breathing.—Breathing increaſed in difficulty towards evening, and ſtill continues, attended by frequent dry cough.—13. Continues to breathe with conſiderable difficulty; p. 100; ſleepleſs nights; cough more frequent; but now attended with conſiderable expectoration.—17th. Difficulty of breathing continued until yeſterday; has paſſed a better night than uſual; and this morning finds himſelf much better.—20. Breathing continues eaſier; cough much leſs frequent; and quantity of expectoration diminiſhed. Has ſlept for ſome nights paſt comfortably, p. 86. Modified air continues to produce conſiderable vertigo.—29. Continues uniformly to recover; his cough is very trifling, and he expectorates better, his ſtrength is ſo much improved, that he can uſe conſiderable exerciſe without

out inconvenience. Sleeps uniformly well.—He returns to work to-morrow, but for the preſent is to work within doors. He is of opinion that he is in every reſpect equal to the undertaking.

I remain,

Dear Sir,

Your's, &c. &c.

J. CARMICHAEL.

XIX. Mr. WATT's *hints on the operation of different airs.*

Heathfield, June 17, 1794.

DEAR SIR,

Having never made the art of medicine my particular ſtudy, I ſhould not have troubled you with my crude ideas upon the uſe of pneumatic medicines, if your approbation of what I mentioned to you, joined to my earneſt deſire to aid your endeavours, with the hope that poſſibly ſome idea might be ſtarted, which may ſave other parents from the ſorrow that has unfortunately fallen to my lot, had not urged me to ſtep over the bounds of my profeſſion.

It appears to me, that if it be allowed that poiſons can be carried into the ſyſtem of the lungs, remedies

may

may be thrown in by the ſame channel. Remedies for ſome fatal or dangerous diſorders may, poſſibly at leaſt, be found in the claſs of airs, which admit of many *known* modifications, and doubtleſs many more ſtill to be diſcovered:—which of theſe may prove beneficial in conſumption, and other analagous diſorders of the lungs, remains to be aſcertained by experiment. You have ſhewn that oxygene air is hurtful in many caſes of theſe diſorders, though beneficial in ſome caſes of aſthma; its oppoſites inflammable, azotic, and fixed air, ſeem then to be thoſe which are moſt likely to be uſeful in phthiſis: But there are alſo ſubſtances which ſome eminent phyſicians have thought might be uſefully employed even in the ſtate of powder, ſuch as Peruvian bark, the calces of lead and zinc, with other aſtringents.

To the uſe of powders, however finely *mechanically* divided, I think there are ſome objections; particularly I doubt whether they could enter the minute veſicles of the lungs; but if ſuch ſubſtances can be *chemically* divided and obtained in the ſtate of ſolution in air of ſome congenial ſpecies, they might have their full effect.

It is well known, that inflammable air, when produced by the common proceſs from iron and vitriolic acid, always carries with it, even through water, a large quantity of iron; ſome of which it afterwards depoſits, but very probably ſome part ſtill remains ſuſpended. If iron ſhould then be eſteemed a proper medicine for diſorders of the lungs, we are thus furniſhed with the means of obtaining it in a ſufficiently divided ſtate; and to free it from any adherent acid, it may be paſſed through a cauſtic alcali.

If

If the calx of zinc is thought preferable, it is ſuſpended in inflammable air in great quantities, by applying water or ſteam to redhot zinc in cloſe veſſels, and probably alſo by the common proceſs of making inflammable air from zinc by vitriolic acid. The calces of zinc are very efficacious in healing external ſores; and are very likely to be ſo in internal ones, provided they can be applied, as I think they may, by the means indicated.

Charcoal has lately been found extremely efficacious in correcting putridity, and in diſpoſing ulcers to heal. It ſeems to me, that no ſubſtance is diſſolved in inflammable air in ſuch quantities as charcoal, nor more intimately united. If water is applied to redhot charcoal in cloſe veſſels, the heavy inflammable air is produced in large quantities; and this air has been found to contain inflammable air, properly ſo called, fixed air, ſeparable by water or by alkalies, and ſome other ſubſtance, which, when the inflammable air is deflagrated with oxygene air, produces fixed air. This ſubſtance I conſider as charcoal in a ſtate of ſolution; for were it fixed air completely formed, it would be ſeparated by the means mentioned. Whether charcoal in this ſtate could be decompoſed by any exceſs of oxygene in the blood of conſumptive patients, I cannot ſay; but it ſeems likely that it would; and at any rate it would act as charcoal powder does, and therefore highly merits trial.—[Since this was written, theſe conjectures have been verified; no ſpecies of air having been found ſo effectual in phthiſical caſes as the heavy inflammable air.]

As fixed air is a ſaturated ſolution of charcoal in oxygene air, it is not probable that the lungs can decompoſe it; we ſhould therefore only look to its

effects as an antiſeptic. As the lungs, when doing their duty, ſhould ſeparate, and throw out fixed air, it is not probable they will abſorb it, though it may have ſome effect merely by excluding the oxygene of the common air.—[It ſeems now certain that the lungs can abſorb fixed air in toto, and that it changes the ſtate of the blood.]—I think, however, it will be found to have moſt beneficial effects in caſes of a putreſcent tendency; or if you do not like this theoretical phraſe, where the breath and expectorated matter are fetid. The ſpecies I would recommend is that from fermentation, and the means, keeping a veſſel of fermenting wort cloſe by the patient, which will in general be found grateful to him.* Fixed air, from vitriolic acid and calcareous earths, may be occaſionally much contaminated by other acids. The oil of vitriol of commerce is generally impure, containing ſulphureous acid, with the nitrous and marine; it ſhould be rectified for the purpoſe of medicine.

If it be certain that butchers are exempt from phthiſis, putrid animal effluvia may be uſeful; and if the matter which conſtitutes the ſmell be not the uſeful part, it may be corrected by powder of charcoal, which does not otherwiſe hinder the progreſs of putrefaction. The ſmell ſeems to be owing to ammoniacal hepatic air.

The mixture of azotic and fixed air to be obtained from burning charcoal (firſt freed from bitumen by heat) might be tried, but I ſhould hope more from the heavy inflammable air of charcoal.

The

* I know that Mr. W. ſpeaks here from attentive obſervation.—T. B.

The oxygene air may alſo be impregnated with various ſubſtances. When it is made by paſſing the ſteams of ſp. nitri through a redhot tobacco-pipe, it is highly charged with a white powder, ſome part of which it lays down on the contact of water; when produced in glaſs veſſels, I have never ſeen it contain any ſuch white matter. An eminent phyſician of your acquaintance, previous to my mentioning to him the ideas I now ſend you, obſerved to me, that the oxygene air from heated manganeſe, had a peculiar taſte and ſmell; and that unleſs ſome other facts led to aſcertain the ſubject, he ſhould be at a loſs to determine whether ſome of the cures you mention *might* not be attributed as much to the manganeſe as to the oxygene. He alſo, a priori, had entertained ideas of the good effects of ſubſtances diſſolved in airs.

It would ſeem that the more pure the oxygene air can be obtained, ſo much the fitter it is for medicine, but the facts here mentioned may ſerve as cautions, as to the ſubſtances from which it ſhould be obtained.

In regard to the manner of breathing theſe medicinal airs, I think it will be done beſt from bags of ſome very flexible and light ſubſtances, ſuch as very thin leather waxed, or oiled ſilk. If a ſmall tube be inſerted into the mouth of the bag, the air may be preſſed out oppoſite the patient's mouth, in caſes when they are too weak to make extraordinary exertions of the lungs, or rooms may be filled with the proper mixture of airs.

It would be deſirable that a liſt were made out of all ſubſtances, which are known to be ſoluble in air of any kind, or are of themſelves reducible to vapour or

ſteam, that experiments may be made upon their ſanative effects in caſes of diſeaſed lungs. The liſt will prove more numerous than may appear at firſt glance.

Having now explained my general ideas, I ſubmit them to your correction.

And remain, &c.

J. W.

July 14, 1794.

DEAR SIR,

I ſend you with this, drawings of my apparatus for producing and receiving the various airs which may be ſuppoſed to be uſeful in Medicine, with a deſcription or explanation of the apparatus, which, if you think it worthy publication, I hope may at leaſt prompt ſome younger and more active man to conceive a better.

In conſequence of your deſire, Boulton and Watt have agreed to manufacture theſe machines for the public. We have no deſire to be the manufacturers, except to ſupply thoſe who may not have the ſame opportunities as ourſelves of procuring them; the price ſhall therefore be as moderate as we can make it; and thoſe who chooſe to have them made by others, ſee what is to be done.—Wiſhing you to be ſucceſsful in this undertaking, which promiſes to be of ſo much utility to mankind.

I remain, &c. J. W.

To Dr. Beddoes.

Sept. 2, 1794.

DEAR SIR,

You deſire me to ſend you a more particular account of my obſervations on the medicinal airs than was contained in my former correſpondence on that ſubject. In my letter of June 17th, I mentioned that it ſeemed to me that the heavy inflammable air, or carbonated hydrogene, being principally a ſolution of charcoal in inflammable air, was more likely than any other to correct any diſeaſe ariſing from ſuper-oxygenation of the blood. I could not, however, foreſee that its effects would be ſo powerful in ſome reſpects as they have proved. In the beginning of July, I made ſome of this air by the application of water to redhot charcoal in a cloſe veſſel. Its ſmell was ſomewhat hepatick, from the new caſt iron veſſel it was made in, and was alſo contaminated, by a bad lintſeed oil varniſh in the refrigeratory, its taſte was that of fixed air, though more feeble. I inhaled a little of it cautiouſly, but had ſcarce withdrawn the pipe from my mouth before I became ſo giddy, that I could not ſtand without a ſupport. I had alſo conſiderable nauſea. A healthy young man, who ſtood about 6 feet from the hydraulic bellows when I diſcharged about a cubic foot of this air, was affected in the ſame manner, as it paſſed by him towards an open door. Another young perſon, merely from ſmelling to it as it iſſued from the bellows, fell upon the floor inſenſible, and wondered where he was when he awaked. None of us experienced any diſagreeable effects in conſequence of the vertigo, &c. only in going to bed ſix hours afterwards, I felt ſome ſmall remains of the vertigo. Several other perſons have inhaled it ſince; and all were affected in the ſame manner. I have no doubt, from

what I have obſerved, that if inhaled in a pure ſtate, this air would ſpeedily bring on fainting and death; when given as medicine, it ought therefore to be much diluted with common air, I ſhould think, with 12 times its bulk. Its effects upon diſeaſed lungs you are better qualified to ſpeak to, and I truſt you will give the neceſſary cautions for the uſe of ſo active a medicine, in a more diſtinct manner than I am qualified to do.

About the ſame time, I made ſome inflammable air by means of zinc; it contained a very conſiderable quantity of the flowers of that metal in a ſtate of ſuſpenſion, which had the appearance of grey ſmoke, as it was diſcharged from the bellows. I breathed this air 3 or 4 times without being ſenſible of any immediate effect; nor could I have diſtinguiſhed it in that manner from common air, though when I blew it out of my lungs againſt a lighted paper match, it took fire. Next morning I ſpit up ſome mucus very ſolid, and at moſt as elaſtick as caoutchouc, and the ſame in a ſmaller degree the ſecond morning; this I attributed to the calx of zinc, which I apprehend it contains in a ſtate of ſolution, as well as of ſuſpenſion.

Of fixed air, I have little to ſay. I have occaſionally breathed it in larger quantities than were agreeable, and always experienced flying ſtitches in the muſcles of my breaſt in conſequence, but they ſoon left me without any medicinal help.

Conſidering that no ſpecies of artificial air is obtained except water is obviouſly preſent, or that there is reaſon to ſuſpect it may be contained as an element, or part of one of the ſubſtances concerned, and that Dr. Prieſtley obtained fixed air from aerated barytes, by paſſing ſteam over it when in a redhot ſtate, though

it

it would yield none by a mere dry heat, I concluded, that if water or ſteam were applied to calcareous earths when redhot, they would readily part with their fixed air. I put 1½lb. of chalk broken into ſmall pieces into the pot of my apparatus, and, when redhot, admitted ſmall quantities of water. I obtained about 4 cubic feet of fixed air, extremely pungent to the ſmell, and greedily abſorbed by water. The laſt portion was fixed with ſome inflammable air from the iron pot, and the chalk was found to be nearly cauſtic, but had no way changed its form.

This air was free from any ſmell ſimilar to that of aquafortis, which that produced by means of vitriolic acid generally has, and perhaps was more pure.

In purſuance of the ſame idea, I concluded that nitre might yield its dephlogiſticated air leſs reluctantly, if water were added when it was redhot. I put 4 ounces of nitre into an iron pot, and, by mere heat, obtained about 400 cubic inches of air, which, being waſhed in its paſſage through the ſpiral refrigeratory, did not taſte of ſpirit of nitre, though it ſmelled ſlightly of it. Fearing that on the addition of water ſome inflammable air might be produced, and there might be an exploſion, I removed the refrigeratory and bellows, and then admitted ſome water. Air immediately iſſued in quantities from the conducting pipe of the pot; and this air was found, on the application of a match, to be dephlogiſticated; but ſome ſpirit of nitre iſſued at the ſame time, and probably ſome azotic air. The pot was conſiderably corroded by the nitre, which had found an iſſue at ſome defective places, that has hitherto prevented a more complete experiment from

being made. It would ſeem, from theſe appearances, that my reaſoning was right, and that nitre may in this way be made to yield all its air in a moderate heat. It ſtill, however, remains a deſideratum to find veſſels which can retain in it a red heat for a ſufficient time.

I put 1½ pound of the Mendip manganeſe you were ſo kind as to ſend me, into the iron pot, and, by dry heat, obtained from it about 1½ cubic foot of air; the firſt and laſt portions ſeemed, by the taſte, and by its extinguiſhing flame, to be fixed air, about half a cubic foot was dephlogiſticated. When it had ceaſed to give air by the heat, I added water, and obtained a conſiderable quantity of fixed air, ſimilar to that from chalk, but in which a grey powder was ſuſpended in conſiderable quantities, which gave the appearance of ſmoke, as it is iſſued from the bellows. A perſon who breathed a little of this air undiluted, experienced a ſlight vertigo and nauſea. May not this proceed from the powder ſuſpended in it?

The purity of the dephlogiſticated air, which you obtained by means of vitriolic acid from the Exeter manganeſe, may not be wholly owing to its ſuperior purity, but to your mode of diſengaging it; for I apprehend concentrated vitriolic acid will diſengage very little fixed air, even from marble, as it ſoon covers it with a coat of gypſum, which protects it from any further action of the acid. If, therefore, this air can be freed ſufficiently from any taint of the acid, the method you have followed ſeems by much the beſt mode of obtaining it, and perhaps the cheapeſt.

In reſpect to pure azotic air, I have tried no proceſſes, but the method I mentioned to you in June laſt,

laſt, of obtaining a mixture of azotic and fixed air from burning charcoal ſucceeded perfectly.

I made a chaffing diſh about 6 inches diameter, and nine inches deep, into one ſide of which, near its middle, there was inſerted a pipe one inch diameter; to this pipe was joined another about 3 feet long, paſſing through a trough filled with water, and connected with the hydraulic bellows, the latter being ſlowly elevated, were filled with the air which had paſſed through the burning charcoal in the chaffing diſh, and this air, upon being poured out of a cup over a lighted candle, extinguiſhed it immediately. Large inhalations were made of it by ſome of my aſſiſtants, without injury to themſelves; but, upon me, it produced effects ſimilar to thoſe of fixed air. Its uſes in medicine I cannot pretend to predict; but if azotic air is found uſeful, this may be given in any caſe, wherein fixed air will be hurtful.

I remain, J. W.

To Dr. Beddoes.

I have juſt made an air, which, as it has great powers, may, for ought I know, have great virtues; my experience extends only to its bad qualities—*Pyro-ſarcate.* I put 2 oz. of lean beef in the fire tube, and obtained, by mere heat, 250 c. i. of air, highly fœtid, like an extinguiſhed tobacco pipe; inflammable, with a very blue flame; little diminiſhed by lime and water. —*Pyr-hydro-ſarcate*, on adding water to the redhot charcoal of this beef, I obtained 600 c. i. of air, with a foetor not ſo bad as the other; burning with an orange-coloured flame; loſing not quite $\frac{1}{13}$ in lime water.

ter. The ſmell of the firſt made me ſick, though I did not inſpire any purpoſely, and not above one third of the quantity mentioned was let looſe in my laboratory, and 3 doors and a chimney were open ; we were, however, obliged to leave the place for ſome time. The P. H. ſarcate ſeemed to poſſeſs the ſame property, but was more cautiouſly treated. G. was giddy all the afternoon. *Pyro-Comate.* Next day, 2 oz. of woollen rags were put into the tube ; they gave, by mere heat, 800 c. i. of air ; fœtid, though not ſo offenſive as the other ; burning with a deep blue flame ; not tried with lime and water.—*Pyr-hydro-comate*, by addition of water to the redhot charcoal, gave above 1½ cubic foot of air, fœtid, but more like vol. alkali in ſmell—burning with a yellow flame ; loſing 1-5th by waſhing with lime and water ; part was undoubtedly alkaline air and abſorbed by the water ; the water in the refrigeratory was ſtrongly impregnated with fœtid vol. alkali. Though none of either of the airs was inſpired, that could be avoided, I had a ſlight, though uncommon, nauſea, attended with ſome elevation of ſpirits, all that evening, but no heat or thirſt. In ſhort, it was very like the effect of the fumes of tobacco on an unexperienced perſon : In bed I was reſtleſs, though without pain or particular uneaſineſs, I could not ſleep. Next day the nauſea, and ſome giddineſs, continued, or rather increaſed, and a head-ache came on.—The uſes of this air, if it has any, I leave you to find out. I think I ſhall have no more to do with it, or with animal ſubſtances : One may diſcover, by accident, the air which cauſes typhus, or ſome worſe diſorder, and ſuffer for it.

JAMES WATT.

October 7, 1794.

XX. *Facts*

XX. *Facts and conjectures reſpecting the medicinal uſe of certain ſolid and liquid ſubſtances.*

Extracts of letters from Dr. GARNET.

SIR,

Were we poſſeſſed of methods of increaſing or diminiſhing the quantity of oxygene in the ſyſtem, we ſhould have advanced a great way towards the cure of ſeveral formidable diſeaſes. The method of doing this by inſpiration is ingeniouſly conceived, and may, where reourſe can be had to it, anſwer the purpoſes, but perhaps cannot be generally uſed.—In conſidering this ſubject in the courſe of the laſt year, the following queſtion occurred to me: *when oxygene exiſts in the ſyſtem in too great a quantity, may not its quantity be eaſily and ſucceſsfully diminiſhed by* liver of ſulphur *exhibited by the mouth?* When this ſubſtance is moiſtened with water, the water is decompoſed; the oxygene uniting with the ſulphur, and forming ſulphuric acid, while its hydrogene is diſengaged in large quantity, which diſſolving a portion of the ſulphur, forms ſulphurated hydrogene gas, which will be readily diſſolved by the chyle and conveyed into the blood. It is well known that hydrogene, at a much lower temperature than that of the human body, has a ſtrong attraction for oxygene, with which it unites and forms water; and I have ſcarcely a doubt that this will take place when the ſulphurated hydrogen is taken into the blood; and from ſome experiments which I have made, I even ſuſpect that the quantity of oxygene in the blood might be ſo far diminiſhed by means of liver of ſulphur, that a real ſcurvy would be produced. If

I am

I am right, will not this prove one of the moſt effectual remedies in florid conſumption, as well as ſome other diſeaſes which depend upon too great a quantity of oxygene in the blood? That the kali ſulphuratum is a powerful medicine I have been fully convinced in caſes where I have given it to ſtop or leſſen a ſalivation which has been brought on by mercury. In theſe caſes I have ſeveral times tried it, and have never ſeen it fail, and in 24, or at moſt 48 hours after the firſt exhibition of this remedy, the ſalivation is much abated. I ſuppoſe that the mercury derives moſt of its activity from its being in the ſtate of an oxid, for crude mercury poſſeſſes little or no power.* On the decompoſition of the water in which the medicine is given by the kali ſulphuratum, ſulphurated hydrogene gas is produced and conveyed into the blood, where the hydrogene unites with the oxygene of the acid menſtruum of the mercury, and forms water; while the ſulphur will convert the mercury into an ethiops which is very inert.—The benefit derived from hepatiſed waters, and from kali ſulphuratum in *colica pictonum*, ſome inſtances of which I have noticed in the laſt edition of my treatiſe on the Harrogate waters, ſhows the great power of ſulphurated hydrogene gas, which probably renders the lead as well as the mercury inert.

The laſt winter, during froſty weather, I walked a good deal for ſeveral days. I at firſt found no bad effects from this exerciſe, but my ſpirits were remarkably good, and I found myſelf leſs affected by cold than uſual. My friends, however, obſerved, that my countenance (which is naturally inclined to red) was more florid

* In the form of mercurial ointment, the mercury is evidently oxygenated by continued frituration.

florid than uſual. In a few days I was ſeized with a difficulty of breathing, great tightneſs in my breaſt, and a ſhort dry cough : I tried ſeveral remedies generally made uſe of, ſuch as inhaling the vapour of water, bliſters, opiates, &c. without relief. On reflecting that having uſed almoſt conſtant exerciſe, for many days, a much greater quantity of oxygene than uſual would be taken into the lungs by the increaſed action of inſpiration, (probably more than the increaſed muſcular exertion required), and likewiſe that the barometer was very high, and the air very cold at that time, both which circumſtances would occaſion the preſence of a greater quantity of oxygene in a given *bulk* of air, I imagined that my ſyſtem was ſuperoxygenated. I began with taking about half a drachm of kali ſulphuratum diſſolved in water every two hours,—likewiſe diſſolving the ſame quantity in boiling water, and inhaling the vapours from it by means of Mudge's machine, every hour. Before 20 hours had elapſed, I found the ſenſe of tightneſs in the thorax conſiderably leſſened, ſome degree of expectoration came on, and the cough was much relieved. In three days, by purſuing this method, my countenance became conſiderably paler, and I found myſelf perfectly free from any complaint. Since that time I have preſcribed the kali ſulphuratum in ſeveral caſes of florid conſumption, and with conſiderable relief ; and in ſome other caſes where there were evident marks of ſuperoxygenation. In ſeveral of theſe caſes I have ordered a mixture of the kali ſulph: and powder of charcoal, thinking if the charcoal could be conveyed into the blood, it might aſſiſt in diminiſhing the quantity of oxygene, by uniting with it, and forming carbonic acid; at any rate, I thought that it might diminiſh the quantity of

oxygene

oxygene in the primæ viæ, and thus aſſiſt the ſulphurated hydrogene, by permitting a greater quantity of that gas to be conveyed into the blood; but whether it really does produce any good effects, I cannot poſitively ſay. That ſulphurated hydrogene gas is conveyed into the blood, and that either it or its ſulphur is given out by the excretorics, is, I think, evident from the urine of perſons who have drank the ſulphur water at this place, immediately rendering viſible characters written upon paper with a ſolution of ſugar of lead, on ſuch paper being immerſed in it; and likewiſe from ſuch perſons finding their watches and the ſilver in their pockets tarniſhed during the time they are drinking the water, though they do not at the ſame time uſe the bath. If you wiſh for an account of the caſes of conſumption in which I exhibited the kali ſulphuratum, I will ſend them.

