

A treatise on the means of purifying infected air, of preventing contagion, and arresting its progress / [Louis-Bernard Guyton-Morveau].

Contributors

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make that pretence, or how should it
 be established but by the *major*: in the
 conclusion is most evidently *in*cessant
 one and fundamental principle of mora-
 we should do to others, as we would
 five they should do to us.
 rule which carries its own demon-
 which; and it was intended on purpose
 off that bias of self-love, which would
 side upon the straight line of equity, and
 be partial judges between our neighbours
 lives. Now, I would not that advocate of
 severities, how he should belish his own
 if they were turned against him? Yet
 to go abroad into new scenes, might I not
 be a Protestant; amen! *in*stant
 Christian? Supposing he was to behave
 as a Christian; like a good man, like a
 avoiding whatever would injure

to pay for pleasure, and to
 receive images, but merely
 to pay for the image of
 the image of the image, and
 other supreme authority
 places in Europe have not
 with the utmost effect
 Allowing for the value of
 properly expressions, the
 of utmost extent and
 of the catcher of hearts,
 of the hearts of hearts,
 to believe that we do,
 on the principle of the
 of religion, no one
 punishment is sent
 against of his own
 could not up
 place, secondly, with
 punishable by any
 toleration limited, by
 suit to express it, to
 as a failure, and
 least with fines and imprisonment

M. H.




NH. 4. 7

~~XXVIII~~ *L. H.*

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A
TREATISE
ON THE MEANS OF
PURIFYING INFECTED AIR,
OF PREVENTING CONTAGION,
AND
ARRESTING ITS PROGRESS.

By L. B. GUYTON-MORVEAU,
MEMBER OF THE NATIONAL INSTITUTE OF FRANCE, &c.
AND OF MANY FOREIGN LITERARY, AND
SCIENTIFIC SOCIETIES.

Dira per incautum serpunt contagia vulgus.
VIRG.

Translated from the French

By R. HALL, M. D.

Hunc lenire dolorem
Possis, et morbi magnam deponere partem.
HOR.

LONDON:

Printed by J. & E. Hodson, Cross-street, Hatton Garden;
FOR T. HURST, PATERNOSTER-ROW.

1802.

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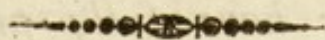
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P R E F A C E

BY THE

TRANSLATOR.



ALTHOUGH, neither the peculiar nature of contagions, nor the manner in which they operate in producing disease, be at present well understood, yet recent investigations have fully ascertained the laws by which they are communicated, and the methods necessary to be pursued in order to check, and effectually put a stop to their progress.

Much ingenuity and force of argument have been, we are aware, exerted by some authors, to show that contagion is the mere result of putrefaction, but though many circumstances serve to prove that they are intimately connected, and capable of being destroyed by similar agents, sufficient evidence has not

hitherto been adduced to warrant us positively to conclude, that contagious effluvia are essentially the same with the miasmata exhaling from putrid substances. Whatever difference of opinion may however prevail respecting the nature and origin of febrile contagions, accurate observations have fully proved that, in whatever way generated, they may all be propagated either by actual contact with infected persons, or things, or by breathing air charged with effluvia, whether proceeding from substances imbued with contagious virus, or from patients labouring under pestilential disease.

Since all contagious effluvia act only when near to the sources whence they arise, and since when diffused in the air, or chemically united with it by solution, they unquestionably lose their deleterious qualities, it must be obvious that, by a proper attention to ventilation and cleanliness, the influence of infection may be generally avoided; but although both reason and experience confirm the efficacy of such measures, in preventing or controlling the destructive agency

agency of contagion, yet, as the time requisite thus to dilute or diffuse the poison is uncertain, and as this mode of purification is not universally applicable, recourse has been had to the more easy and expeditious means which Chemistry affords.

All the mineral acids have been successfully employed to destroy or neutralize contagious virus; but the Muriatic seems to possess advantages which render it superior to every other chemical agent hitherto recommended for this purpose, not only from its greater expansibility and more powerful action, but from the ease and safety with which it may be applied in all cases whatever :—circumstances which cannot fail ultimately to insure its general adoption.

The employment of this acid, for the purification of vitiated air, seems first to have been suggested by Dr. James Johnstone of Worcester, so early as 1758, in a Treatise, entitled “*An Historical Dissertation on the Malignant and Epidemical Fever which prevailed at Kidderminster in 1756,*” though it is indisputably

to

to M. Morveau that we are indebted for having fully established its efficacy by a variety of well conducted and decisive experiments.

Notwithstanding these, however, and other instances, in which the acid fumigations were employed with the greatest success, the practice appears from that period to have been neglected and almost wholly forgotten in France, although it seems evidently to have suggested the experiments of Dr. Smith with the Nitric Acid Vapour, on board the Union Hospital Ship at Sheerness in the year 1795.

The mortality occasioned at Genoa by the contagious malady which raged in that city in 1800, as well as the disposition