When deficiency of oxygene occurs, as is the caſe in ſcurvy, typhus, &c. may not the oxygenated muriatic acid be uſed with great advantage, or perhaps the oxygenated muriat of potaſh would be ſtill better. We have here a large quantity of oxygene looſely attached to the ſalt, which would probably be ſoon ſeparated by the blood. Sir W. Fordyce's account of the efficacy of the oxygenated muriatic acid in typhus, ſtrongly ſupports the opinion.

I am, &c.

THOMAS GARNET.

Harrogate, Dec. 13th, 1794.

SIR,

SIR,

In the month of February, 1794, I was deſired to viſit Mr. L. of Knareſborough.—I found him extremely emaciated; he had a ſhort dry cough, with very little expectoration; and the little which he expectorated was of the conſiſtence of cream cheeſe; he complained conſtantly of a pain in the left ſide. His face, though pale, had a circumſcribed ſpot on each cheek, of a fine florid colour; his tongue and lips were likewiſe very florid; he had cold colliquative ſweats every night; his pulſe, though ſmall, was *ſharp* beating like a ſtretched cord, and he had a conſiderable degree of fever with exacerbations twice a day; his body was rather coſtive; his hair came off in great quantity on paſſing a comb through it, and his nails had in a great degree the curved appearance deſcribed by authors; in ſhort, there was preſent every ſymptom characteriſtic of phthiſis. He had been firſt attacked with theſe complaints about nine months before I ſaw him; they came on with ſymptoms of common catarrh. The expectoration was very conſiderable about ſix weeks before I ſaw him, mixed with ſtreaks of blood, and remarkably fœtid. This diſcharge had gradually leſſened, and become more conſiſtent, attended with an increaſed difficulty of breathing, and pain of his ſide. I found upon inquiry that he was of a ſcrophulous family; and he told me that he was the only ſurvivor of a large family, his brothers and ſiſters having all died conſumptive. Before I ſaw him, moſt of the remedies generally uſed in ſuch caſes had been applied. Bliſtering, bleeding, myrrh, &c. had given him no relief, and his ſymptoms ſeemed aggravated by the bark and opium, which laſt, though given in doſes of from one to three grains,

produced

produced not the leaſt effect upon his troubleſome cough. I directed him to take a drachm of kali ſulphuratum, mixed with half a drachm of powdered charcoal four times a day in tea, and beſides to put a tea-ſpoonful of kali ſulphuratum into Mudge's inhaler, pour boiling water upon it, and inhale the vapour for a quarter of an hour at a time twice a day.— When he had purſued theſe methods for two days, his breathing was ſenſibly relieved, and his cough was by no means ſo troubleſome; he expectorated more freely, and what he expectorated had more the appearance of bland pus. In a few days the expectoration became much leſs conſiderable and fluid; the hectic fever was leſs marked; the cough was much eaſier; he ſlept tolerably at night, and the florid ſpots on his face had nearly diſappeared. His pulſe, though ſtill 120, was much more ſoft; and though the perſpiration was free in the night, the ſweats were not cold and partial as before; his appetite was better, and his bowels quite regular. Encouraged by theſe appearances, I deſired him to perſiſt. In about a fortnight he found himſelf ſo much ſtronger, as to be able to walk about the room five minutes at a time, ſeveral times a day. One day during my abſence, being told that the weather was very fine, and the air very warm for the ſeaſon, he expreſſed a great wiſh to walk out, and continued in the open air for near two hours. In the evening the cough and pain of the ſide returned, and were more troubleſome than ever; he expectorated with difficulty, and in very ſmall quantity; the fluſhing of his face and ſweats returned. The powders were again had recourſe to, but did not afford much relief, though the expectoration became rather more eaſy. Bliſters and opiates did not cauſe any alleviation;

tion; a diarrhœa came on, and after languiſhing about a week, he died. When I firſt viſited him, he had been given over by his apothecary, who had left him declaring that he did not think he could live till the morning. I myſelf did not think he could ſurvive above a day or two.

April 94.—I viſited —— Byron, of Knareſbrough, aged about 40, of a ſtrong habit of body, and in general healthy.—After hard labour for ſome days in cold weather, he was ſeized with a difficulty of breathing, a ſhort dry cough with but little expectoration, a great ſenſe of heat, and face uncommonly florid; he was very reſtleſs and ſlept none; his pulſe was 96, and rather full, and he had ſome pain in his right ſide. I directed about ten ounces of blood to be taken from the arm, and the application of a bliſter to the pained ſide, but he was not in the leaſt relieved by them; the blood drawn was remarkably florid. In the evening I directed him to take a draught with 25 drops of laudanum, in hopes of relieving his cough, and procuring ſome ſleep, but it did not produce the deſired effect, he having a very reſtleſs night. Suſpecting from appearances that the ſyſtem was ſuperoxygenated, I directed him to take a drachm of kali ſulphuratum four times a day in a little tea. He took it four times the firſt day, thought himſelf ſomewhat relieved in the evening, ſlept better than he had done for ſeveral nights, his cough was much eaſier in the morning, he expectorated a little more freely, and the pain in the ſide was gone. He perſiſted in this plan two days more, and then found himſelf perfectly well.—An ingenious young friend of mine, Mr. George Birkbeck, who is now a ſtudent at Edinburgh, was on a viſit with me at the time, ſaw the patient along with me, and was ſurpriſed

at the quickneſs of the cure. Similar caſes are often met with among labouring people in this pure air; and I muſt own that they have often perplexed me. I have generally found that no remedy affords permanent relief; but that the diſeaſe gradually goes off in ten days or a fortnight, if the patient will confine himſelf to his chamber, and more particularly to his bed. I hope, however, that I have it now in my power to ſhorten its duration. No doubt if the patient could have an opportunity of inhaling hydrogene gas, it would alſo remove the complaint.

I am, your's, &c.

THOMAS GARNETT.

Letter from Mr. WILLIAM SANDFORD.

Worceſter, Feb. 20, 1795.

DEAR SIR,

Among the variety of patients that apply for ſurgical aſſiſtance, thoſe afflicted with putrid ulcers form a principal part; the laws of moſt hoſpitals forbid their admiſſion as in-patients; but compaſſion frequently ſuſpends the operation of theſe laws; and it is a melancholy truth, that the general poverty, inattention, and improper conduct of out-patients, often counteract the means directed for their relief.

I cannot flatter myſelf that ſucceſs will invariably attend the application I am about to recommend for putrid

putrid ulcers mortifications; but my own experience has proved it to be efficacious in ſome of the worſt of theſe caſes, and I can add the reſpectable teſtimony of my colleagues, Mr. Jeffreys and Mr. Cole. I feel ſatisfaction in communicating my obſervations to you as they are fundamentally connected with a ſyſtem of medical practice, from which you have ſhewn by experiments, that great expectations may be juſtly entertained.

Accounts of the good effects ariſing from the external application of charcoal in a ſtate of combination, or in that of fixed air, have been publiſhed by Mr. Juſtamond, Dr. Percival, Dr. Dobſon, and more recently by the ingenious Dr. Ewart of Bath. Various periodical publications of modern date, have made the efficacy of charcoal in ſweetening putrid ſubſtances ſufficiently known. Dr. Johnſtone of this city, informs me, that he has found this ſingular ſubſtance mixed in the proportion of two drachms with two ounces of ſyrup of roſes, to be very ſpeedily efficacious in removing apthous, and putrid ulcerations of the tongue and palate. I have been likewiſe informed of ſeveral caſes in which charcoal has been adminiſtered with ſucceſs as an internal medicine.

In private as well as public practice, it has long been cuſtomary to apply fermenting mixtures to ſphacelated or mortified parts. Mr. Ruſſel and Mr. Jeffreys of this city, whoſe extenſive practice has afforded them many opportunities of obſerving its effects, aſſure me (and particularly the former) that they have found no application ſo generally uſeful as yeaſt in every ſpecies of mortification, attended with an offenſive diſcharge, except that which Mr. Pott has ſo well de-

ſcribed as taking place in the extremities of old people. Mr. Jeffreys informs me, that many years ago it was his cuſtom to apply to putrid ulcers ſtupes wrung out of the common fomentation, and ſprinkled with *ſpiritus mindereri* in a ſtate of effervescence. The effects, he adds, were beneficial; and the books of the Worceſter infirmary ſhew, that he followed this practice in 1751. The late Dr. Cameron and Mr. Edwards alſo employed it with great ſucceſs, as far back as 1759. The real efficacy of fermenting applications, depends, perhaps, ſolely on the quantity of fermenting matter they contain; in other words, of carbonic acid generated and has no connection with ſeveral articles introduced by the fancy of different practitioners.

If the opinion be juſt, we ſhould expect that the effect of fermenting applications, and of the carrot poultice among the reſt, would ceaſe with the production of carbonic acid air; and this really appears to be the caſe. But by the application of charcoal, not only is the putrid condition of the ulcer corrected, but pus of a more bland nature is generated, the granulations are much quicker in their growth, and the diſpoſition to heal is much quicker after this than after any other dreſſing I have ſeen employed. The granulations, indeed, frequently after a ſhort time, become very luxuriant, and require early preſſure to ſuppreſs their growth.

Putrid ulcers, as I have been credibly informed, have been conſiderably benefited by charcoal ſtrewed in fine powder on their ſurface; but of this I cannot ſpeak poſitively from experience; for the pain which it ſeemed to occaſion on ſeveral trials, induced me to lay it aſide, and to have recourſe to the following cataplaſm.

Mix

Mix as much oatmeal and water as appear neceſſary to form a poultice large enough for the part affected. The conſiſtence, after they are well boiled, ſhould be rather thinner than the ſtate in which poultices are generally applied; becauſe it is to receive a large quantity of charcoal, which ſhould be very finely powdered and ſifted. The charcoal ſhould be added, when the poultice is nearly cool enough to be applied, in ſuch proportion as to give the whole a pretty firm conſiſtence, ſince after 6 or 8 hours application it becomes very liquid, particularly if the diſcharge be conſiderable. The poultice, when made, ſhould be ſpread upon a ſoft linen cloth, much larger than the ſpace occupied by the poultice, It will perhaps be thought unneceſſary to inſiſt upon equal ſpreading, or upon making the edges as thick as the centre; but this precaution is too often neglected.

The poultice, after being properly ſecured, muſt be ſuffered to remain at leaſt 12 hours; and unleſs the diſcharge be great, it need not be removed in leſs than 24; and a freſh poultice ſhould always be in complete readineſs before the other is removed; the part ſhould not be wiped more than neceſſary, and that the atmoſphere might not affect the ulcerated part, the poultice ſhould be applied as quickly as poſſible.

When the edges are ſoftened and look healthy, when the effluvia are corrected, and good pus appears on the ſurface, the poultice may be laid aſide. Any other application which the ſurgeon ſhall think likely to promote cicatrization, may be ſubſtituted in its ſtead. I have experienced nothing more generally uſeful than to dreſs the edges with mild cerate, and very plentifully to ſprinkle over the face of the ulcer

a fine powder, compoſed of two parts of Peruvian bark, one of calcined zinc, and one of myrrh.

In mortifications the poultice muſt be continued till the ſloughs or unſound parts are completely thrown off.—Theſe means, with gentle preſſure, generally effect a cure. In one or two inſtances, where the poultice has been laid aſide too early, the ulcers have put on their former ill conditioned appearance, which, however, on returning to the charcoal, has immediately changed for the better. I ſhould not omit to inſiſt with Dr. Crell, on the neceſſity of carefully preparing, finely powdering, and keeping in clean veſſels the charcoal. It adds much to the efficacy of the poultice, if a *very* ſmall quantity of yeaſt be occaſinally ſpread on its ſurface.

The following are a few, out of many caſes, in which the cataplaſm, thus prepared, has been ſucceſsfully employed. If it be found equal in efficacy to any hitherto imagined, its cheapneſs ſeems to give it a claim to be adopted in hoſpital practice.

Case I.—T. B. æt. 64, was admitted an in patient of the Worceſter infirmary, November 23, 1793, as a caſe that required immediate attention; a mortification of the right leg having taken place, which extended from the middle of the upper part of the foot, to about three inches below the knee; a ſeparation of the unſound parts had in ſome places commenced, but the diſcharge, which was ſlight, was highly offenſive and putrid; the back part of the leg, where no ulceration had taken place, was livid, cold, and inſenſible.

He was immediately put into bed, and the limb laid in a large carminative poultice of the hoſpital, compoſed

poſed of bay-berries, æc. in which yeaſt alſo formed a principal part. The next morning I ſaw the patient with Dr. John Johnſtone; he informed me that he had heard of charcoal having been applied externally to mortified parts with great ſucceſs; and as he conceived the preſent caſe was a favourable one for the trial of its effects, it was immediately applied in the form of poultice prepared in the manner before deſcribed.—Though the leg looked better after the application of the poultice with yeaſt, yet the change after the charcoal had been twice applied, (which it was in the courſe of 24 hours) was as favourable as it was rapid. By the time the poultice had been 7 or 8 times applied, a compleat ſeparation of the diſeaſed parts took place; bland pus was produced, and the edges of the ſound parts appeared healthy and clear; as the application was continued, the leg in the courſe of a few days loſt its livid aſpect, and was warmer and more ſenſible to the touch.

Some of the ſloughs, particularly upon the upper part of the limb, when digeſted clearly off, expoſed the tibia; the perioſteum ſloughed a little, but granulations ſoon made their appearance, without any exfoliation of the bone; to this part of the leg, therefore, the poultice was ſoon diſcontinued, and mild dreſſings ſubſtituted in its place. The exterior tendons of the foot were laid bare when that part ſloughed: but this, as well as other parts of the limb, was ſoon clear, and preſented a healthy and granulating ſurface; but ſo large a portion of the true ſkin having been deſtroyed by ulceration, *rendered* the healing proceſs long and tedious. The patient, during the firſt month, took the Peruvian bark in as large doſes as his ſtomach would

bear, together with half a pint *only* of port wine made into negus, in the courſe of 24 hours; afterwards he was allowed two pints of porter per diem, and his doſe of bark was leſſened: he was diſcharged cured, excepting a trifling ulceration upon the inſtep.—*February* 1ſt, 1794.

CASE 2.—I. P. æt. 60, came recommended to the Worceſter infirmary, as an out-patient, Aug. 2, 1794, for a large putrid ulcer of the left leg, with which he had been afflicted for upwards of 4 years; at this time the diſcharge was ſo acrimonious as to excoriate the leg in different parts near the ulcer, which was attended with ſwelling, pain, and inflammation. Being judged in too bad a ſtate to receive much benefit as an out-patient, he was admitted into the infirmary; he took a doſe of calomel the night of his admiſſion, and next morning a doſe of Glaubers ſalts, and the ulcer was covered with a thick poultice of charcoal. When the firſt poultice was removed, which was not till the expiration of 24 hours, the ſurface of the ulcer appeared more favourable, and the quantity of the diſcharge was altered for the better; he repeated the doſe of calomel and ſaline purgative twice again within the ſpace of 8 days, and the poultice was renewed every day for a fortnight longer; a large ſlough was then thrown off from the ulcer, and granulations made their appearance from the bottom, but the edges remained rather callous; theſe parts were dreſſed with mercurial ointment, and the face of the ulcer with the aſtringent powder. The ulcered part filled up in due time, and the man was diſcharged perfectly cured.—*October* 4.

CASE 3.—I. F. æt. 24, a ſoldier belonging to the Scotch Greys, quartered in this city, was admitted an in-patient of the infirmary October 25, for a large ill-conditioned ulcer of the leg, which was at that time in a very putrid ſtate. Immediately upon his admiſſion, the charcoal poultice was applied. When the ſlough of the ulcered part firſt began to ſeparate, it appeared more deeply attached to the ſound parts than any I ever remember to have ſeen, except in the patient (No. 5), and which was produced by mortification in an old ſubject: the degree of inflammation in the ſurrounding parts of the ulcer was very great; he was bled freely, and took ſaline medicines for ſome time; the charcoal poultice was applied to the ulcer, and continued till the ſlough was completely ſeparated and digeſted off, which took place in about 6 weeks, when the cerate edging and aſtringent powders were made uſe of, and would moſt probably have completed the cure, had the patient paid more regard to his conduct; but having twice abſented himſelf from the infirmary without leave, and coming home intoxicated, I was obliged to diſcharge him for irregularity.—*December* 26.

CASE 4.—J. I. æt. 24, another ſoldier belonging to the ſame regiment, was alſo admitted an in-patient of the infirmary, November 15, 1793. He had a very large and painful ulcer about the middle of the leg, extending acroſs the tibia, which had been healed at different times, and from ſlight accidents had broken out again. At this time the edges were callous, and the ſurface of the ulcer remarkably foul, with a greeniſh aſpect, and attended with conſiderable inflammation

of

of the ſurrounding parts. The charcoal cataplaſm was applied to the ulcer, and he took every third day a ſolution of Epſom ſalts for the firſt fortnight.

The ulcer, ſoon after the firſt week, loſt its offenſive ſmell, and the ſurface appeared clearer, but no granulations ſucceeded, nor were the callous edges at all ſoftened. I then laid aſide the poultice, and applied mild digeſtives, with the gentle preſſure of a flannel roller. Still the ulcer continued in a very ill-conditioned ſtate, and without the leaſt ſign of further amendment. About this time having ſome reaſon to to ſuſpect his conduct, and hearing from the nurſe of ſome ſuſpicious circumſtances with regard to his linen, upon being queſtioned, he confeſſed that he then laboured under an inveterate venereal complaint.

I then immediately altered my preſent mode of treatment, gave him mercury by the mouth, and dreſſed the ulcer with mercurial ointment, which ſoon produced an appearance for the better.

This caſe exhibited ſtrong proof of the efficacy of of the charcoal, in removing the fœtor, and clearing the ſurface of the ulcer—more could not *here* be expected from it, for reaſons too well known to be alledged.

The man was now made an out-patient, and ſoon after having ſome money left him by a relation, he purchaſed his diſcharge from the regiment, and I ſaw no more of him.

Case 5.—As there are ſome remarkable circumſtances attending the cauſe that required the application of the charcoal poultice in this caſe, I ſhall take the

the liberty to treſpaſs a little upon your time in relating them.

F. M. æt. 60, was brought to the infirmary Oct. 30, with a ſimple fracture of the left leg, occaſioned by a bull treading upon it, he having unfortunately fallen down whilſt endeavouring to ſecure the animal for ſlaughter; by which accident the fibula was tranſverſely fractured immediately above its formation of the outer ankle. The accident happened about 5 miles from Worceſter, and his friends, from an over officioufneſs, which, though well meant, was ill-directed, bound a narrow liſt garter ſo *very* tight round the fractured part, as to preſs in the ends of the bone, and act like a tourniquet on the parts below; he was brought in this ſtate to the infirmary 6 or 7 hours after this misfortune had befallen him. The limb below the bandage appeared perfectly livid, and above it, highly inflamed and much ſwelled. The bandage (which had a little excoriated the ſkin) was immediately taken off; a ſaturnine poultice was applied to the leg, and a ſolution of Epſom ſalts was ordered to be taken. This was at night; I ſaw him next morning, and the limb looked then very unfavourably; the poultice was now laid aſide, and linen cloths wet with a mixture of ſpirit minder; and ſpirit of wine was kept conſtantly upon the part. The day after, veſications appeared near the fracture, with every other appearance of gangrene having taken place; which in the courſe of a day or two terminated in a large ſphacelated ulcer immediately over the fracture, which extended about three or four inches in circumference, diſcharging a putrid and highly offenſive ichor. At this time Dr. Cameron ſaw him with me, and the

cortex

cortex was given him in the form of cold infuſion, with a ſmall quantity of the tincture in each doſe; he was alſo directed to take half a pint of port wine made into negus, in the courſe of 24 hours. His ſtomach bearing the preſent mixture ſo well, I then gave him a mixture with extract of common oak bark, (quercus) a preparation that Dr. R. W. Darwin, ſome years paſt, informed me had been applied externally with good effect to ſcrophulous ulcers; for which purpoſe I have often found it ſerviceable; and ſince that time I have very frequently given it *internally*, in moſt of theſe caſes where the Peruvian bark ſeems indicated.

Dr. Lewis remarks, that "an extract made from "oak bark, is ſaid by ſome to be equal in virtue to "that of the Peruvian bark."—*(See Lewis's Mat. Medica*, p. 474*)*.

I have experienced equally good effects from this extract, (if joined with an aromatic) as from that of the true Peruvian bark. Some of the phyſicians of this infirmary have alſo lately preſcribed it with very beneficial effects. With this patient it agreed remarkably well, improved his appetite, and ſupported his ſtrength, which had been greatly reduced. This man's caſe ſeemed to prove, as clearly as any I have met with, the ingenious theory advanced by the late Mr. Hunter, that the "mortification which is preceded by inflammation, is produced and accompanied with increaſe of action and loſs of power."—*(See Hunter on the blood, inflammation, &c.)*—Hence the neceſſity of giving the cortex, or ſome ſimilar tonic, in as large doſes as the ſtomach will bear, and no more alcohol in any form than is merely ſufficient to keep up the *neceſſary* action, and thereby prevent its *exceſs*.

But

But to return to the ſituation of the limb—the ſame day the bark was adminiſtered internally, the charcoal cataplaſm was applied to the mortified parts, and daily renewed at firſt twice, and latterly only once in the 24 hours, till the whole of the ſlough, which was large and deep, was entirely ſeparated and thrown off. When this was effected, the fibula was laid bare, and the fractured part expoſed to view; it was then of courſe to be treated as a compound fracture, and cured by the ſecond intention; the poultice was now diſcontinued; the edges of the ulceration dreſſed with epulotic cerate, and the centre with the doſſils of lint dipped in a mixture compoſed of equal parts of *mel. roſar*, *tinct. myrrh*, and *decoct. cortic. Peruv.* Granulations ſoon appeared; a ſlight exfoliation took place, and the cure went on perfectly well. The man is now able to walk about with the aſſiſtance of a ſtick, and the motion of the foot (which I feared would have been deſtroyed by ſuppuration) has been fortunately preſerved, and is recovering its action.

Case 6.—J. H. æt. 27, was admitted an in-patient November 15, 1794, having a large putrid ulcer of the right leg, about the middle, and acroſs the tibia; he had been afflicted with it for more than 2 years, and it had been in its preſent ill-conditioned ſtate upwards of three months; he had dreſſed it with variety of unguents of different kinds, and at this time it had every appearance of approaching gangrene. The charcoal poultice was immediately applied to the ulcer, and he took the extract of oak bark in the proportion of 15 grains to an ounce and half of ſaline mixture; to each doſe of which 1¼ of aromatic tincture was added every ſix hours. This plan he continued with little alteration for upwards of a month, before the ſlough

was

was completely ſeparated; when this was thrown off, the poultice was laid aſide, and the ulcer treated as before mentioned. The ulcer, from the luxuriance of its granulations, required the preſſure of lead to aſſiſt in the cicatrization.

Case 7.—(Mr. Cole's patient).—O. C. æt. 20, was admitted an in-patient of the infirmary, for a compound diſlocation of the ankle, which had been in ſo bad a ſtate for ſome time previous to his admiſſion, that it was judged neceſſary to amputate the leg, which was according removed at the uſual part below the knee. The man underwent the operation very well. The lips of the ſtump were brought together by ſtrips of adheſive plaiſter, to be healed (as is now generally practiced, I believe) by the firſt intention.

Four days after the operation, the ſtump and thigh appeared much ſwelled, though the bandages were by no means tight. I happened to be in the ward when Mr. Cole removed the dreſſings, and examined the ſtump, the lips of which had receded, and expoſed the face of the ſtump, which we were ſurpriſed to find in an highly offenſive and gangrenous ſtate; added to this unpleaſant appearance, the patient's countenance was pale and ſunk, and his pulſe quick and tremulous.

Mr. Cole immediately ordered him a ſaline mixture with the cortex, and port wine negus occaſionally; a thick charcoal poultice was alſo applied to the face of the ſtump. In leſs than 48 hours every unpleaſant appearance was changed for the better, a good digeſtion came on, and the cure was by theſe unfavourable circumſtances protracted for a ſhort time. The patient ſoon loſt his fever; recovered his ſtrength; and the ſtump did well.

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In this caſe, it was not found neceſſary to continue the charcoal poultice for a longer time than three or four days.

Having informed Mr. Field, who attends the invalids in the houſe of induſtry lately eſtabliſhed in this city, of the good effects of the charcoal applications, he has in conſequence applied it to ſeveral putrid ulcers of the legs, &c.—in ſubjects from whoſe age and other infirmities, little hope of relief was to be expected.

He aſſures me it has *never failed* to effect a ſpeedy and favourable change, by correcting the putrid diſcharge, and producing healthy granulations, with a bland and well digeſted pus.

Two of the caſes in which he has applied it I think merit particular attention. The one was a cancerous ulcer of the ſide, (the breaſt having been removed ſeveral years paſt at the infirmary), extending deep under the axilla. Mr. Field applied the charcoal in *fine powder*, which he ſprinkled very freely over the face of the ulcer, firſt ſmearing it with a very ſmall quantity of yeaſt. In a few days it removed a moſt offenſive fœtor, and procured a healthy aſpect of the ulcer, with a diſcharge of mild and inoffenſive matter. The arm of this patient on the diſeaſed ſide, after ſwelling to an enormous ſize, became gangrenous, and a mortification ſucceeded, with putrid and deep ſloughs upon the wriſt of the elbow; the ſame mode of application was adopted with the hope of removing the intolerable fœtor. Though it was conceived the patient could not live many days, being upwards of 60 years of age, and very much reduced by the pain and long continued diſcharge of the ulceration, the progreſs, however, of

the

the mortification, which ſeemed extending upwards toward the ſhoulder, was immediately checked; in a very few days the ſloughs completely ſeparated, leaving healthy granulations, and the wound, though a very large one, is filling up as kindly as could be expected in a younger or healthier ſubject.

The other was a woman upwards of 50, who, from long confinement to bed, and the effect of conſtant and unequal preſſure, had a deep ſlough formed upon one of the nates, which was dry, perfectly inſenſible, and without any diſpoſition to ſuppuration.

The charcoal powder was applied here as in the former caſe, and retained by a large piece of leather, the edges of which were ſpread with adheſive plaiſter; in leſs than a week a complete ſeparation had taken place, when a dreſſing of mild digeſtive effected an eaſy and ſpeedy cure.

In neither of theſe caſes did the patients complain of any increaſe of pain from the application.

No medicine was given to the laſt; and in the firſt caſe nothing more than a few grains of extr. cicutae, with about 20 drops of tincture of opium at bedtime.

In ſome caſes in which I am now applying charcoal powder, no pain has enſued. The yeaſt has been added in theſe caſes; and it operates as effectually as the cataplaſm.

Believe me, dear Sir, &c. &c.

WILLIAM SANDFORD.

To Dr. Beddoes.

Letter

Letter from Dr. JOHN JOHNSTONE.

Birmingham, Feb. 14, 1795.

DEAR SIR,

Herewith I ſend you an abſtract of trials of ſome of the chemical ſubſtances; I began to make them early in the year 1793, after having ſeen the relations of M. Lowitz and Kels. Many of the experiments of both theſe gentlemen I repeated, and others were inſtituted to ſatisfy my mind on ſome topics relating to putrifaction, a ſubject till lately involved in much darkneſs, and concerning which, our knowledge at preſent is far from preciſe.

Long before the time of M. Kels, Macbride had diſcovered, that the aerial product of fermentation, rectified the ſmell and taſte of putrifying bodies; and there are many accounts of its ſervice in diſeaſes, recorded in the 4th vol. of Prieſtley on air, and in Dobſon's Commentary. But this power, though poſſeſſed univerſally by the carbonic principle, is not confined to it. Subſtances containing oxygene, have it probably in a greater degree. Half an ounce of nitre will produce a more inſtantaneous effect on the ſame quantities of putrid fluids or fleſh, than an ounce of powdered charcoal. The ſame holds good with reſpect to many other oxygenated ſubſtances. The hyper-oxygenated acids, deſtroy putrid ſmells, in very ſmall proportion.

By theſe leading facts, and by many others which it is unneceſſary to detail, I conceived myſelf authorized to make trial of the ſubjects of them, in caſes of diſeaſes which ſeemed to bear any affinity to the proceſs

of putrefaction. Theſe trials I ſhall here claſs together, without any reſpect to the order of time in which they were made, though many of them were made or improved ſince I came to this place in the laſt Autumn, in conjunction with my brother, Dr. Edward Johnſtone.

Ulcerations.—In hardly one caſe of foul ulceration of the extremities have I been diſappointed in the application of carbon, though it has been applied in a vaſt number of caſes under my inſpection. Whether in the form of powder or of liquid (yeaſt), it univerſally renders them clean. In the caſe of Nurſe Purton, an old woman of 80, a patient in the Worceſter infirmary, and who had been afflicted with a ſore leg for almoſt half a century, the carbon cataplaſm never failed to cleanſe the wound, though the application ſometimes gave pain.

During the Autumn of laſt year the meaſles aſſumed a peculiarly putrid appearance in the town of Birmingham and its neighbourhood. Children were generally affected with a very offenſive and obſtinate diarrhœa, during their continuance, and towards the cloſe of the diſeaſe with very foul ulcerations, ſpreading about the face and mouth. In the caſe of a girl of 8 years old, the right cheek was much ſwelled, and the inſide of the mouth was occupied by a foul ſpreading ulcer. Various unguents had been tried in vain, the ulcer ſpread, became black, and every day aſſumed a worſe appearance. The change for the better was very quick after the application of the carbon, and the ulcer ſoon healed. From the ſame cauſe, the roof of the mouth, and the upper gum of an infant were in a dreadful ſtate, in part eaten away, and exceſſively foul. A paſte

compoſed

compoſed of charcoal powder and yeaſt was ordered to be applied, and was effectual in healing the wound, though the ſtructure of the parts will probably be never entirely reſtored.

In two caſes of mortification, one of the leg in a man of 50, the other in the thigh of a young boy, the application of the carbon was moſt ſatisfactory. In the firſt caſe the wound extended all over the foot and nearly up the leg: The ſloughs began to ſeparate the next day after the application. In the caſe of the boy the ſeparation of the ſloughs was ſucceeded by univerſal eryſipelas. Both patients took bark and I believe nitre internally, and both recovered.

To ſcrophulous ulcers I have applied carbon in ſeveral caſes, as well as given it internally, but never with permanent benefit. I have alſo given theſe patients nitre in large doſes, at the ſame time that the ulcers were covered with carbon, and with no better apparent effect.

CANCER.—In one caſe in which a cancer had occupied the whole breaſt, and had ſpread towards the neck, eating it into foul ulcerations, the carbon powder was applied. The appearance of the wound was much mended; it became clearer and looked redder, but no permanent relief was obtained; and ſometimes there was a great deal of pain.

In a cancer of the os uteri, after various trials, I directed a paſte compoſed of carbon powder and yeaſt to be applied by a peſſary to the part. There was ſome inconvenience in the application, though the patient complained much leſs of it than of the fumes of cin-

nabar, which had been previouſly adminiſtered. She could not be prevailed upon to perſiſt in its uſe.

Cutaneous Eruptions.—The face of Poole, a patient in the Worceſter infirmary, was covered with a dark-coloured reddiſh blotch, which was painful and ſpread. Her right arm was covered with the ſame ſpecies of eruption, particularly about the elbow, where there were ſeveral ſores. She had theſe complaints many years, ſometimes more, and ſometimes in a leſs degree. I directed the carbon cataplaſm to her arm, and to waſh her face with yeaſt frequently. The effect was very ſatisfactory, as ſhe had previouſly employed mercurials and many other means without benefit. The ulcers healed in a ſhort time, and the eruption in great meaſure varniſhed.

In two caſes of Erythema without ulceration, after the meaſles, yeaſt was applied with the beſt effect, the eruption diſappearing in the courſe of a day and night.

The progreſs of pimples upon the face is generally ſtopped by waſhing them often with yeaſt. They grow lived after a few times waſhing, and ſoon diſappear. I ſubmit it therefore to my fair countrywoman, whether it may not become a much more uſeful coſmetic than milk of Roſes, or any of thoſe doubtful preparations ſo commonly uſed.

Erysipelas.—In ſeveral caſes the carbon was uſed both by my brother and myſelf with complete ſucceſs. In the caſe of Mrs. H——, it was very threatening, as it ſpread very much about the face, accompanied with delirium. My brother ordered her face to be waſhed with yeaſt frequently, and to take bark internally. She recovered in three days.

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In caſes of ſcarlatina and angina maligna, I now generally direct yeaſt to be uſed in gargles, and to be rubbed upon the ſkin. In repeated inſtances I have found this plan uſeful, exhibiting at the ſame time occaſional emetics, with nitrous mixtures.

In phthiſical caſes, when the night ſweats were urgent, I have for ſome time paſt directed yeaſt to be taken in the quantity of a large ſpoonful, or two large ſpoonfuls in milk, three or four times in the day. It generally appears to be ſerviceable at firſt, but I have ſeldom found its good effects permanent. In one caſe I think it ſucceeded,

Typhus.—In two inſtances I had the opportunity of trying the carbon fully.

The firſt, a ſoldier, had been very improperly treated with antimonials previouſly to my ſeeing him. His debility was extreme with occaſional delirium; his tongue black and parched; his ſtools offenſive, and he could keep nothing upon his ſtomach. The bark in all forms was vomited up. He firſt of all took a ſaline effervеſcing mixture, which ſtaid upon his ſtomach. He afterwards took one ounce of charcoal powder three times a day, with port wine and water, and 15 drops of laudanum at night. The foulneſs of his tongue and the vomiting ſoon diſappeared, and he recovered ſlowly, occaſionally taking bark.

In a girl of 14, the ſmall-pox aſſumed the worſt appearances. The eruption began on the third day, with great fever, violent pain of the head and ſide. A bliſter was immediately ordered, which gave eaſe, and ſhe took ſome opening medicines. The next day, after the bliſter had riſen, the puſtules ſhowed no ele-

vation, and every ſymptom clearly indicated that the diſeaſe was in the worſt degree. Her ſtools were offenſive, and the debility extreme. I ordered a drachm of charcoal powder to be taken every four hours, with a mixture of decoction of bark and yeaſt, and that ſhe might have as much port wine as ſhe liked, and freſh ale. This plan was perſiſted in, with bliſters occaſionally for nine days, at which time the patient died, with more marks of putrefaction than I ever ſaw before. Her body was univerſally black, and at a ſmall diſtance ſhe looked like a negro. She drank great quantities of the freſh ale, and during the two days before her death, 3 pints of port wine. Purple ſpots appeared on the thighs about ten days from the beginning of the diſeaſe, which vaniſhed on the application of a paſte of charcoal and yeaſt. I much regret that ſhe was not waſhed all over with yeaſt, but I confeſs this circumſtance did not occur to me. After the full trial of the carbon in this caſe ſo unſucceſsfully, I have never truſted to it ſolely in any of thoſe diſeaſes in which the powers of life are ſo exhauſted as they are in typhus. I believe it may be uſeful to correct the filth that accumulates in the mouth and in the inteſtines, but it certainly is not to be truſted to alone for their cure. Subſtances containing oxygene are infinitely more appropriate for this purpoſe, and ſhould be employed. Nitre contains oxygene in great abundance, and has been uſed with advantage in typhus. But its uſefulneſs in inflammatory diſeaſes, and indeed its effects when taken as a poiſon in large quantity, make me ſuſpect, that the baſis of the acid contains a power capable of abſtracting from vitality. On this ſuppoſition we may account for the contradictory effects aſcribed to it. But the conſideration ſhould make us

look

look out for other ſubſtances that are not contaminated with any powers contrary to thoſe for which we wiſh to employ them. The oxides of manganeſe have occurred to me as likely to anſwer the end. I have given then in very large doſes to healthy perſons, and have ſwallowed them myſelf without the leaſt apparent injury. On this ſubject, however, I ſhall not enlarge, and I will only add one more ſpeculation to what is already perhaps too long.

From the notions that I entertain of the nature of the gout, I have been led to ſuppoſe that the inſpiration of an atmoſphere above the common ſtandard might be ſerviceable for its cure. If the diſeaſe ariſe in the firſt place from a deficiency of oxygene in the blood of the arteries of the extremities, and the chain of ſymptoms be induced by this deficiency, certainly an hyper-oxygenated atmoſphere is the remedy to be adopted. But this is all hypothetical, and I ſhall content myſelf with having given the hint, without purſuing the ſubject further.

This is what I know of the effects of carbon; it is imperfect as every abſtract muſt be, but it is faithful as far as it goes; and it would have been impoſſible to have comprehended within the room that you could ſpare, the caſes in their full extent.

I am, dear Sir, &c.

JOHN JOHNSTONE.

Dusting-Box.

Several years ago, Dr. Darwin contrived the apparatus, delineated pl. 4, fig. 3, with intention to apply ſubſtances, that might be ſuppoſed capable of a ſalutary action, to the ulcerated ſurface of the lungs. The facts in the preceding communications and ſome others, together with the preſent diſpoſition of the public to favour attempts towards the cure of conſumption, induced me to apply for permiſſion to inſert a ſketch of this little machine in this pamphlet. Whether it will be uſeful to coat the pulmonary ulcers with fine charcoal, calx of zinc, any of the preparations of lead, Peruvian bark, or ſome ſuch compoſition as Mr. Sandford mentions, remains to be tried. The box may be 10 inches high and 8 ſquare. It has within a circular lathe bruſh, with a croſs bar of wire, againſt which the briſtles of the bruſh, loaded with duſt, ſucceſſively ſtrike; the duſt is thus ſpurted up through the mouth-piece, and the patient inhales it at his inconvenience. The ſtructure of the box will eaſily be underſtood from the plate. On ſeeing this contrivance, another perſon thought that a *powder-machine*, formerly more in uſe for the waſte of wheat than at preſent, would very well anſwer the purpoſe: this is repreſented fig. 4.

Obſervation on the effect of charcoal, in correcting rancid eructations.—Extract of a letter.

—My dyſpepſia was not attended with much flatulence nor heartburn, but was very troubleſome after eating any ſtrong diſh, ſuch as gooſe, garlic, or cabbage, from a riſing of rancid matter from the ſtomach, perhaps every

every 5 minutes. This was always *immediately* checked by a table ſpoonful of very fine ground charcoal—ſo much ſo that the next eructation would be ſcarcely offenſive; and in a little time the ſtomach was completely ſet to rights. Several perſons in our family have received benefit from it in the ſame way.

Having had no ailment in the ſtomach for a long time, I cannot ſay that I have had *much experience.*—Perhaps I may have been relieved a dozen times, and I think never took it without a very ſenſible effect. I do not believe it has much effect on the bowels; it is aperient, however, rather than otherwiſe. As to your queſtion of prevention of wind, mine was ſo little a caſe of flatulency that I cannot ſpeak very poſitively of its virtue in that particular. It certainly, however, had this effect to a certain degree. Upon the whole, I have not the ſmalleſt doubt of it being a very uſeful family medicine.

I am, your's, &c. — — —

To Dr. Beddoes.

I inſert this obſervation with the greater pleaſure, from the hope that it may take away one excuſe for dram-drinking. I ſtrenuouſly recommend it to perſons whoſe ſtomachs are weak; as alſo to perſons apt to overload a ſtrong ſtomach, to have in readineſs ſome fine powder of charcoal, and to take it inſtead of wine or diſtilled ſpirit, to prevent food from *repeating*. It may be prepared by burning corks perfectly and throughout black, and then rubbing them to powder. This preparation is uſed in ſome places for the colic in horſes; but as it is given in fermented liquor, its power is ſomewhat dubious. I have been informed by

by another intelligent correſpondent that he has found charcoal gently aperient; an obſervation which ſeems well worth attention.

Mr. Capper's deſcription of his apparatus for experiments on brute animals.

The letters k, l, m, n, pl. 5, repreſent the wooden chamber, which is dovetailed to make it air-tight; the ſize may be varied according to the ſize of the animal which is deſtined for experiment. The one from which the plate is taken, is three inches and a half, by four and a half.

The letters i, j, k, l, repreſent the mouth-bag, which is of oiled ſilk nailed on the chamber at b; but before you put them together, glue on a narrow ſtrip of leather; when the glue is dry, plait the oiled ſilk; and as faſt as you plait, nail on a narrow ſtrip of leather, ſimilar to the one underneath; the plaits ſhould be very ſmall, and the nails of courſe very cloſe to each other. The mouth-bag is eaſily ſecured round the mouth of the animal by means of tape, uſed as a ligature.

The letters m, n, o, G, repreſent the bag which contains the air to be inſpired, and is nailed to the chamber in the ſame manner as is deſcribed. G is the aperture thro' which the bag is filled; h the inhaling valve (at the bottom of the chamber) made of very thin wood, covered with leather, which being extended on one ſide farther than the wood, (and this being glued to the chamber), ſerves as a hinge to the valve. At d is the exhaling

exhaling valve, made and ſecured (but on the outſide of the chamber) in the ſame manner as the other.

When you fill the bag, the valve at the bottom of the chamber muſt be preſſed down with the finger, to prevent the eſcape of the air.

At G the ſilk ſhould be lined with ſoft leather, otherwiſe it will ſoon be worn out by the frequent uſe of the ligature.

The manner to make the ſilk air tight, is by ſowing weak leather within the ſeam, and then covering it with the ſame, making the needle always paſs through the leather between the oiled ſilk,

W. W. CAPPER.

Query.—Would it not be an improvement if a ſtrip of leather were nailed over the valves, ſo as not to allow them to turn quite back.—T. B.

XXI.—*Recapitulation with ſome additional Facts.*

It appears already that the principles, which had been deduced from the modern experiments on reſpiration, are too narrow to explain the effects of differently modified atmoſpheres on the animals, by which they are reſpired. This is nothing diſcouraging; for the more various the powers of elaſtic fluids, the greater, we may hope, will be the reſources of pneumatic medicine.—The two inſtances in which greater toughneſs of the fleſh and tendency in the blood to coagulate were obſerved after immerſion in oxygene air, afforded the pleaſing proſpect of a phyſiological diſcovery; but in an enquiry, where unobſerved

powers

powers may ſo eaſily intervene, I have laid it down to myſelf as a rule of prudence not to admit any cauſe, unleſs the effect ſhould diſtinctly appear upon four or five repetitions of an experiment with or without variation of acceſſory circumſtances. Two other pairs of rabbits were therefore procured; and one individual of each pair was oxygenated; the other being left without preparation, and then both were killed by blows on the back of the head. The difference of coagulation in the blood was the ſame as in the former experiments; but after boiling I could not ſatisfy myſelf that there was any difference in the ſtate of the muſcular fibres. One of theſe rabbits remained in the oxygene air 20, and the other 25 minutes: the others had only remained 15 minutes. Theſe rabbits ſeemed as thirſty as the former; one drank eleven times.

Of two white pigeons, ſeemingly of the ſame age, one was kept in a veſſel of oxygene, mixed with a third part of atmoſpheric air for 25 minutes; birds conſume air very faſt; and at the end of this time, a candle was immediately and repeatedly extinguiſhed on immerſion in the veſſel, which was the ſame as that in which the cats had been placed; the pigeon ſhewed no other ſign of diſtreſs than a little quickneſs of breathing; which took place ſoon after its introduction. The power to ſtand erect in ſuch an atmoſphere, depended probably on the oxygene it had previouſly inſpired, as in the experiments on drowning. The pigeon was ſtrangled on being taken out of the veſſel and quickly opened; the blood coagulated inſtantly after effuſion, and in ſome of the veins it was already coagulated. The heart was hard and inirritable;

inirritable; the cavity of the ventricles was cloſed; the auricles contained a little coagulated blood; the lungs were florid and appeared inflamed.

The other pigeon was put into a mixture of more than one third atmoſpheric, with leſs than two thirds of hydrocarbonate air. It died in leſs than half a minute; its ſpeedy death probably aroſe from the ſame cauſe as the rapid conſumption of oxygene in the former experiment. No ſigns of recovery appeared while the feathers were haſtily ſtripped from the belly and breaſt; the liver as before appeared much more ruddy than in the former pigeon; this undoubtedly depends on the greater proportion of venous blood in the liver than in any other organ; the heart and other viſcera were more ruddy in the hydrocarbonated pigeon; the lungs excepted, which were of nearly the ſame colour in both. The ventricles of the heart were inirritable, and contracted in the hydrocarbonated; but the right auricle was ſpontaneouſly acting. The blood was fluid and ruddy; it was ſome time before it coagulated. The fleſh of the heart was remarkably ruddy.

Theſe pigeons being boiled, the hydrocarbonated was univerſally of a light red; the colour was ſtrongeſt in the legs; it was well ſeen in the marrow and ſpongy part of the bones; the cartilage looked as they ſometimes do in the young ſubject injected: in the breaſt of the pigeon (which on account of the ſtate of the air when it was taken out of the veſſel, I dare not call oxygenated) a degree of redneſs was perceptible; but the difference was great in favour of the hydrocarbonated: this was throughout as red as a ſalmon in ſeaſon; it was obſerved on occaſion of the redneſs

produced

produced by the ſame air in the muſcles of the thighs in a fowl, that one might have ham and fowl in the ſame piece, for the breaſt and wings were of a tender pink.—The fleſh of the hydrocarbonated pigeon four perſons agreed in thinking more agreeably taſted.—In point of tenderneſs there was no great difference; if any exiſted, it was perhaps in favour of the latter.

The effect of hydrocarbonate on the blood and fleſh was ſo oppoſite to all expectation, that I could not be ſatisfied without repeating the experiment till all fear of an erroneous concluſion vaniſhed. Of a pair of fowls, one was put into carbonic acid air, and one into hydrocarbonate; in the former, the appearances were the ſame as in drowned and ſtrangled animals, only the liver appeared a ſhade paler. In the hydrocarbonated, the phænomena were as uſual. It was thought by ſeveral perſons who taſted theſe fowls after they were boiled, that the fleſh of the hydrocarbonated was leſs conſiſtent; it was ſaid to approach towards the ſoftneſs of dreſſed liver.—Of two equal rabbits, one was immerſed in ſuch a mixture of atmoſpheric and hydrocarbonate airs as did not deſtroy life in 15 minutes; it was then taken out in a ſtate of great debility; both were killed in the uſual manner. The blood, liver, and other viſcera of the hydro. rabbit exhibited the accuſtomed phænomena. The fleſh was of a light pink colour when boiled, the marrow of a fine red.

The power therefore of hydrocarbonate air to redden the blood and fleſh of animals, made to reſpire it, either pure or diluted, admits of no doubt. I have attempted to determine the circumſtances of its operation, by applying it directly to the blood. In two phials containing one hydrocarbonate, and the other carbonic

carbonic acid air, two funnels were cemented, the necks of which were cloſed by a wooden ſtopple.—Blood was received into each funnel as it flowed from a man's vein; when the funnel was full, the ſtopple was withdrawn and the blood deſcended into the phials, while the air iſſued through another ſmall perforation in the cork, which could be cloſed at pleaſure. When the greater part of the blood had deſcended into the phials, they were ſtopped, ſo as on trial to prove air tight. The blood in the phial containing carbonic acid air, acquired no florid colour on its ſurface; the edges of the coagulum, as they lay againſt the phial, appeared brighter; but this upon careful examination, appeared to be owing to their thinneſs. The hydrocarbonate evidently brightened the upper part of the coagulum to as great a depth as it is uſually brightened by oxygene or atmoſpheric air. The colour was not quite ſo high, and yet not a great deal leſs florid.

Three equal and ſimilar veſſels were filled, two with hydrocarbonate, and one with atmoſpheric air. Blood was received from the vein of a horſe into a funnel, and then ſuffered to run into theſe phials. That containing atmoſpheric air, and one of the others, were immediately ſtopped and ſhaken. The blood was obſerved to acquire a brighter colour throughout; in both caſes a head of foam reſted upon the ſurface; and this appeared nearly of the ſame colour in both; the head was rather brighter than the cloſe and condenſed maſs, on account of the light tranſmitted thro' bubbles of air catched and detained in the blood.

Four phials were filled; one with oxygene, one with hydrocarbonate, one with atmoſpheric, and one with

with hydrogene air from zinc, diſſolved in muriatic acid. Blood was received into a funnel from the vein of a horſe, and then ſuffered to run into each of theſe phials. The blood in the oxygene and atmoſpheric airs was equally brightened and to an equal depth; in both the other phials, the ſurface of the blood was brightened; but more in the hydrocarbonate and to a greater depth. In this the florid colour (which was inferior to that produced by the oxygene and atmoſpheric airs) reached three lines in depth; and the reſt of the coagulum was leſs dark than the reſt of the coagulum in the hydrogene; in which the brightened part did not deſcend more than a line.

The change of colour on the ſurface of the hydrogene (which does not I think agree with the obſervations of ſome philoſophers, who have expoſed blood to different airs, but without ſtating the circumſtances of the experiment, particularly the age of the blood), induced me to immerſe a third pigeon, nearly the fellow of the two former, in hydrogene from zinc, diſſolving in muriatic acid. The liver appeared rather paler than in pigeons killed in the common manner; but it had by no means the brightneſs of the liver in animals deſtroyed in hydrocarbonate; the veins were of their uſual dark colour, and ſo was the blood. The heart was not ruddy, but it was flaccid; and in this reſpect formed a remarkable contraſt with the hearts of the two other pigeons. The right auricle was working; the ventricles not irritable. The boiled fleſh did not ſenſibly differ from the fleſh of pigeons that have inhaled atmoſpheric air, except perhaps in a very ſlight redneſs of part of the breaſt.

The

The muſcles of the legs, which when they are brown in birds, ſhew the colouring power of h. a. ſo diſtinctly, were not at all tinged; nor did the cartilages of the joints look as if beautifully injected, but were pale, as in common caſes. Hydrogen, as far as this ſingle experiment warrants the concluſion, has no power to make the fleſh of animals tender: and in two or three days the brightened ſurface of the blood expoſed to it grew dark again, and the whole clot ($\frac{1}{2}$ an inch thick,) ſeemed blacker.

To diſcover the effect of hydrocarbonate on the blood at different periods after venæſection, a portion of the dark coagulum of a horſe's blood two days old, was put into a quart of this air, and another part into a quart of atmoſpheric air. The veſſels were equal and ſimilar. A florid coat ſoon appeared on the blood in the atmoſpheric air; but no change took place upon the blood in the hydrocarbonate, though it was watched ſeveral days. Human blood was put to the ſame trial nearly as ſoon as it coagulated, which was within a quarter of an hour after it was drawn; no change in the bottle of hyd. a.—The clotted part of a horſe's blood was tried a day after it was drawn; a comparative experiment was made with both oxygene and atmoſpheric air: theſe laſt brightened the ſurface as uſual. The hydrocarbonate produced this effect in a very ſlight degree: upon the credit of theſe and ſome other ſimilar experiments, it may be affirmed that hydrocarbonate air has little power to render blood florid, except it be fluid; but this I think depends on the coheſion it acquires, and not on the life it loſes. There is ſome danger of miſtake from haſty obſervations on the thin edges; I

depended principally upon the appearance of the ſurface, where the maſs was ſuch as to produce perfect opacity. Mr. Charles Gimbernat remarked in various inſtances that more ſerum ſeparated from the blood in hydroc. a. and that the coagulum formed a much ſmaller cylinder in the phials containing this air, than in thoſe containing oxygene, atmoſpheric, hydrogene, or carbonic acid.

When phials containing hydrocarbonate and blood were opened under water, there was no ſign of diminution in the bulk of the air.

Experiments I am now proſecuting, make me believe that blood renders hydrocarbonate exploſive, and that it alters the colour of its flame; but in the promiſed appendix, I will give the reſult of theſe experiments, and a full account of the conſtitution of the reſiduary air.

Blood being received into a funnel from the arteries of an horſe, and tranſmitted into hydrocarb. the phial was ſtopped air-tight and ſhaken; the colour did not become deeper or darker. Venous blood being at the ſame time treated in the ſame manner, acquired a colour little leſs bright.

Theſe facts will ſuggeſt a variety of reflections and many new experiments. They ſeem to diſcloſe the principle on which hydrocarbonate acts, in changing the colour of the venous blood. Its effect ſo far as colour is concerned, is not deſtroyed in paſſing through the ſmall arteries; hence the alteration is ſeen in the veins, and by conſequence in the ſolids, particularly the liver. This colouring principle (ſuppoſing ſomething to be imparted to the blood) differs

therefore

therefore in its affinity to the animal fibre from oxygene, if oxygene be diſtributed by the arteries.—Hydrocarbonate kept in contact with living blood appears, from its becoming more exploſive, to approach to the nature of hydrogene; whence its bulk ſhould be expected to increaſe inſtead of diminiſhing; but this is a point to be determined by nicer inſtruments than I have it in my power to employ at preſent. The principle which one ſhould ſuſpect from analogy, that hydrocarbonate communicates to the blood is charcoal, (or carbone, which I conſider as a compound of hydrogene and azote) or ſome ſubſtance nearly allied to it. It might therefore be tried whether charcoal in any form will brighten the blood.

A florid complexion, may then, it ſeems, as far as it is connected with the mere ſubſtance of the blood, depend equally on arterial blood highly oxygenated, or venous blood brightened, as by the application of hydrocarbonate. It may at preſent be difficult to diſtinguiſh the two caſes. The blood is frequently florid, as it flows from a vein. But in many of theſe inſtances, arterial blood only eſcapes the change it commonly undergoes in its progreſs through the ſmall blood-veſſels. Thus when Mr. Hunter ſays "I bled a lady whoſe blood at firſt "was of a dark colour; but ſhe fainted, and "while ſhe continued in the fit, the colour of the "blood that came from the vein was of a fine ſcarlet;" we may ſuppoſe the action of the ſmall arteries to have been ſuſpended, and the oxygene not to have been communicated to the ſolids; the ſame when an animal is bleeding to death. Mr. Hewſon obſerves that the blood from faint animals is brighter and coagu-

lates more ſpeedily; which may depend on its containing more oxygene. Yet if the rapid coagulation in my experiments was occaſioned by oxygene actually preſent in the venous blood, it was in ſuch quantity as not to brighten the colour.

It might be thought that the oxygene of the blood, forming carbonic acid with hydrocarbonate gives redneſs; but the application of carbonic acid, both to the blood and to the lungs, diſcountenances this idea. Theſe experiments ſhould be further proſecuted with arterial blood. Meanwhile as it is certain that the blood and the ſolids may acquire a bright red colour from cauſes totally diſtinct from the preſence of oxygene, my conjectures concerning the condition of the ſyſtem in ſome caſes of conſumption loſe their ſupport.—— But although I cannot now believe that the permanent redneſs of the fauces in ſome conſumptive patients, and other analogous appearances, indicate hyperoxygenation, I ſtill think that exceſs of this principle does occaſion diſeaſe. But beſides colour, I ſhould require ſome of the ſymptoms occaſioned by the reſpiration of too much oxygene to appear, before I admitted this cauſe. Dr. Garnet has, I think, fixed upon inſtances of this nature; and perhaps the frequent pleuriſies in the Caſtiles depend on the dryneſs of the atmoſphere; a quality which, if it ariſe from the want of water, and not its combination, implies the preſence of more oxygene in a given bulk of air.

The cautions and ſuggeſtions reſpecting the reſpiration of ox. air, which I had deduced from perſonal experience, ſeem confirmed by circumſtances in ſeveral of the foregoing reports. Elevation of ſpirits, and power of reſiſting cold, have oftener than once followed

lowed its uſe; it has alſo been found to heighten the complexion. Mr. Barr's patient, and Mr. Atwood, furniſh ſtriking proof of its power to improve ſome debilitated conſtitutions. Both communications afford inſtruction reſpecting the doſe, which requires much vigilance. In the former of theſe caſes it was neceſſary to leſſen the quantity; and in Mr. Atwood's intereſting journal, though we have unfortunately no preciſe information on this head, there are particulars that ſeem to ſhew that he proceeded to the utmoſt verge of prudence. Theſe examples will encourage further trial in different ſorts and ſtages of debility. This elaſtic fluid deſerves to be oppoſed to the approach and to the infirmities of old age, eſpecially where the extremities are habitually cold. A quart inhaled every day, for a few weeks, and repeated from time to time, as the patient's feelings ſhall direct, bids fair to contribute to the comfort and prolongation of life. Its employment in chloroſis, will, I truſt, be continued with ſucceſs. I am authorized to ſay, that a remarkable cure of hyſteria will be related in the 2d vol. of Mr. Townſhend's *Guide to Health*. Its power in the laſt ſtage of malignant and nervous fevers, ought to be aſcertained in the courſe of another year.

In palſy, fact does not yet appear to coincide, as could be wiſhed, with expectation. We may very ſafely put a paralytic patient on a courſe of oxygene air; but we ſhould begin with very ſmall doſes, and be alive to ſuſpicion. To prevent groundleſs alarm, I muſt add, that I have no other reaſon to give this warning, than what is already before the reader, (*See p.* 69, 70).—In paralyſis of the abſorbents, occaſioning

anaſarca of the lower extremities and of the lungs, I have been informed that conſiderable temporary relief has been afforded. One caſe has fallen under my own care—it is as follows :—R. G. about 60 years of age, after living freely, had dropſical ſymptoms. He underwent a long courſe of violent cathartics, and afterwards came to Briſtol Hotwells. The paralytic appearances were ſo ſtriking, that I declared to his friends, in the moſt poſitive terms, that I apprehended he would in no long time die ſuddenly. The digitalis (which I have never ſeen to fail in caſes of this kind) procured a diſcharge of the water. It repeatedly collected, and was repeatedly evacuated by the digitalis, and once or twice by ſquill and the *pulvis ari comp.* The medicines had now no ſooner ceaſed to operate, than a relapſe followed, and threatenings of apoplexy were ſeveral times obſerved. At this period oxygene air, mixed with twice its bulk of atmoſpheric, was adminiſtered for the ſpace of one minute, four times a day. During the whole courſe of his diſeaſe, the patient had that tendency to ſickneſs and vomiting, which the long abuſe of fermented liquors produces. The modified air was found by the patient to relieve theſe ſymptoms ; and by reſpiring it, he ſaid he could prevent and remove nauſea. From his obſervations I think ox. air more likely than any thing elſe to carry off violent affection of the ſtomach, ariſing from an overdoſe of digitalis. The difficulty of breathing was always relieved by his mixed air, though only for a ſhort time. In leſs than a month, he by degrees came to reſpire for 15 minutes in a day. The ſwellings, however, increaſed, and there were evident ſigns of effuſion in the thorax ; ſo that the oxygene did not appear to render the abſorbents more irritable. One day,

after

after walking for half an hour, (which was an unuſual exertion) the patient ſuddenly expired on entering his apartment.

The idea of adminiſtering oxygene air to perſons affected with ſea ſcurvy, is extremely obvious. But the frequent inſtances of ſudden death, when ſcorbutic patients are brought into the open air, deſerves ſerious attention. The principal doubt ſeems to be, whether it is muſcular exertion, ſome ſenſation, or the free atmoſphere, that proves fatal. After reading Dr. Trotter's late candid publication, I applied to the author for a ſolution of this difficulty; his inſtructive anſwer follows; and I own, that it appears to me to amount to a prohibition of the practice.

Spithead, March 13th, 1795.

SIR,

In anſwer to your query, whether the perſons who died ſuddenly in ſcurvy on expoſure to the air, had uſed much muſcular exertion, I beg leave to inform you, that I do not think any preceding exerciſe of muſcular motion had any ſhare in producing this effect. The firſt caſe of the kind I ever ſaw, was from opening a port to windward; the air ruſhed in with conſiderable force, I was ſtanding by the man, he had converſed with me with apparent eaſe, and ſeemed to feel no pain when he expired. I have ſeen others drop down immediately on coming above the hatchway, although they could walk below with tolerable agility: Some have died after being carried above, in a horizontal poſture, both legs being ſo hardened and

contracted that they could not walk ; and others have been ſaved by going immediately below. Might not all this be owing to the diminiſhed temperature of the air, independant of its chemical qualities ? Scorbutic patients bear cold very ill, but ſudden death happens often under ſimilar circumſtances in hot tropical countries, and I own this explanation not ſatisfactory.

I am afraid opportunities of trying the diluted oxygene in a ſhip, cannot be eaſily commanded. There is no medical board in the navy to countenance improvement. There is alſo ſo much room left for reformation in other reſpects for the benefit of health, that ſince I had the honor of attending the channel fleet, our great commander has been conſtantly ordering ſome beneficial regulations. From ſuch active benevolence and authority, I have ſtill much to hope. Wiſhing you health to continue your valuable purſuits,

I am, Sir, &c.

T. TROTTER.

Having lately received information of a very ingenious application of air to ſurgery, I ſhall inſert it here, as the effect appears to depend on a reſidue of oxygene.—" Mr. Gimbernat, Surgeon at Madrid, reflecting upon the action of atmoſpheric air, admitted into the joints, was led to ſuppoſe that its introduction into the ſcrotum would excite an inflammation of the adheſive kind in the parts that require to be united for the radical cure of the hydrocele ; in which caſe this might prove the eaſieſt and moſt efficacious method of treating the diſeaſe.

Mr.

Mr. G. therefore paſſed through the ſcrotum of a patient, afflicted with hydrocele, a trocar much longer and thinner than that commonly employed in the operation for aſcites; taking great care to leave the teſticle as much as poſſible behind, and at a diſtance from the inſtrument. He then withdrew the perforator, leaving the canula; which being pierced with ſmall holes in its whole circumference, allowed an iſſue of the water contained in the ſcrotum. When this was completely diſcharged, the operator ſtopped one of the orifices of the canula, and through the other blew into the ſcrotum a quantity of air from the lungs. This operation was repeated once or twice a day till the ſcrotum was reduced to almoſt its natural ſize; for which purpoſe the canula was properly ſecured by a bandage in the ſcrotum.

When the parts had acquired ſo much adheſion as to contract round the canula, the inſtrument was removed, and the cavity it left was ſoon filled with new ſubſtance.

Mr. G. contrived this method 15 years ago; and he has uniformly ſucceeded in a very conſiderable number of caſes of hydrocele. A fortnight or three weeks has generally been ſufficient for a radical and complete cure. The patient is never confined to his bed, but can walk about his room without inconvenience. Mr. Gimbernat thinks the great ſucceſs of his method is owing to the ſmall degree of inflammation excited by the expired air."

Mr. Townſhend, in the 1ſt vol. of his GUIDE, relates three caſes in which the reſpiration of oxygene appeared highly beneficial. One is a caſe of hypochondriaſis;

chondriaſis, another of aſthma, and a third of ſuch diſorder of the ſtomach, that eating " almoſt conſtantly produced vomiting;" in this caſe the patient " continued free from ſickneſs as often as the oxygene " air in a diluted form was adminiſtered;"—(p. 277, 292, 398).

I had formerly been led to infer that " an atmoſ- " phere with a diminiſhed proportion of oxygene, " would be in ſome caſes a better ſoporific than any " we at preſent poſſeſs." I have ſince received confirmation of this opinion. A perſon in conſumption, who for months had taken opium at night, ſlept perfectly well without opium when he came to reſpire hydrogene. His ſleep he remarked to be more profound than uſual. The air of his room being looſely mixed with hydrogene, his ſervant, a very bad ſleeper, declared that " he did not know what was come to " him, he ſlept ſo ſound." This man neceſſarily inſpired much hydrogene from attendance on his maſter. A phyſician has favoured me with the following memorandum of an obſervation on himſelf; which poſſibly may be referred to the ſame cauſe. He could not fix upon any other. " For ſeveral years I " have paſſed reſtleſs nights, and have ſeldom ſlept " longer than from half an hour to an hour at a time; " but on the night of the general illumination for the " victory of the 1ſt of June, I enjoyed a ſound and " almoſt uninterrupted ſleep; this I impute to my " having ſat between four and five hours in a room " with about twenty candles burning immediately " before I went to bed, and to having had the ſame " number burning as long in my bed-chamber; al- " though the weather was warm, I felt a glow of

" heat

" heat on entering the chamber, with a ſtrong ſmell of " the candles; and as heat generally prevents my reſt, I " was pleaſantly diſappointed by a more comfortable " ſleep than I had had for fourteen years before. I " have experienced the ſame want of good and conti- " nued ſleep ſince." Whether a diminiſhed atmoſphere produces a tendency to ſleep or not, diluted hydrocarbonate (of which the properties can ſcarce be ſuppoſed to depend on privation of oxygene) undoubtedly poſſeſſes this property. My experience amply confirms the preceding reports. In two conſumptive patients, I am able to induce ſleep almoſt at pleaſure by this air. In a great majority of ſuch caſes, it is well known that the nights are exceedingly diſturbed in ſpite of opium, freely adminiſtered. The ſoporific virtue of hydrocarbonate, ſeems however by no means to be confined to conſumption.

I introduce here the following letter reſpecting conſumption, from Mr. Darling, Preſ. of the R. M. Soc. at Edinburgh. It did not come in time for inſertion in its proper place. Mr. D. does not ſeem to have uſed hydrocarbonate air.

Edinburgh, Feb. 24th, 1795.

SIR,

The caſe to which I alluded in my letter was ſimply this.—A young lady labouring under every ſymptom of confirmed phthiſis pulmonalis, and daily ſinking under the diſeaſe, happened to be reſiding at the houſe of an eminent tar merchant to whom ſhe was related. No remedy ſeeming in the leaſt degree efficacious, it was propoſed that ſhe ſhould walk in one of his warehouſes, where a large quantity of plantation tar was

uſually

uſually kept. The firſt time ſhe was introduced into it was on a Monday morning, when it was imagined, in conſequence of the warehouſe having been ſhut up ſince the Saturday afternoon, the air would be the moſt fully impregnated with effluvia. She walked a conſiderable time through the different ranges of barrels, and bore the experiment very well. This practice was perſiſted in ſeveral mornings with advantage: and finding the cough and other ſymptoms gradually decreaſe, ſhe perſevered till ſhe was reſtored to perfect health.

Since I laſt wrote to you I have finiſhed the account which I was then drawing up, of experiments with factitious airs in the cure of conſumption, and read it to the medical ſociety of this place. I have had about ten opportunities of trying their effects, but have been conſiderably diſappointed, as I was not able to effect a permanent cure of any of them; but it muſt be obſerved, that in all of them the moſt diſtreſſing ſymptoms were evidently relieved—as the cough, night ſweats, diarrhœa, want of reſt, fever, &c. and in one of them the hectic fever totally diſappeared, and at preſent there only remains a cough, which is not very troubleſome: nevertheleſs, I am much afraid that this immenſely ſevere ſeaſon may poſſibly bring on a relapſe, but this muſt be guarded againſt as much as poſſible. My want of complete ſucceſs I attribute in ſome meaſure to the imperfect ſtate in which my apparatus was; or it may poſſibly have ariſen from the remedies not having been applied with ſufficient vigour, or perhaps from the diſeaſe in all the caſes having made too great a progreſs before the adminiſtration of a reduced atmoſphere.

W. C. DARLING.

In

In aſthma it is extraordinary that oxygene, hydrogene, and hydrocarbonate, ſhould have afforded relief. Dr. Carmichael has this reflection in one of his letters. It aroſe from the caſe of an aſthmatic patient, whom one of the phyſicians to the Birmingham Diſpenſary, has lately much relieved by oxygene.—Dr. Ferriar (p. 80.) and Mr. Townſhend, confirm the fact. It may be ſaid that oxygene air prevents the paroxyſm by exhauſting excitability, as ſpirituous gargles cure an incipient inflammation of the throat; and that unreſpirable airs withhold ſtimulus; but this ſeems by no means probable of hydrocarbonate; and the truth is that we have not yet experience to eſtabliſh thoſe diſtinctions, which are requiſite to the certain direction of the pneumatic practice.

In the inflammatory ſtage of catarrh, and all the gradations of diſeaſe which connect a common cold with pleuriſy, I hope the exhibition of a lowered atmoſphere, will prove an effectual cure. In theſe caſes I am at preſent inclined to prefer hydrogene or azotic air, becauſe they can be ſo freely and frequently adminiſtered. In my letter to Dr. Darwin, I have deſcribed the effect of atmoſpheric lowered with one-eighth of hydrogene air, and reſpired for a quarter of an hour, in an inflammation of the cheſt. The acute pain entirely ſubſided while the patient was breathing this mixture, and the febrile ſymptoms diſappeared.——Mr. Townſhend (p. 103.) has a ſimilar example. "Mrs. Tovey, of "Charles-Street, Tottenham-Court-Road, having loſt "one child" by the croup "brought her only re- "maining boy to Dr. Thornton for his advice. He "immediately made the child inhale azotic air with a "proportion of common air; and the father and mo-

"ther

" ther were ſurpriſed when they obſerved that the " hands which were before *parching hot*, now felt *cold* " to the touch; the pulſe was rendered twenty beats " leſs in a minute; the child no longer coughed as " through a brazen trumpet, the fever ſeemed ſmo- " thered, and the formation of the fatal membrane " was prevented."—If a lowered atmoſphere proves as ſerviceable in inflammatory catarrh as the analogy of theſe caſes, reaſonable conjecture and a few direct trials ſeem to promiſe, an apparatus for factitious airs will ſoon come to be conſidered as a neceſſary part of houſhold furniture.

Different factitious airs enable us to change the conſtitution of the fluids and ſolids. By their operation on the extenſive ſurface of the lungs, they muſt alſo produce motions by aſſociation in diſtant parts of the ſyſtem. On theſe principles (if we had no immediate experience) they might be concluded capable of great effects on the chemical and mechanical agency of the animal organization. I dare not enter fully into the contemplation of their powers; but there are two or three points on which it may be uſeful to touch.

Doubts have been expreſſed whether the uſe of a modified atmoſphere and eſpecially of unreſpirable airs could have any other than a momentary effect. This difficulty, a man who can ſee but a little way before him, will perceive. It has been cleared up by experiment; and I need not heſitate to affirm that the occaſional reſpiration of modified air has a continued effect. But it is nevertheleſs true, that this important ſubject can never be ſifted to the bottom, till we have the command of rooms filled with modified air.—

Uſeful

Uſeful as diluted hydrocarbonate has proved, no man can ſay that it would not be more uſeful, if more diluted and reſpired with greater conſtancy. The ſame doubt extends to other airs.

It has been apprehended that the fine particles of mangeneſe, ſuſpended in oxygene, might injure the lungs, as in ſtone-cutters. But there is no analogy in the caſes; engine-men, caſters in braſs, and numerous other artiſans, reſpire fine powder without detriment; and experience with the air itſelf diſcountenances apprehenſion. For we have now a number of inſtances in which oxygene from manganeſe was breathed for many weeks; and no ſuch inconvenience has been felt.

Pulmonary tubercles are regarded by ſome as beyond the power of factitious airs to remove. Tubercles however do not appear inconſiſtent with tolerable enjoyment of life; and there are many inſtances in books of medicine and ſurgery, of the removal of bodies equally formidable. By facts related in Dr. Ewart's pamphlet on cancer, I am perſuaded that the lymphatics were excited into vigorous acting by carbonic acid air. In Mrs. A.'s caſe the ſurface of the ulcer became dry; and in that of Alford, " when the " gas moſt frequently renewed, the diſcharge was the " moſt diminiſhed." In an inſtance of cancer, not yet publiſhed, I am well informed that the ſwoln and indurated glands have been reduced by carbonic acid air to their natural ſize and ſoftneſs. Hence I conclude that the ſalutary operation of this air in part conſiſts in its action on the lymphatic ſyſtem; and it can hardly be doubted that there is a degree of abſorbent operation equal to the removal of tubercles.—

Whether

Whether hydrocarbonate poſſeſſes this property, the trials now making on cancers, are likely to decide.—I wiſh the reſpiration of unreſpirable airs were tried in encyſted dropſy; in one caſe of which I fully tried oxygene without benefit.

If a ſpecies of opium, capable of lulling the excruciating pain of cancer for weeks or months, had been diſcovered, it would doubtleſs be received with avidity by the members of the medical profeſſion, and with benedictions by the diſeaſed. But becauſe it is uncertain whether a compleat and permanent cure can be effected by the application of air, this treatment is not only neglected, but reſiſted; yet no pretence is made to ſubſtitute any thing more efficacious; no natural cure or mitigation is looked for; no injury is dreaded from the new method; and the authority on which it is ſaid to afford at leaſt long-continued eaſe, is neither queſtioned nor queſtionable. For ſuch conduct, language wants a term ſufficiently opprobious, for it implies whatever is contemptible and odious in ſloth, in ignorance, in narrowneſs of mind and hardneſs of heart. Here I invite all my readers to reflect and to hold their opinions at all times ready for delivery; for although this great crime againſt humanity is not puniſhable by law, it may be prevented by the cenſure of an enlightened public.

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Of

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At Mr. CHIPPENDALE's, *Saliſbury Court, Fleet-ſtreet, London,* Mr. WATT's Air apparatus may be ſeen.

It is left to the reader to put *and* after *ulcers* p. 123, l. 1. to alter *varniſhed* to *vaniſhed*, *formentation* to *fomentation*, and to correct a few other, principally literal, errors. In Sect. XVI, it might have been remarked, that hydrogene will be generated as well as hydrocarbonate, when the fire tubes are new. This may be known by filling a phial with the air produced, and burning it. If it takes fire at once, hydrogene is preſent. To fill the phial with air, invert it full of water into a baſon of water, introduce ſome of your air into a wet bladder, and paſs it through a tube, bent like an S, into the phial.

PART II.

DESCRIPTION

OF A

PNEUMATIC APPARATUS,

WITH

DIRECTIONS

FOR PROCURING

THE FACTITIOUS AIRS.

By JAMES WATT, Engineer.

Mr. Watt's advertiſement to an edition of his Deſcription, publiſhed ſeparately.

SINCE the first publication of this Description, experience has suggested some improvements in the mode of conſtructing and of using the Apparatus, which in the present state of Pneumatic Medicine, it would be improper to delay communicating to the Public. Every hint, however trifling in itself, now attention is awake, may lead to useful discoveries.

The Author has also availed himself of this opportunity to methodize and elucidate his description in a manner which the former hasty publication would not admit of. One of the original plates has been rejected, and another representing the improved use of the Fire-Tubes, has been inserted in its place. Conceiving the Apparatus may fall into the hands of persons who have not been accustomed to

chemical experiments, clearness has been aimed at, even at the hazard of prolixity. Though the Author wishes to shun the imputation of neologism, yet to avoid circumlocutions, he has found himself obliged to form some new words, such as the Martial, Zincic, *and* Carbonic Inflammable Airs, *which latter he has also called* Hydro Carbonate.— *He has indifferently made use of the terms of the old and new Chemical Nomenclature, wishing merely to be understood, and not intending to enter into discussions upon theories in a treatise, the objects of which are facts.*

The purchasers of the first edition, it is hoped, will not deem any apology necessary. It contained all the Author then *thought worthy the notice of the Public, as this contains all he* now *deems essential to the right use of the Apparatus, which probably from the progressive advancement of Pneumatic Chemistry, will soon receive great additions.*

At the time of the former publication, few professional men having considered the subject, the Author ventured to give his opinion in some letters to Dr. Beddoes, on the airs which he thought the most likely to be of use in diseases of the lungs, and he esteemed it a duty to relate the few physiological observations he had made in the course of his chemical experiments to produce the airs; but he now thinks it would be improper to swell his pamphlet by a republication of those letters, as the subject is taken up by persons who are better able to judge in such matters. For what has yet been done in the application of the air to medicinal purposes, the Reader is referred to the publications of Dr. Beddoes and Dr. Ewart upon this subject.

Several of the apparatus are now in the hands of able practitioners, and the public at large is apprized of the importance of the practice, and will no doubt give it a fair trial. It is honourable to the present improved state of science, and it is honourable to the faculty in particular, that the application of Pneumatic Chemistry to medicine far from meeting with that persecution which has generally in every age followed new opinions, has obtained the well wishes and liberal support even of those who have doubts of its efficacy, but who are no less desirous of having those doubts cleared up by actual experiment.

HEATHFIELD, *Jan.* 1795.

DESCRIPTION

OF A

PNEUMATIC APPARATUS.

THE apparatus may, for the facility of deſcription, be divided into four parts, the uſes of which are eſſentially different. Firſt, an ALEMBIC or POT, A, *ſee plate* 1, *fig.* 1, or in lieu of it, a FIRE-TUBE, *a*, (*ſee plate* 1, *fig.* 3, *and plate* 3, *fig.* 1, 2, *and* 3) intended to contain the material or ſubſtance to be expoſed to the action of the heat, with a *Water-pipe* D C, adjuſted to its capital, for the purpoſe of admitting water to aſſiſt the generation or expulſion of the factitious air. Secondly, A REFRIGERATORY G (*plate* 1, *fig.* 1) ſerving to cool and waſh the airs, which are conveyed thither by the *Conducting-pipe* F, connected with the Capital of the Alembic or Fire-tube. Thirdly, an HYDRAULIC BELLOWS H J, to receive and meaſure the air as it comes cooled from the Refrigeratory through the *Communicating-pipe* P.--- And, fourthly, AN AIR-HOLDER Y, *plate* 3, *fig.* 1 *and* 2, into which the Hydraulic Bellows diſcharge the factitious air by means of the *Transfer-pipe g*, and in which it is afterwards preſerved, and may be removed from one place to another.

In lieu of this latter veſſel, in caſes where the patient is at hand, the air may be immediately transferred from the Hydraulic Bellows through the *Diſcharging-pipe* Q, into *oiled ſilk or linen bags*, or ſuch other veſſels as ſhall be thought convenient for mixing it with the proper portion

tion of common air, and alſo for the patient to inhale from.

1. The ALEMBIC and FIRE-TUBE. *The Alembic* A, *ſee plate* 2, *fig.* 4. is made of ſoft caſt iron, about half an inch in thickneſs, and ſix inches in diameter in its wideſt part or *bilge*. It has a Capital B, of the ſame metal, the lower part of which is made conical and ground into its mouth, ſo that the joint may be made tight with a ſmall quantity of cement. Through the middle of the upper part of the Capital paſſes the *Water-pipe* D C, which reaches to within a ſmall diſtance of the bottom of the Alembic; at the top of it is a cup D, to contain water, in the centre of which a wire E, is placed, extending within the Water-pipe to C, where it terminates in an acute cone, accurately fitted to the lower opening of the Pipe as ſhewn in *plate* 2, *fig.* 5. The upper end of this wire has a button affixed to it to turn by hand, and the part immediately under it is formed into a ſcrew, which works in a bridge fixed acroſs the cup, ſo that by turning the ſcrew, you may either raiſe or depreſs the wire, and thereby regulate the quantity of water to be admitted, or entirely exclude it. The joints of the Water-pipe at C, and at the top of the Capital are made conical for the greater facility of rendering them tight, by anointing them with a ſmall quantity of the china clay or other lute hereafter deſcribed; which is likewiſe to be applied to the joint where the *Conducting-pipe* F, enters the ſide branch of the Capital.

The Alembic above deſcribed, may be uſed for producing any of the artificial airs, and ſeems the beſt veſſel for making that from Zinc. At the time this deſcription was firſt publiſhed, it was thought that it would have

proved the moſt convenient for all purpoſes, but experience has ſince ſhewn the contrary.

The *Fire-tube*, ſuch as repreſented in plate 1, fig. 3, when of equal contents with the Alembic, expoſes a greater ſurface to the action of the fire, and expoſes the ſubſtances contained in it better to the operation of the ſteam produced from the water, and thus yields the airs more readily and with leſs waſte of fuel. It is therefore preferable for preparing air from charcoal, iron turnings, chalk, &c. and anſwers very well for the Oxygene air from Manganeſe.

The main tube *a*, *plate* 3, *fig.* 1, 2, *and* 3, is of caſt iron, open at both ends; a kneed pipe, called an *End piece*, *b*, is afterwards fitted to one extremity, and receives into its perpendicular part a water pipe, ſuch as that deſcribed for the Alembic. To the oppoſite extremity of the tube, another ſimilar end-piece, *c*, is fitted, the ſide branch of which is placed horizontally to receive the Conducting-pipe F, which conveys the air to the refrigeratory. The joints are made conical, ground into one another, and made tight with lute in the ſame manner as thoſe of the Alembic.

The caſt iron of which the Alembics and Fire-tubes, with their Capitals and End-pieces are made, is certainly liable to ſome objections; but it has been preferred as being the only *ſubſtance*, yet tried, which can bear the viciſſitudes of heating and cooling, and the application of water, when red hot, without much injury, and the only *metal*, not too coſtly, the fumes or abraſions of which produced by the action of the water and airs might not have deleterious effects For this latter reaſon no copper is employed in any part of the apparatus.

The *Conducting-pipe* F, which conveys the air from the Alembic or Fire-tube to the Refrigeratory, is made of forged-iron, about $1\frac{1}{4}$ inch in diameter, tapering to the ends to fit better. The length is from three to ſix feet, as ſuits the conveniency of the operator. To aſcertain the nature of the air, a ſmall hole, ſtopped with an iron plug, is made near the refrigeratory end; by taking out the plug, and holding a lighted candle to the hole, you may in ſome degree determine when any particular kind of air begins to come over. It would make the apparatus ſtill more perfect, if a bent tube were fitted to the Conducting-pipe near this place, and the air was received according to Dr. Prieſtley's method, in jars through water; but care muſt be taken that the pillar of water through which the air paſſes, be not greater than that in the Refrigeratory. The quality of the air might then be more accurately determined by the uſual teſts.

2. The REFRIGERATORY. This veſſel is made in three different ways, according to the nature of the airs to be cooled by it.

The *Circulating Refrigeratory* G, *plate* 1, *fig.* 1, is uſed for airs which require waſhing as well as cooling, to make them depoſit any extraneous matters which they would otherwiſe carry over with them. It conſiſts of two parts, as ſhewn in the plans and ſections, *plate* 2, *fig.* 2 *and* 3, the upper part is repreſented in the inverted poſition in which it is to be placed within the other. In *fig.* 2, the outer veſſel G is repreſented, furniſhed at one ſide with a funnel and pipe R, for conveying cold water to the bottom; on the oppoſite ſide are two circular apertures, with ſhort pipes and corks fitted to them;

the

the upper ſerves to let off the heated water, and the lower to empty the veſſel. *Fig.* 3, is a plan and ſection of the inner veſſel S ; it is open at bottom, but its cover is convex, and has a ſpiral channel winding along the underſide, which being likewiſe open below, the air coming from the Alembic or Fire-tube by the pipe N, at the circumference, paſſes through the whole of it in conſtant contact with the water of the Refrigeratory, until it arrives at the pipe O, fixed near the centre, which delivers it to the Hydraulic Bellows, by means of the Communicating-pipe P. In this long circuit it is both cooled, and in a conſiderable degree waſhed and freed from any matters from which water has an attraction. In the centre of the inner or ſpiral veſſel, is a ſhort pipe open at both ends, reaching to the lower edge of the plates that form the ſpiral, and intended to ſerve as a paſſage for the hot water to riſe through by its leſſer ſpecific gravity, when cold water is introduced below by means of the funnel R, and alſo for the ſtem of the Agitator to work in. The hot water is then ſuffered to run off through the upper pipe of the outer veſſel, and thus by a frequent renewal, the water in the Refrigeratory is kept both cool and unſaturated. A notch is made in the inner veſſel at T, to receive the pipe R, and prevent its impeding the rim of that veſſel from reſting upon the bottom of the other; in which poſition, when in uſe, it is to be kept ſteady by laying lead weights upon it.

When it is wanted to free the airs more perfectly from any acid taint, the *Agitator* or *Stirrer* is to be employed. This inſtrument is made of wood, in form of an inverted T, with a ſmall winch to turn it by at the upper end of the axis or ſtem. The lower end of the axis or ſtem fits into a ſmall cup at the bottom of the Refrigeratory,

and

and the other paſſes through the ſhort pipe in the centre of the inner veſſel, and turns in a ſocket affixed to the pipe O. The agitator being gently turned round by the winch, puts the whole water in motion; thus continually expoſing freſh ſurfaces to the air in its paſſage to the bellows, and when the water is mixed with the powder of quick lime it ſerves to keep it ſuſpended.

Tin plates japanned have been found to be the beſt material for making both the inner and outer veſſel.

The *Cloſe Refrigeratory* may be uſed for airs which are liable to be abſorbed by the contact of water, ſuch as fixed or carbonic acid air. It conſiſts of a cylindrical veſſel, with a cloſe diaphragm fixed a few inches from its bottom, as repreſented at X, *plate* 3, *fig.* 1 and 2. The conducting-pipe from the alembic opens into the ſpace below the diaphragm, where the ſteam it brings with it is condenſed, and the air cooled by means of cold water poured into the upper part of the veſſel upon the diaphragm, which is to be renewed as it warms, by letting off the heated water through a pipe *h* made for that purpoſe, and pouring on freſh. By this means the air is compleatly cooled, without coming in contact with the water, and is afterwards conveyed to the hydraulic bellows through the communicating pipe P. An aperture with a ſhort pipe *i* is left in the lower or cloſe part of the veſſel, to let off the condenſed ſteam, and inſpect the quality of the air, if at any time need be.

Should however the circulating refrigeratory be preferred for the ſake of waſhing the air, and freeing it from ſome of the calcareous earth, or other extraneous matter it brings over with it, the loſs of air by the abſorption

ſorption of the water will not be very conſiderable, for the water ſoon becomes ſaturated, and as it grows warm yields back great part of the air in a purer form.

The *Pipe Refrigeratory* is the moſt ſimple of all, but can only be uſed when the air produced brings no aqueous vapours over with it, and requires no waſhing. Its uſe is therefore confined to the cooling of *dry* airs, ſuch as that produced from charcoal burning in the open air. It conſiſts of a plain pipe *n* paſſing longitudinally through a trough *m* filled with water, ſuch as that delineated *plate* 3, *fig.* 5, and connecting the hydraulic bellows immediately with the furnace or pot *l*, in which the charcoal is burning.

By connecting this pipe with any cloſe veſſel, to collect the condenſed water, it may be made to anſwer all the purpoſes of the cloſe refrigeratory.

3. The HYDRAULIC BELLOWS. An outſide view of this veſſel is given in H J, *plate* 1, *fig.* 1, and *pl.* 3, *fig.* 1, and an inſide view in *plate* 2, *fig.* 1. It conſiſts of an outer or fixed veſſel H, and an inner or moveable veſſel J, which moves eaſily up and down within the other, and is ſuſpended by a cord paſſing over two pullies K K, and ſuſtaining a counterpoiſe L. To avoid the incumbrance of a great weight of water, the outer veſſel H is made double, ſo that only an interſtice of about half an inch is left between its two cylinders for the veſſel J to move up and down in, and this muſt be filled with water as high as the pricked line in *plate* 2, *fig.* 1. The cup or rim W is to prevent the water from overflowing when the inner veſſel is preſſed forcibly down. The factitious air enters from the refrigeratory

by

by the communicating pipe P, and paſſes along the perpendicular pipe V into the cavity of the veſſel J, which continues riſing until it is full, when the framing M will permit it to go no higher. The air is then expelled into the air-holder or bag, through the *diſcharging-pipe* Q, by lifting up the counterpoiſe L, and allowing the inner veſſel to deſcend by its own weight.

This veſſel is alſo made of tin plate japanned. Some ſlight variations have been made in the execution of thoſe for ſale ſince the two firſt plates were engraved, but none of ſufficient importance to merit particular mention.

4. The AIR-HOLDER. The ſtructure of this veſſel is ſhewn at Y, *plate* 3, *fig.* 1 and 2. It is made of tin-plate, japanned both inſide and outſide, and is cloſe at both ends; but for the conveniency of japanning the inſide, it is made in two halves, which are joined together in the middle of the veſſel, by a cement compoſed of bee's-wax and one fourth of its weight of roſin, applied hot. By warming the joint before a fire, the veſſel may at any time be taken aſunder, and cleaned. Two ſhort pipes, U and Z, proceed from the ſide of the veſſel, near its top and bottom, and another pipe, *t*, paſſes through the middle of the top or cover, to which it is well ſoldered, and reaches to within half an inch of the bottom.

When the lower pipe Z is corked, the upper one U remaining open, the veſſel may be filled with water through the central pipe *t*, to which, for the conveniency of pouring, a funnel *k* is fitted; by withdrawing the cork of the pipe Z, the water may again be diſcharged, the external air which enters through the pipe U

ſupplying

ſupplying its place. So that if when it is filled with water, a ſhort pipe *g*, called the *Transfer-pipe*, be inſerted and cemented into the upper pipe U of the air-holder, and into the diſcharging-pipe Q of the hydraulic-bellows, and if the lower pipe Z of the air-holder be then opened, and the inner cylinder of the bellows be allowed to deſcend, by lifting the counterpoiſe, it is obvious that the factitious air contained in it will be transferred into the air-holder. The pipes Z and *t* are to be well corked as ſoon as the air holder is filled, but there ſhould always be left an inch of water at the bottom of it, to impede ſtill more all communication with the external air; as ſoon as it is disjointed from the reſt of the apparatus, the pipe U ſhould likewiſe be carefully corked.

Corks are preferred to cocks for ſhutting theſe openings, both becauſe when good, and well fitted, they are perfectly air-tight, and becauſe common cocks are made of a metal, the ruſt of which is very poiſonous, being a compoſition of copper, lead, tin, arſenic, and antimony, or whatever other metals the ores may happen to contain.

Oiled Silk Bags, as it has been already mentioned, are convenient for removing factitious air from one room to another, and for the patient to inhale from. They may be made in the form of a common ſack, tapering at one end like a bottle, and having a conical wooden faucet fixed in the mouth, with the ſmaller end outwards, into which a ſpiggot is to be inſerted.

To free oiled ſilk from its diſagreeable ſmell, cut it into pieces of the ſize wanted for the bags, and provide a ſmooth table ſomewhat larger than the pieces of ſilk and a flat board the ſame ſize as the table. Take *charcoal*

coal freſh burnt in an open fire until it is free from ſmoke, extinguiſh it by ſhutting it up in a clean cloſe veſſel, and reduce it to powder. Sift this powder over the table to the thickneſs of a quarter of an inch or more, ſpread a piece of your ſilk upon it, and ſift upon that again another layer of your charcoal duſt, and thus proceed alternating the layers of ſilk and charcoal, until the whole of your ſilk is depoſited; then lay your moveable board upon the top of all, and leave the whole undiſturbed for four or five days. If upon removing the charcoal duſt, the ſilk has not loſt its ſmell entirely, repeat the proceſs. The charcoal duſt is to be ſwept off the ſilk, and the ſilk to be waſhed upon a table with a wet ſponge until it is clean. The bags muſt then be carefully ſewed up, and the ſeams anointed with japanners' gold ſize, taking care to uſe that kind which does not become brittle when dry. This is uſed in preference to drying oil, becauſe it has not ſo bad a ſmell. Green oiled ſilk ſhould be avoided, as it is ſtained by means of verdigris, which rots it; the yellowiſh ſilk is the beſt.

Dr. Beddoes ſays he obſerved the thicker oiled ſilk to anſwer better than the thinner kind; that probably oiled linen will be found to anſwer; that the bags, when out of uſe, ſhould be hung up by a ſtring tied to the faucet, and that they ſhould be as little creaſed as poſſible. To this it may be added, that the beſt way of emptying them of all the air they contain, is to lay them flat upon a table, and to paſs the hand, or a round paper ruler, gently over them.

It is neceſſary to obſerve here, that although oiled ſilk be the beſt ſubſtance known for making the bags of, it is very imperfectly air-tight; and although charcoal duſt

duſt deprives it of ſmell for the time, yet as it can only attract the odoriferous particles from the ſurface, it re-acquires ſome ſmell by keeping, but by no means equal to what it had at firſt.—The deſideratum is ſome thin flexible ſubſtance, whoſe pores can be more perfectly cloſed than thoſe of ſilk, and a varniſh without ſmell, or ſome kind of light bellows, not of the hydraulic kind.

FURNACE. Many perſons to whom this apparatus will be uſeful, being unprovided with a convenient furnace, I have endeavoured to make one of ſuch a conſtruction as to adapt it to the uſes both of the alembic and fire-tube, which has neceſſitated ſome ſlight variations from the one repreſented *plate* 1, *fig.* 1, but which are all ſhewn in *plate* 3, *fig.* 1, 2, 3.

The aſh-pit and furnace are both made of one piece, of a cylindrical form. The furnace part is lined with fire bricks, is 14 inches diameter within, and 18 inches over all; the depth to the grate is 11 inches, and that of the aſh-pit about 7. Two circular holes, of $4\frac{1}{2}$ inches diameter, are made in two oppoſite ſides of the furnace to admit the fire-tube, which when the alembic is uſed are to be ſtopped with plugs of fire clay. Two caſt iron rings, *r r*, are ſent with the fire-tubes, which when they are uſed fit upon the ends, and ſerve to ſhut up the circular holes of the furnace as accurately as can be done. The covers drawn in *plate* 1 are not found to be neceſſary.

A *ſmaller* furnace has likewiſe been made for a ſmaller apparatus, 9 inches diameter within the brick lining, and 9 inches deep to the grate. The fire-tubes for this are only 3 inches diameter without.

Thoſe

Thoſe who wiſh occaſionally to convert theſe furnaces into diſtilling furnaces, may have a fire-door *d* fitted to one of the ſide holes, a chimney-pipe *p* to the other, and a caſt iron pot for containing ſand, adapted to the mouth of the furnace ; *ſee plate* 3, *fig.* 4 ; but none of theſe are neceſſary for the particular application of it to this apparatus.

Both furnaces have a door *f* to ſhut up the aſh-pit, and at one ſide a ſliding damper *s*, to regulate the quantity of air admitted, for when the coaks are good, and the grate clear from aſhes, the fire might become too ſtrong if the fire door were to be left open. No chimney is uſed in the operations for producing airs, becauſe a ſufficient and a better regulated heat is produced without one ; a flat plate, however, is uſeful to cover the furnace when the operation is over, which when the door of the aſh-pit and the air-hole are ſhut, will ſoon extinguiſh the fire.

Dimensions of the Apparatus. The apparatus is made of *two ſizes*. The hydraulic bellows of the *larger*, is 12 inches diameter, and the moveable veſſel J riſes about 15 inches, ſo that each inch in height contains 113 cubic inches, and the whole bellows 1695 cubic inches, or rather leſs than a cubic foot. The bellows of the *ſmaller* apparatus are about one third of the contents of the larger, being $8\frac{1}{2}$ inches diameter, and riſing 13 inches, ſo that each inch in height contains 57 cubic inches, and the whole of the bellows conſequently 570, or about one third of a cubic foot.

The Air-holders are alſo made of two ſizes, the larger containing a cubic foot, and the ſmaller half a cubic foot ;

foot; which dimenſions have been fixed upon as convenient for carriage when filled with air, and capable of being lifted by one perſon when full of water, which would not be the caſe if the contents were more than a cubic foot. The ſmall air-holders will, on account of their reduced contents, be chiefly uſeful for conveying *Fixed air*, which ſhould be ſent out in ſuch quantities only as are likely to be uſed at once. For if water be poured into an air holder to expel part of the fixed air, and the air-holder be afterwards corked up and laid by, great part of the remaining air will be abſorbed by the water.

The large Fire-tubes are three inches in diameter within, and have 14 inches in length expoſed to the action of the fire; the Alembic, when filled to the neck or cylindrical part, is about equal to them in its contents, The ſmall fire-tubes are $2\frac{1}{4}$ inches diameter within, and have 9 inches expoſed to the action of the fire, conſequently the contents of the larger tubes is to that of the ſmaller as 54 to 126, but the quantities of air which will be produced from them reſpectively, will not follow that ratio, becauſe the heat will be more readily communicated to the centre of the matter contained in the ſmall tubes, than it will to that of the large ones. Their reſpective actual performances have not been compared.

The larger apparatus is particularly uſeful where conſiderable quantities of air are required, eſpecially for carbonic acid air from chalk or marble, or oxygene air from manganeſe, where it is of ſome conſequence to be able to operate upon a large quantity of materials at once.

For

For the uſe of private individuals, or for experiments, the ſmaller apparatus will be found large enough; but if any quantity of air is wanted to be produced, and the operator is not too much confined for room, it will be adviſeable to combine the larger bellows and refrigeratory with the ſmaller furnace, to avoid the trouble of too frequently emptying the bellows, and to enable the operator to retain a reſerve of air within them.

Stools. Before attempting to uſe the apparatus, ſtools ſhould be provided for the different parts to ſtand upon. They are beſt made with round tops, and for the *large apparatus* ſhould be 16 inches diameter, and about $1\frac{1}{2}$ inch thick, of elm or oak board, with three plain feet.—The following heights are taken from the ſtools to the ground:

Stool for the Refrigeratory	-	18 inches.
Ditto Hydraulic bellows	-	24
Ditto Air-holder, allowing an inch for the thickneſs of the tub it ſtands in	}	$8\frac{1}{2}$

When the fire-tubes are uſed, the ſame ſtools as above will ſerve, only an additional one of $14\frac{1}{2}$ inches high, muſt be provided to place the furnace upon. This may be made of iron, but the heat is not there ſufficient to burn it, even if of wood.

The *ſmall apparatus* is adapted ſolely to the uſe of fire-tubes, and the following ſtools of one foot diameter will be neceſſary in uſing it:

Stool for the Furnace to ſtand upon 12 inches high.
Ditto for Refrigeratory - - 17 ditto

Ditto for Hydraulic bellows - 23 inches.

Ditto for *large* Air-holder (allowing one inch for the thickneſs of the tub) - - - - - - } 7 ditto

Theſe ſtools are required to be ſo high on account of the air-holder, which would not otherwiſe have room to empty its water into a moderate ſized tub. The elevation of the apparatus will be found a convenience to the operator.

If the ſmaller furnace be adapted to the larger apparatus, the heights of the ſtools will be as above, excepting that of the refrigeratory, which muſt be reduced to 16 inches; but in that caſe the ſtools of courſe muſt be of the diameter mentioned for the larger apparatus.

A ſtool that can be raiſed and depreſſed at pleaſure, will be found convenient for placing the apparatus upon that is intended to receive air under water. See page 7.

GENERAL

GENERAL DIRECTIONS FOR *THE USE OF THE APPARATUS.*

AS it has been already mentioned that the fire-tubes are more convenient for general purpoſes than the alembics, it may be proper to deſcribe their uſe firſt.

FIRE TUBES. Thruſt the plug ſent with the apparatus into one end of the tube, and holding it perpendicularly reſting upon that end, put into it what quantity you pleaſe of the material to be acted upon, taking care that the whole lie within the wide part. Lay the tube upon its ſide, take out the plug, anoint the end piece, which correſponds to the conducting-pipe, with the *Fire-lute* hereafter deſcribed, and (having firſt put one of the caſt iron rings upon that end of the tube) inſert it into the tube, turn it round a little, preſſing it in at the ſame time, and then give it a gentle blow with a piece of wood, to force out the ſuperfluous lute. Paſs the fire-tube through the two holes made in the furnace to receive it, and put the remaining iron ring upon the other end of it, ſo as to fill the hole on that ſide. Anoint the conical end of the conducting-pipe with lute, and thruſt it into the end piece above-mentioned, letting it incline about an inch towards the refrigeratory, into the receiving-pipe N of which the other end muſt be inſerted, being previouſly anointed with the *Cold Lute* hereafter deſcribed. Join the pipe O of the refrigeratory with the communicating pipe P of the hydraulic bellows, uſing the above lute for the joints. Theſe being adjuſted, anoint the other

end piece of the fire-tube with fire-lute, and fix it in its place, ſo that the water-pipe C D may be perpendicular. Lute alſo the joint of the water-pipe, and fix it in its place. Fill the cup D with water, having firſt ſcrewed down the wire E, that no water, can paſs into the fire tube.

As water is not abſolutely eſſential for the production of oxygene from manganeſe, you may in that proceſs inſert the iron plug, properly anointed with fire lute, into the tube, in lieu of the end piece above-mentioned.

You may now proceed to light the fire*.—Lay the lead weights upon the inner veſſel of the refrigeratory, and fill it with water, as alſo the outer veſſel of the hydraulic bellows up to the dotted line ſhewn in plate 2, fig. 1, but no higher, otherwiſe the water will run down the perpendicular pipe V. Preſs down the inner veſſel J of the bellows to empty it of air, cork the diſcharging-pipe Q, and hang on the balance weight L †.

As ſoon as the lute of the joints which are expoſed to the action of the fire is dry and hot, apply to them ſome of the *Fat-lute* hereafter deſcribed, and to prevent its running off, ſtrew ſome dry ſlacked lime over them. This fat-lute will prevent the joints from cracking, but care muſt be taken that none of it get into the inſide of the fire-tube, as it would give a bad ſmell to the air.

* The directions here given are for the *Circulating* Refrigeratory, as being moſt commonly uſed; thoſe for the *Cloſe* Refrigeratory will be found under the article Fixed Air; and thoſe for the *Pipe* Refrigeratory under Phlogiſticated Air.

† The Air-holder may either be fixed on now, or hereafter, as deſcribed page 22.

In caſes where water is neceſſary for the production of the factitious air, as ſoon as the fire-tube is become red hot, unſcrew the wire E, ſo as to admit a little water into it. The air will immediately paſs through the conducting-pipe to the refrigeratory, and gliding along its ſpiral in contact with the water, will arrive at the bellows through the pipe P, waſhed and cooled. It is beſt to admit no more water into the fire-tube than enters into the compoſition of the airs, or is neceſſary for their expulſion, as you will thus obtain them apparently more condenſed and powerful than when a ſuperfluous quantity of water is admitted. The latter circumſtance may be known by the pipe at N becoming too hot for the finger to bear.

Care ſhould be taken to renew the water from time to time in the refrigeratory, and to keep the agitator conſtantly in a gentle motion if the production of the air is quick, but in caſes where the production of air is not very rapid, it will be ſufficiently waſhed and cooled without uſing the agitator. In proceſſes where you wiſh the fixed air to be abſorbed that may accompany the other factitious airs, it will be found neceſſary to fill the refrigeratory with lime water, or ſtill better, to add powdered quicklime to the water contained in it. The inner veſſel J of the hydraulic bellows will riſe gradually as the factitious air enters, but when it is full, or nearly ſo, it is proper to transfer the air into the air-holder, which for that purpoſe muſt be placed upon a ſmall ſtool in a ſhallow tub, and filled with water through the central pipe, in the manner already directed. Connect the air-holder to the bellows by means of the transfer-pipe *g*, and lute the joints. Then take out the cork from the lower pipe Z, and the counterpoiſe of the bellows being lifted up,

the factitious air will pass into the air-holder, and the water be emptied into the tub. The issuing of the water may be rendered slower at pleasure, by holding the end of the cork against the opening of Z, which should be re-corked as soon as the air-holder is full, or the bellows completely emptied of air. The air-holder is then to be removed, and all the pipes to be well corked.

It should be kept in a cool place until the air is wanted, which may be transferred into one of the oiled bags, as follows :—Fix the Faucet, or mouth piece of the bag, lapped round with some wet linen rag, tied with a thread, into the inner pipe U of the air-holder, having previously squeezed out all the common air out of the bag, in the manner directed page 13. If you want a quart, gallon, or other measure of factitious air, pour that quantity of water into the air-holder, by means of the funnel *k*, through the central pipe (which reaching within half an inch of the bottom, precludes the air from escaping) and exactly that measure of the inclosed air will issue out into the bag.* Then recork your air-holder, if not exhausted of air, apply at the same time your thumb on the outside of the bag, and pressing it against the inner orifice of the faucet, to prevent the exit of the air until you can insert the spiggot, which should be previously wetted.

The quantity of atmospheric air wanted to be mixed with the factitious air, should be thrown into these bags

* It has been already remarked, that the factitious air may be transferred immediately from the hydraulic bellows into the bags, by inserting the faucet, lapped round with a linen rag, into the discharging pipe Q, and suffering the inner vessel of the bellows to descend, until as much air as is required enters the bag, which you may know by marking the quantity of the descent of the bellows.

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by a pair of common bellows, the nozzle of which will admit the faucet of the bag, or by an hydraulic bellows appropriated to that purpoſe, and not by that which receives and meaſures the factitious airs, which will in general be otherwiſe employed. The ſmaller ſized bellows will be found ſufficiently large for this purpoſe. When both the airs are included in the bag, it ſhould be repeatedly turned up and down, in order that they may be perfectly mixed.

Some gentlemen prefer an hydraulic bellows made to hold three or four cubic feet of air, to the bags for breathing out of; but ſuch an apparatus cannot fail of being cumberſome in many caſes, and in all will be troubleſome to remove, eſpecially when filled with air.

Should the factitious air contained in the air-holder, require to be more thoroughly freed from fixed air or acid fumes, than has been done before; it may be effected by putting ſome dry ſlacked lime down the central pipe, pouring a ſmall quantity of water upon it, and agitating the veſſel briſkly; but ſo much atmoſpheric air will enter on uncorking the pipe as there was fixed air abſorbed.

AIR MAGAZINE. Some perſons may wiſh to preſerve in readineſs larger quantities of air than can conveniently be kept in air-holders. The moſt readily conſtructed veſſel to anſwer this purpoſe, would be a common caſk or hogſhead, open below, and ſuſpended over another larger caſk, filled with water, by a cord going over pullies, and a counterpoiſe, in the ſame manner as the hydraulic bellows. The air might be admitted and taken out by means of a flexible pipe and a cock attached to and communicating with the upper end of the ſuſpended caſk; the latter veſſel being rendered air-tight,

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by ſhaving it ſmooth both inſide and out, and filling up its pores with bees wax, applied when the caſk has been made very hot by a fire of ſtraw or ſhavings. The wax ſhould continue to be applied until the pores will receive no more, and then the ſuperfluity be wiped off. Oiled paint would give a poiſonous impregnation to the water, and a mixture of roſin gives a bad ſmell.

For inflammable and dephlogiſticated airs, the water over which they are kept may be impregnated with lime, which will prevent the putrefaction of the water, and will alſo ſerve to abſorb the fixed air. Fixed air itſelf cannot long be preſerved in this way, even when there is no lime in the water. Something of the ſame nature with the air-holder, ſeems moſt proper for this air, as the ſmall quantity of water included with the air, would ſoon be ſaturated; and for the ſame reaſon, the air-holder applied to this uſe, ſhould not be large, otherwiſe the water employed to expel part of the air, might abſorb the remainder.

ALEMBIC, or FIRE-POT. When you have put into this veſſel the proper quantity of materials to produce the factitious air, force a piece of iron down through them to make way for the water-pipe, then lute the joint of the capital B, and fix it in its place. Lute and put in the lower part of the water-pipe C; ſet the pot on its pedeſtal in the middle of the furnace, and connect together the remaining parts of the apparatus, as has been deſcribed when the fire-tubes are uſed.

In letting in the water and regulating the whole of the apparatus, proceed exactly in the manner related above.

LUTES,

LUTES, or CEMENTS. *Fire-lute.* To join together the joints expoſed to the action of the fire, viz. the end pieces and water-pipe with the fire-tube, the capital with the alembic and the conducting-pipe to either of them, the proper lute is the Corniſh porcelaine clay, or ſlacked and finely ſifted lime, mixed to the thickneſs of paint, with a ſolution of two ounces of borax in a pint of hot water.

Cold lute. For the other joints, a paſte of dough made of about equal parts of wheat flour and porcelaine clay, or common whiting, which, for greater ſecurity, may when the joint is luted, be wrapped round with a rag. A ſlip of oiled ſilk does very well without any lute.

Fat lute. Is made of finely ſifted ſlacked lime and drying linſeed oil, wrought into a pretty ſtiff paſte, and applied to the hot joints with a ſmall trowel.

Fuel. The proper fuel is good coaks or cinders of pit coal, which ought not to be of the heavy ſort, nor too ſmall, as in either caſe you would have a dull fire. The charcoal of wood would anſwer very well, but it is expenſive, and the conſumption would be conſiderable. A fire of pit-coal not coaked, is irregular and unmanageable. Care muſt be taken to have your coaks well dried; and the firſt time you uſe the furnace, you will do well before you operate, to warm and dry it with a fire of coaks, to chaſe off any moiſture the bricks may have imbibed, otherwiſe your fire will be long in lighting.

GENERAL CAUTIONS.

EACH time before you uſe the apparatus, it ſhould be waſhed with cold water, to free it from any effluvia it may retain from the laſt operation. The ſame fire-tube or pot ought not to be uſed for producing different airs; and for this reaſon, it will be proper to keep one appropriated to the making of each. Indeed, ſhould ever an eſtabliſhment be formed for making large quantities of the different kinds of air, it will be certainly adviſeable to have an entire apparatus appropriated to the making of each kind.

No bituminous or oily ſubſtances ſhould be put into the pots or tubes, for the making of inflammable airs, or any other purpoſe. Nor ſhould any ſubſtance likely to yield any of the mineral acids, be uſed in the apparatus, as the fumes would deſtroy both the conducting-pipe and the refrigeratory. The ſame objections lie againſt the volatile alkali, and to putting any alkali into the water of the refrigeratory; but as far as has been obſerved, lime-water does not hurt the varniſh.

The proceſs for obtaining the inflammable airs, ſhould not be conducted by candle-light, otherwiſe the approach of the candle to the ſtream of air may occaſion dangerous exploſions. For the ſame reaſon, when any patient is inhaling this air by candle-light, the candle ſhould be kept as diſtant as poſſible.

In all caſes, wherein the powdery matter which the air brings over in the form of ſmoke, is not intended to be taken into the lungs, the air ſhould be kept twelve hours at leaſt before it is uſed, that it may make its depoſit.

DIRECTIONS

DIRECTIONS

FOR

PROCURING THE AIRS.

THE directions here given, are not intended to compriſe all the methods of procuring each air, but merely thoſe which have been found the cheapeſt and moſt eaſily practiſed. For the hiſtory of Factitious Airs, their chemical qualities, and the means of judging of their purity, the reader is referred to the laſt edition of *Dr. Prieſtley's Experiments, in* 3 *vols.* 8*vo.* to *Lavoiſier's Elements of Chemiſtry*, and for a conciſe general view of the ſubject, to *Nicholſon's firſt principles of Chemiſtry.*

I. DEPHLOGISTICATED, or OXYGENE AIR. This air is beſt obtained from manganeſe, by mere heat. The methods of obtaining it from nitre, from ſpirit of nitre, or from manganeſe, by means of vitriolic acid, are objectionable, becauſe ſome acid always accompanies it in theſe caſes, from which the air is difficultly freed, and this apparatus would ſuffer from corroſion, unleſs very troubleſome means were employed to purify the air before it arrived at the refrigeratory.

Manganeſe, for this purpoſe, ſhould be free from calcareous earth and noxious minerals. A very good kind is found near Exeter, which ſeems to poſſeſs theſe requiſites. The preſence of calcareous earth may at any time be detected, by pouring diluted nitrous acid upon the powdered manganeſe, for if it contain any, there will

will be a continued effervescence, which otherwise would not take place.

The manganese to be put into the fire-tube or pot, must be reduced to a coarse powder, all the joints must be properly prepared, and every part of the apparatus fixed in its place, as has been directed; the opening for the water-pipe is to be stopped with an iron plug, or with the water-pipe itself, having screwed down the wire so as to admit no water; but some water may be put into the cup by way of precaution, merely to prevent the escape of air, if the conical wire should not be tight. The fire is then to be lighted, and suffered to burn gently until the air begins to come, when it may be gradually augmented until the air ceases to be produced.

Water is not absolutely necessary in this process, for although it seems rather to accelerate the production of the air, it does not augment the quantity produced. It is therefore as well to make use of the iron plug to stop up one end of the fire-tube, instead of the end-piece and water-pipe as above directed.

A pound of the hard part of *Exeter* manganese, yields about 1400 cubic inches of air, highly dephlogisticated, and a very small portion of fixed air, which will be absorbed by the water in the refrigeratory. The soft or clayey part seems not to yield so much, but what it does yield is equally pure.

Some manganese yields its air at so low a heat, that it is necessary to have every joint tight, and all the apparatus ready before the fire is lighted. If the manganese happen to be wet, it will be a considerable time before any air comes over.

The

The fire-tube of the large furnace holds about 6lb. of manganeſe, which will yield about five cubic feet of air; thoſe of the ſmall furnace contain nearly 3lb. and yield about two and a half cubic feet of air.

Mendip manganeſe contains much calcareous earth, and conſequently yields fixed air combined with phlogiſticated or azotic air, both in the beginning and end of the proceſs. A pound yields only about 500 or 600 cubic inches of impure dephlogiſticated air, of which about one third part is abſorbed by waſhing it with lime and water. To aſcertain the point at which it begins to yield dephlogiſticated air, take out the plug in the conducting-pipe, from time to time, and hold a lighted candle near the hole; from the brightneſs of the flame you will eaſily diſcover when the oxygene begins to come and when it ceaſes, and thus you may be able to keep it ſeparate from other airs.

Objections have been ſtarted againſt the air from manganeſe, the ſalubrity of which it is ſaid has not been conſtituted by experiment, and even if it ſhould be found innocent when taken into the ſtomach, that as an earthy powder it may have bad effects upon the lungs. To this it is anſwered, that if the air ſtand a few hours, it will depoſit the merely ſuſpended earth, and what it retains will be in a ſtate of ſolution in the air, and of too fine a texture to prove hurtful, as ſoft powders are found not to injure that organ. It is farther anſwered, that Dr. Beddoes and others have conſtantly given the air from manganeſe, without perceiving any bad effects attributable to that cauſe; and laſtly, that no other means of obtaining this air equally unexceptionable, have yet been pointed out. For it ſeems undeniable, that the fumes of nitrous acid, or of the ſulphuric, muſt prove much

much more deleterious than the powder of manganeſe, and they ſeem almoſt *inſeparable* from the airs obtained from nitrous and vitriolic ſalts.

II. PHLOGISTICATED, AZOTIC, or NITROGENE AIR. No proceſs for producing this air unmixed with other airs, by means of mere heat, has yet been diſcovered, but it may be readily enough obtained mixed with fixed air.

Plate 3, *fig.* 5, repreſents a chafing diſh, nine inches high and ſix inches diameter, communicating through the medium of the pipe refrigeratory *n m*, with an hydraulic bellows at *n*. The chafing diſh is to be compleatly filled, or rather heaped, with the charcoal of ſome of the ſofter woods, and in preference to that of the twigs or ſmall branches, previouſly kindled and made red hot in a common chafing diſh. The trough of the refrigeratory is to be filled with cold water, and the end *n* to be connected with the pipe P of the hydraulic bellows. Theſe muſt be ſuffered to riſe very ſlowly, ſay thoſe of the larger apparatus in five or ſix minutes. The air which has ſerved to animate the fire, and has there been deprived of its oxygene, will paſs through the ſide pipe of the chafing diſh and the pipe of the refrigeratory into the bellows; and when the operation has been properly performed, it will be found to contain no uncombined oxygene air.

If the uſe to which this air is to be applied, requires it to be freed from the fixed air it contains, that may eaſily be effected, by agitating it in the air holder with a mixture of lime and water, or with a ſufficient quantity of pure water.

III. FIXED,

III. Fixed, or Carbonic Acid-Air. Take as much good chalk as your fire-tube or pot will hold, break it into bits of about a quarter of an inch cube, and ſoak or boil it in a large quantity of water, to extract any ſaline matter it may contain. Put it into the fire-tube or pot, and prepare your apparatus, as has been already directed, making uſe of the cloſe refrigeratory, as repreſented in *plate* 3, *fig.* 1; unleſs, for particular purpoſes, you wiſh to have your air waſhed, and do not value the loſs of a ſmall quantity; in which caſe you may make uſe of the circulating refrigeratory, as has been ſaid before.

When your fire has burnt up, and your fire-tube or pot is become fully red-hot, admit water ſlowly by the water-pipe, and the fixed air will immediately iſſue and paſs to the bellows.

If you make uſe of the cloſe refrigeratory, you muſt renew the cold water in the upper part from time to time, that the air below the diaphragm may be properly cooled, and any ſteam it brings over with it may be condenſed.

Chalk is recommended in preference to marble, as it gives out its air at a lower heat.

The fire-tube of the ſmaller apparatus, when filled full, which it always ſhould be, as otherwiſe the ſteam may paſs over without acting upon it, will hold about 1½lb. of chalk, which will yield about four cubic feet of very ſtrong fixed air, mixed with ſome inflammable air from the iron tube.

The

The fixed air thus obtained, carries with it ſome of the chalk in a ſtate of ſuſpenſion, which it will depoſit by ſtanding a few hours in the air-holder, or other convenient veſſel.

IV. Inflammable, or Hydrogene Airs. Firſt, *Zincic Inflammable Air*. The pureſt, or at leaſt the lighteſt ſpecies of this air, is produced from zinc. The metal being broken or granulated, a few pounds of it is to be put into the alembic, and the apparatus being adjuſted with the circulating refrigeratory, &c. as before directed, it is to be brought to a ſtrong red heat and water to be admitted very ſlowly. It ſeems impoſſible to avoid the circumſtance of a conſiderable quantity of ſteam accompanying the air, which renders it neceſſary to renew frequently the water in the refrigeratory.

This air carries with it a large quantity of the flowers of zinc in ſuſpenſion, which it depoſits by ſtanding at reſt; it probably alſo contains another quantity in a ſtate of ſolution, which ſeems to form a part of its ſubſtance, and on which ſome of its virtues may depend.

If the air is wanted to be ſtill more highly charged with the flowers of zinc, it would be proper to make uſe of the cloſe refrigeratory.

When the fire-tubes are uſed in this proceſs, part of the zinc ſublimes in a metallic ſtate, and is apt to choak the end pieces; the alembic is therefore recommended in preference, as being free from that inconvenience. Only a ſmall quantity ſhould be put in at a time, as the water could not force its way through any depth of the melted metal.

As

As zinc does not produce very large quantities of inflammable air, and is more expenſive than iron, Dr. Beddoes adviſes to put in only a few ounces of zinc, and to fill up the fire-tube with hammered iron turnings. The air produced in this way will probably carry with it both iron and zinc.

2. *Martial Inflammable Air*, or Hydrogene Gas from Iron, is the next in ſpecific gravity to the inflammable air from zinc, and like it carries with it ſome of the metal from which it is formed. It has alſo more of an hepatic ſmell than the zincic air.

To produce it, the fire-tube or pot is to be filled with the turnings or chippings of hammered iron, which may be had from the whiteſmiths. Caſt iron turnings or borings give much more of the hepatic ſmell, and alſo contain more charcoal or carbone. Before the turnings are put into the fire-tube or pot, they ſhould be heated red hot in a crucible, and quenched in water, to free them from oil, or other combuſtibles.

The apparatus is then to be adjuſted as in the former caſes; and when the fire-tube or pot is red hot, water is to be gradually admitted, which will readily extricate the air.

The fire-tubes of the ſmall apparatus hold about two pounds of hammered iron turnings, which yield a large quantity of air.

When the turnings uſed for this purpoſe have not been exhauſted, if they are plunged red hot into water, they

will throw off the ſcale or calcined iron, and when heated again, will preſent freſh ſurfaces, to the action of the water.

3. *Heavy Inflammable Air, Carbonated Hydrogene,* or *Hydro Carbonate.* Take charcoal made of the twigs of the ſofter woods, ſuch as willow, poplar, hazle, birch, or ſycamore, avoiding ſuch as have reſinous or aſtringent juices. Prepare the charcoal by heating it to full ignition in an open fire, and quenching it in clean water; or by filling a crucible with it, covering it with clean ſand, and expoſing it to a ſtrong heat in an air furnace; and then ſuffering it to cool. In either of theſe caſes it will be found free from any bituminous matter, which might contaminate the air, as generally happens with common charcoal.

The fire-tube or pot is to be heated red hot, and water admitted, as directed in the other caſes. It has been obſerved by Dr. Prieſtley, and confirmed by my experience, that where much water paſſes in the form of ſteam, there is alſo much fixed air formed; but leſs, or none, when the water is admitted ſo ſparingly that no ſteam reaches the refrigeratory; and in the latter caſe it ſeemed to me that the air was more potent, that is, it was more ſubject to cauſe vertigo, &c.

This air having generally a diſagreeable ſmell, an experiment was made with a view of producing it more free from that quality. Half an ounce of charcoal, finely powdered, was intimately mixed with half a pound of ſlaked, but cauſtic lime, quite dry. This mixture was put into the fire-tube, and without the addition of water, produced about a cubic foot of inflammable air, with much

much leſs ſmell than uſual, and in the opinion of my operator not ſo likely to cauſe vertigo.

The production of the carbonic inflammable air by the addition of water is very rapid, as even the ſmall fire-tubes will produce a cubic foot in five or ſix minutes. With the lime the production is ſlow.

4. *Animal Inflammable Air* is produced by putting any animal ſubſtance into the fire-tube or pot, and expelling the air by mere heat; wool, hair, and feathers, produce it in larger quantities than the muſcular part of animals. In all caſes the air thus obtained is extremely fœtid and deleterious, cauſing vertigo and permanent nauſea. It brings over large quantities of volatile alkali, which hurts or deſtroys the varniſh of the apparatus. If it ſhould be thought that it would prove uſeful in any diſeaſes, it is probable that the air obtained from the charcoal of animal ſubſtances may be as ſalutary, and leſs nauſeous, than that obtained from them in their freſh ſtate. It is therefore propoſed to reduce wool, feathers, or hair to charcoal, in a cloſe veſſel expoſed to a ſtrong heat; to put this charcoal into the fire-tube, and to obtain the air by the addition of water; by which proceſs it is thought it will be obtained more free from the fœtor, and from the volatile alkali.

MISCELLANEOUS OBSERVATIONS.

IN every operation in which water is requiſite to the production of the airs, the fire-tube ſhould be filled compleatly with the bruiſed material, otherwiſe the ſteam would paſs over the ſubſtance without acting upon it. This precaution alſo renders the production of the air more rapid and certain, and at the ſame time leſſens the proportionate produce of inflammable air from the fire-tube, which, eſpecially with a new tube, might otherwiſe form a conſiderable part of the whole.

A *Coating* for the inſide of the fire-tubes, which would prevent the action of the ſteam, or other ſubſtances on the tube, is deſirable, but none which compleatly anſwers that purpoſe has hitherto occurred. The beſt has been the lute of China clay and ſolution of borax. To apply this, the tube ſhould be made as warm as the hands can bear, and one end being ſtopped up by the plug, the lute ready mixed up to the conſiſtency of cream, is to be poured into the tube. The other opening is then to be ſtopped, the tube agitated in all directions for a ſhort time, and the lute, which does not adhere, ſuddenly poured out; after which, the tube muſt be rolled upon a table until the heat has evaporated the water of the lute. It is probable that this lute might be improved by an addition of calcined flints ground to fine powder, ſuch as are uſed in the Staffordſhire potteries.

When

When the inflammable air is prepared by means of zinc, the pot ſhould be coated in this manner, to prevent the zinc, or its calx, from adhering to the iron, which it would otherwiſe do, and be difficultly got off.

Earthen tubes or *pots*, which would be air-tight, and would ſtand repeated heating and cooling, would be a valuable acquiſition; but conſidering every circumſtance, this ſeems hardly practicable, as the crucible compoſitions which are beſt adapted to bear the heating and cooling, are too porous to contain the airs, and generally too tender to bear the fitting in of the end-pieces.

From ſome circumſtances it appeared probable, that the matter which communicated ſmell to the inflammable airs, might alſo be the cauſe of vertigo, and other diſagreeable effects; it was therefore attempted to deprive them of ſmell. A quart bottle was filled with ſome very ill-ſcented hydro carbonate, and an eight ounce vial, with a mixture of calcined charcoal-duſt and water. The mouths of the two were luted together with a ſtrip of bladder, and inverted; the contents of the vial fell down into the bottle, where it was well agitated with the air, the apparatus was then reverſed, and the operation repeated more than once. On opening the bottle, it was found that the air had loſt its *bad* ſmell; its odour was not entirely gone, although what it retained was not unpleaſant. However I ſoon found, by merely ſmelling at the mouth of the bottle, that it had not loſt its power of cauſing vertigo. Conceiving theſe ſmells to be cauſed by ſulphur in ſome of its forms, it was thought that *a metallic calx* might produce the ſame effects. The powder of calcined manganeſe was ſubſtituted for the charcoal in another experiment, and apparently produced a

ſtill

ſtill more powerful effect. The proceſs with charcoal was attempted upon a larger quantity of air in the air-holder, but it was found that it required conſiderable quantities of charcoal-duſt and of water, to produce the effect even in an imperfect manner. The experiment, however, ſeems worthy of repetition, as the ſmell with people of delicate nerves, will always be ſome obſtacle to the free uſe of the airs.

In the mean time, it is recommended to try the following method in the extrication of inflammable air from charcoal and from iron. When you charge the tube, fill it half or three quarters full with clean waſhed and calcined ſand, the kind called *Calais ſand* ſeems the moſt proper, and upon this put the charcoal or iron to be operated upon, which will thus lie next to the water-pipe. The air produced muſt paſs through the interſtices of the red hot ſand before it can arrive at the refrigeratory and it is expected will be conſiderably changed by thus coming into contact with ſo much hot ſurface. The experiment may be varied, by ſubſtituting cauſtic ſlacked lime, or clean pounded tobacco pipes, in lieu of the ſand.

Whether the Hydro Carbonate thus obtained in a purer or more inflammable ſtate, would have the ſame virtues as a medicine, muſt be left to Phyſicians to determine; I fear it would not, as it would approach near to the nature of the metallic inflammable airs, which are not ſo powerful.

If the fire-tube is entirely filled with ſand, and the vapour of ſpirits of wine, or of ether, from a ſmall retort, are made to paſs through it, inflammable airs will be produced of the nature of hydro carbonate, though ſpecifically ſomewhat different.

REFERENCE

REFERENCE *to the* PLATES.

PLATE I. *Fig.* 1, Elevation of the Large Pneumatic Apparatus, with the Alembic. *Fig.* 2, Bird's Eye View of the Furnace, with its Covers. *Fig.* 3, Section of the Fire-tube and Furnace, according to the firſt Conſtruction.

PLATE II. *Fig.* 1, Section of the inner and outer Veſſels of the Hydraulic Bellows. *Fig.* 2, Section of the outer Veſſel of the Circulating Refrigeratory. *Fig.* 3, Section and Plan of the inner Veſſel of the Circulating Refrigeratory. *Fig.* 4, Section of the Alembic and Water-pipe. *Fig.* 5, Section or the upper Part of the Water-pipe, and View of the Conical Wire.

PLATE III. *Fig.* 1, Elevation of the Large Pneumatic Apparatus, with the improved Furnace Fire-tube, Cloſe Refrigeratory, and Air-holder. *Fig.* 2, Plan of ditto. *Fig.* 3, Section of the Furnace and Fire-tube. *Fig.* 4, Section of the Small Furnace, with Sand Bath, Retort, and Chimney adapted for Diſtilling. *Fig.* 5, Section of the Pipe Refrigeratory.

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LEAST the difficulty of conſtructing and procuring the apparatus ſhould prove an obſtacle to the extenſion of its uſe, BOULTON and WATT undertook to manufacture them. The difficulties of this new branch are ſo far overcome as to enable them to ſupply orders without delay. A liſt of the parts furniſhed by them, both of the larger and ſmaller apparatus, is ſubjoined, but they can only ſtate the price by approximation, as the buſineſs is too new yet to enable them to determine the poſitive coſt at which they ſhall be able to conſtruct them in future.

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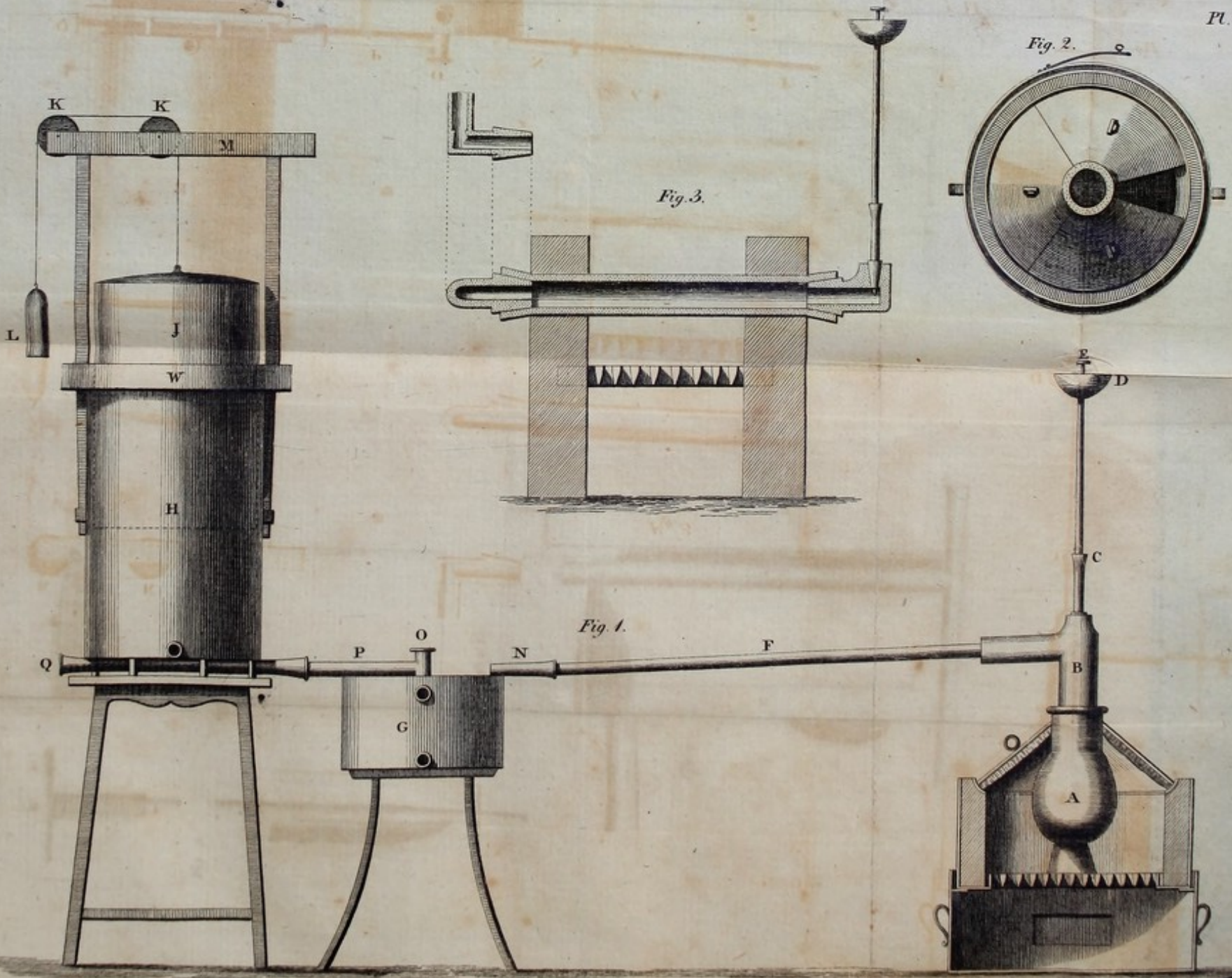

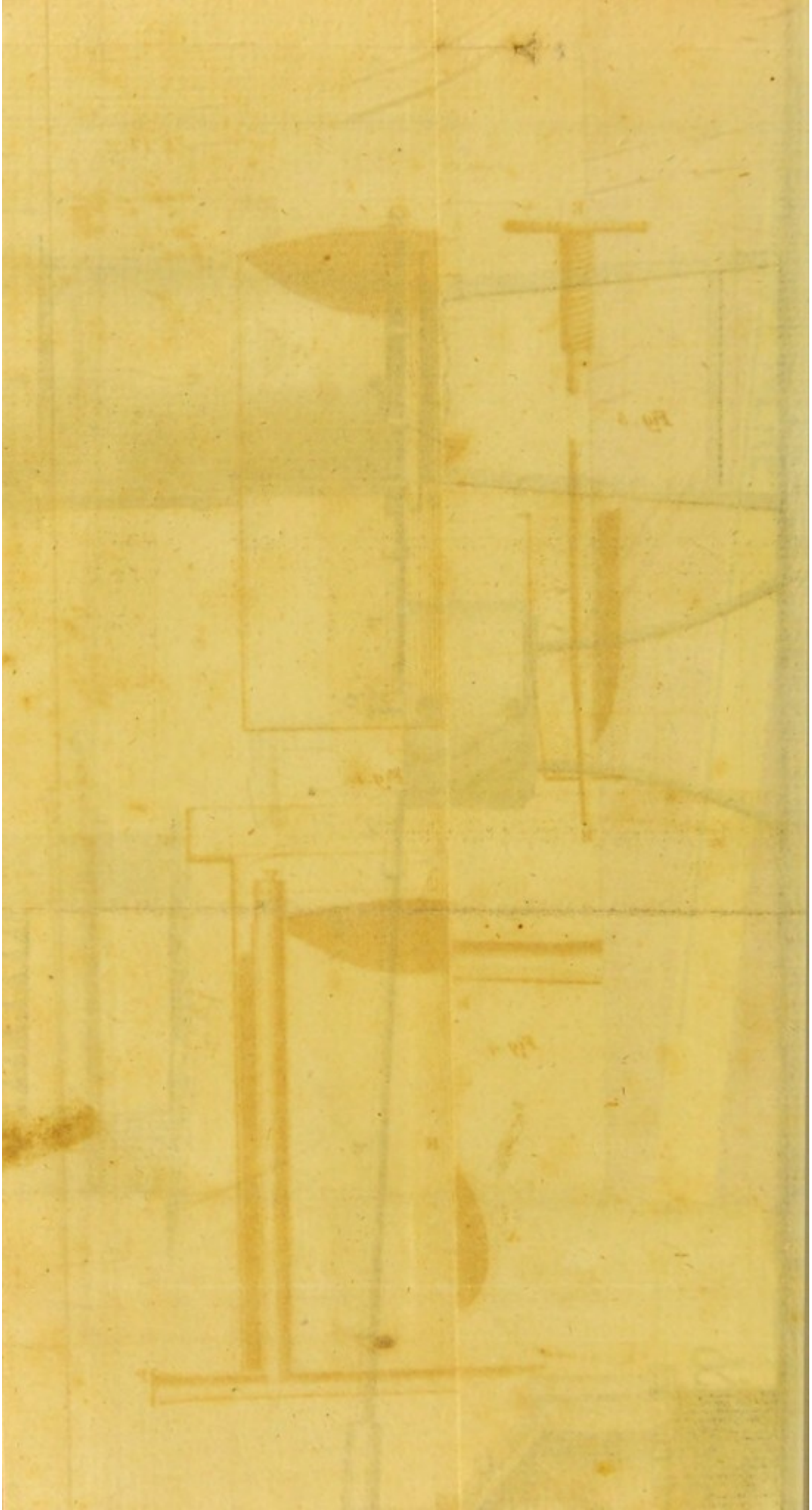

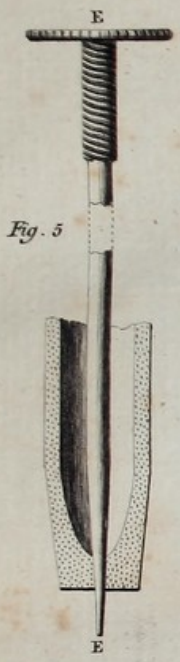

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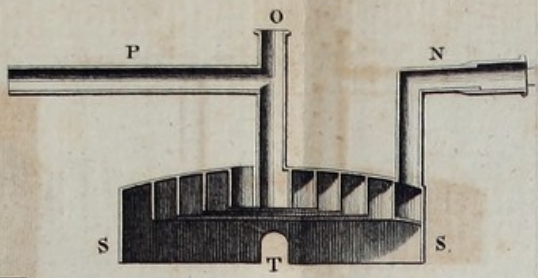

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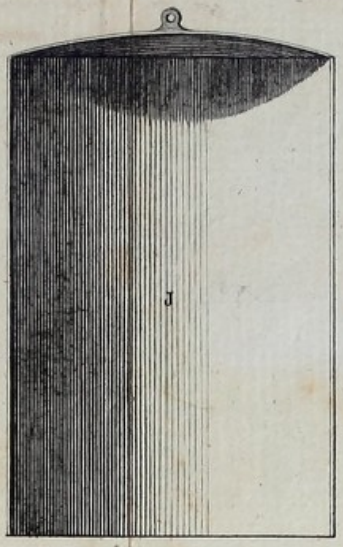

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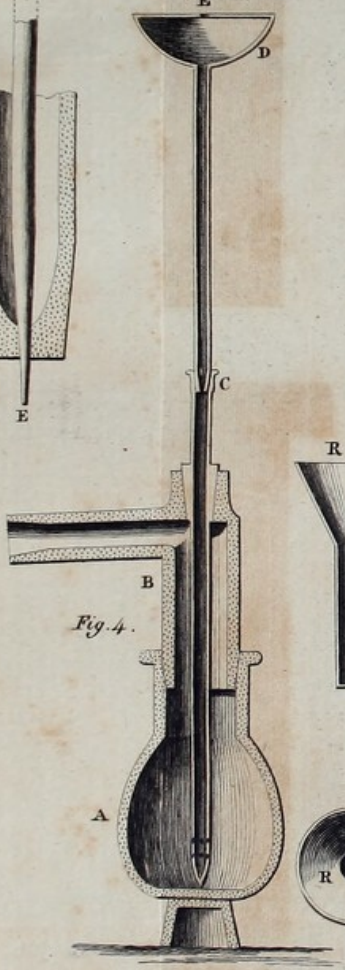

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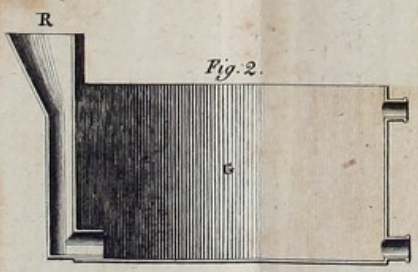

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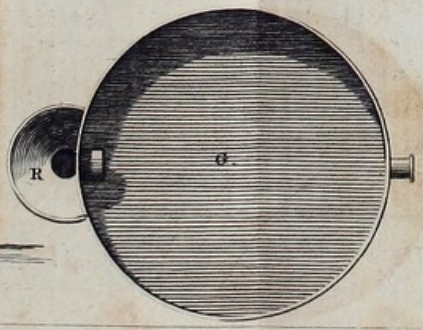

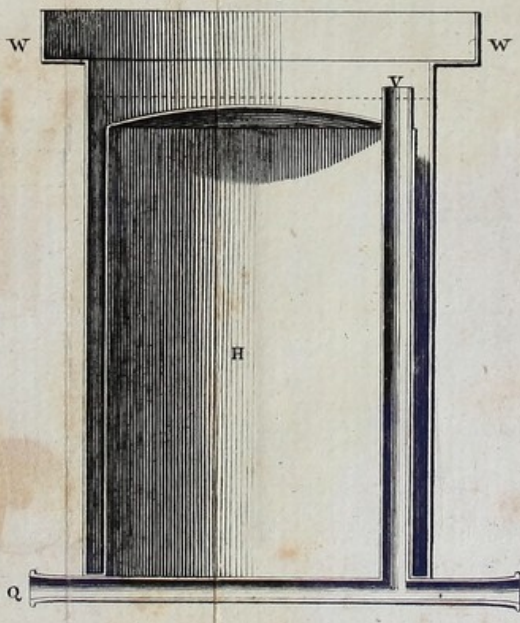

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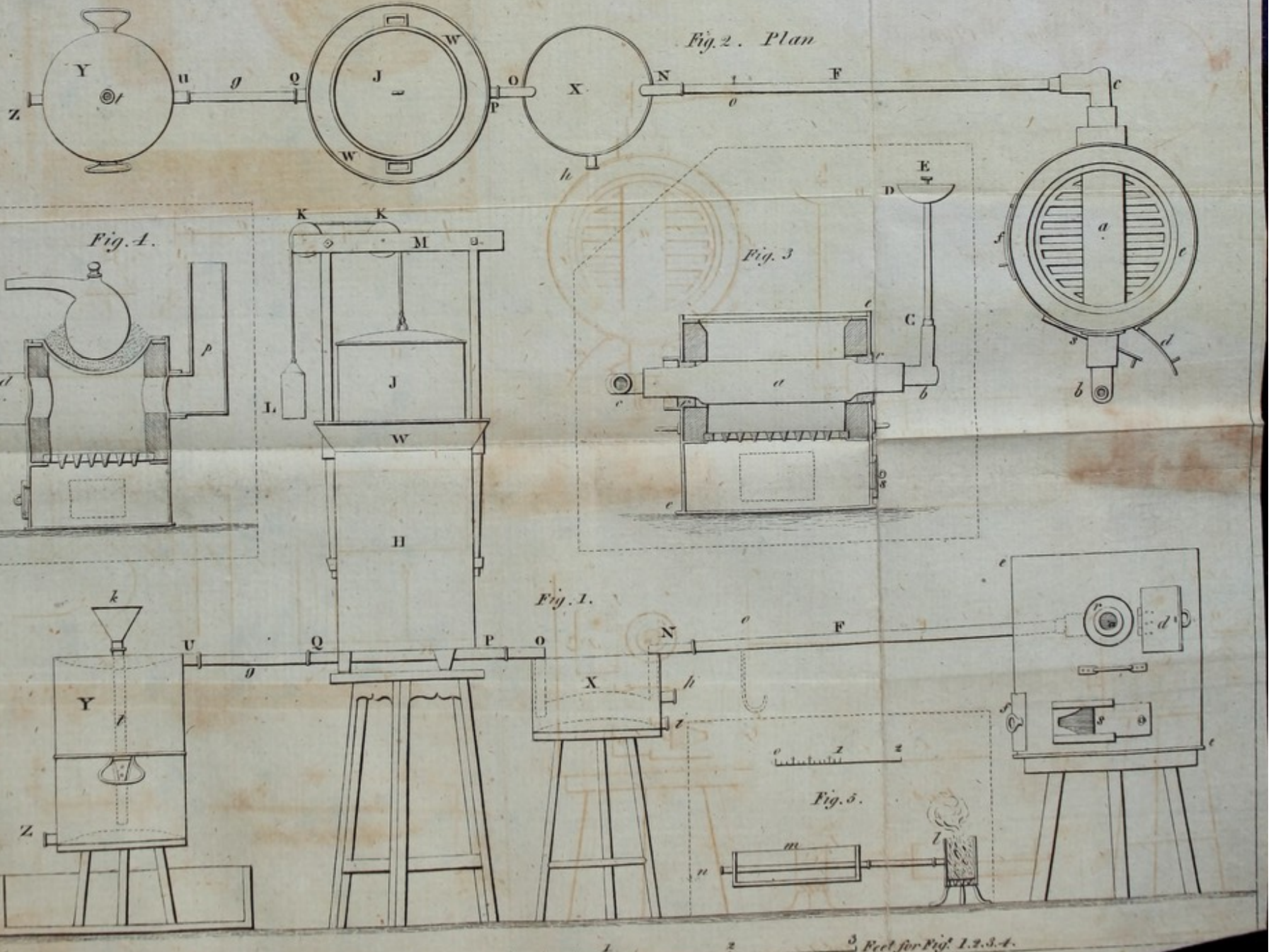
Fig. 2. Plan
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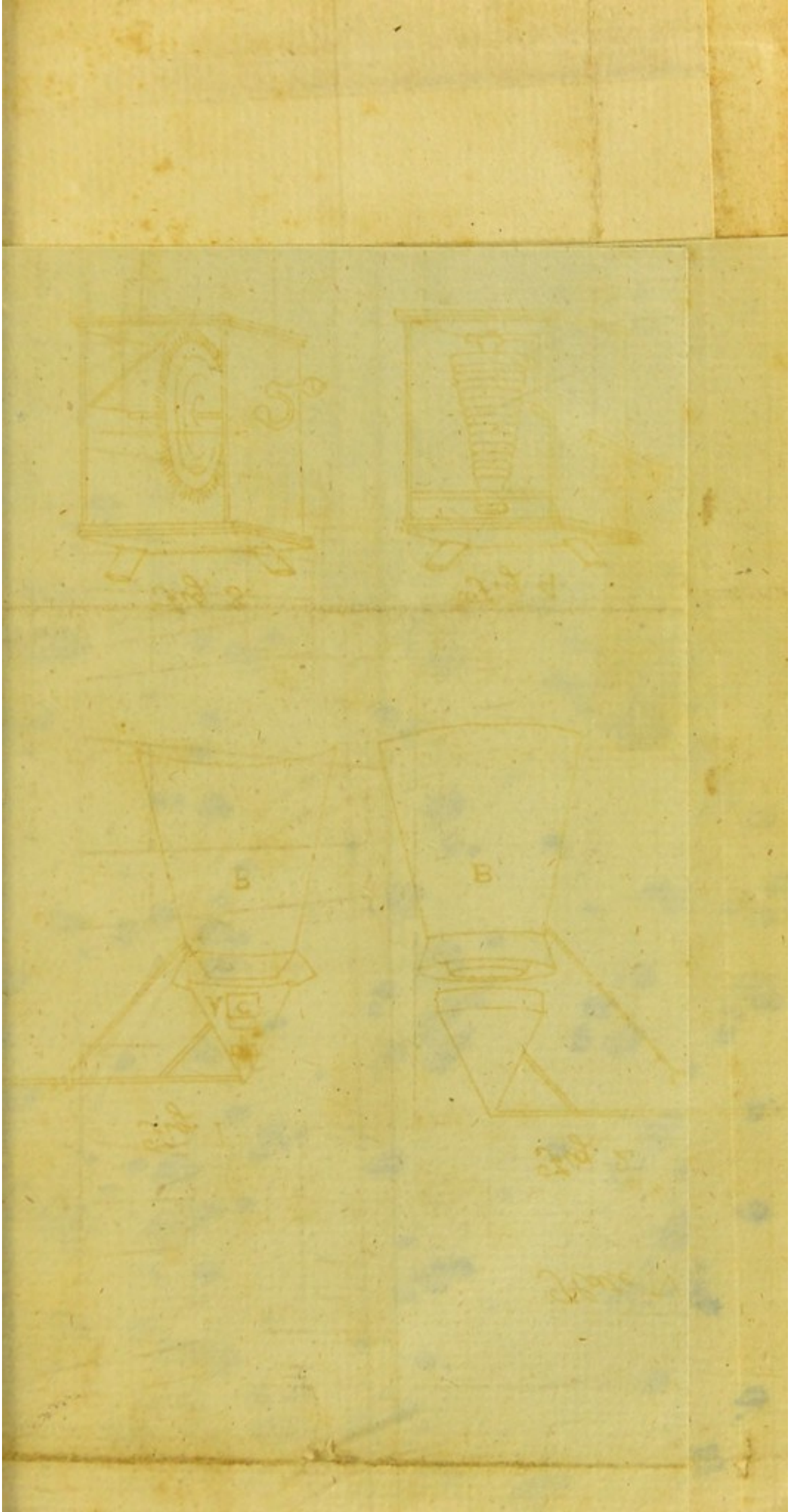
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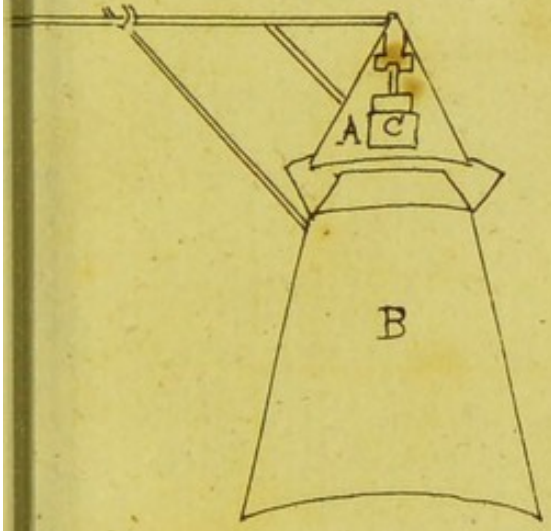
Plate IV.

Fig. 1.



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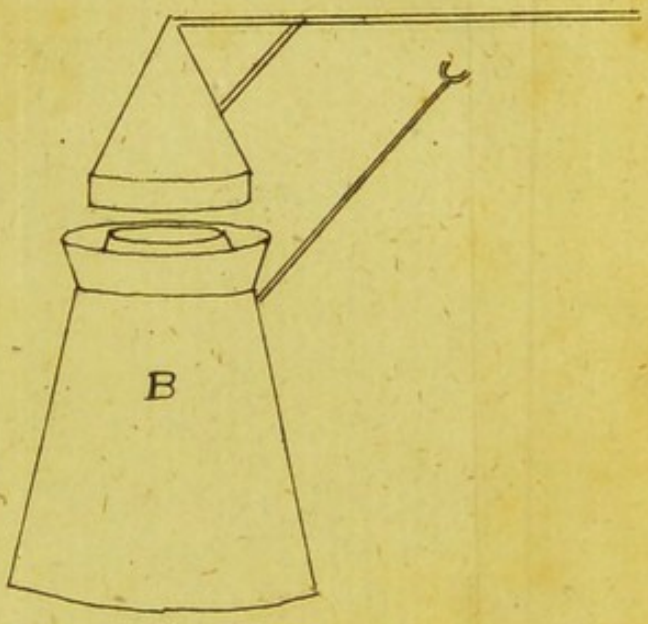

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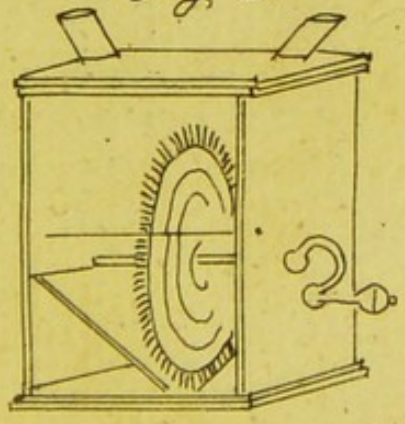

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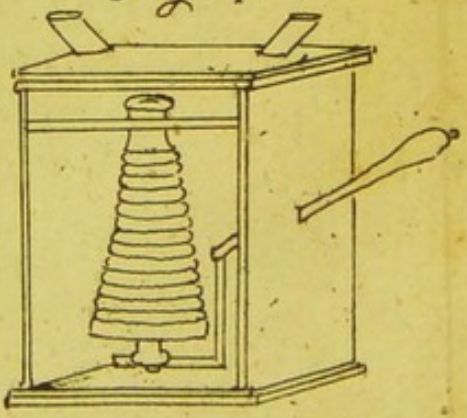

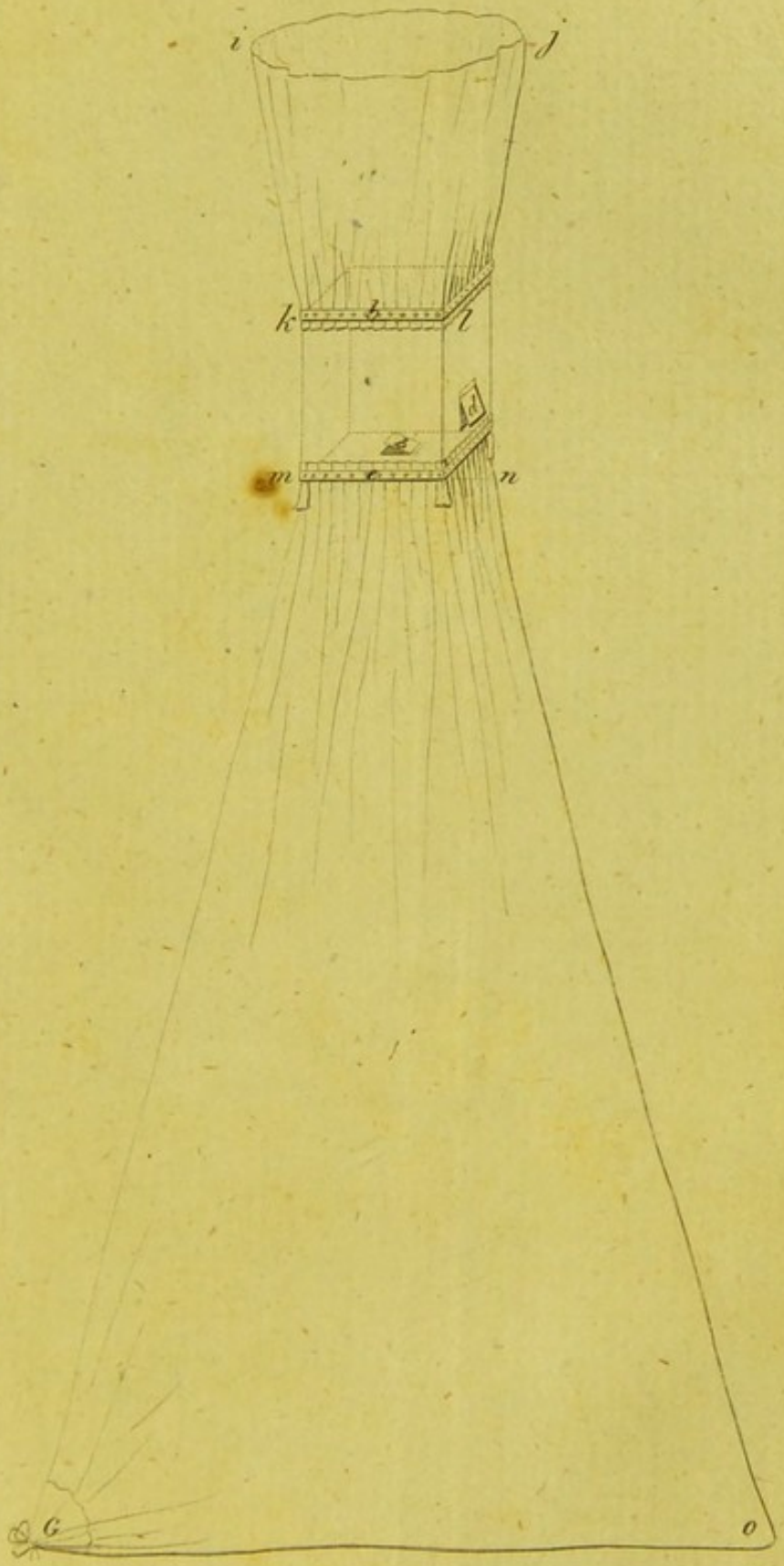
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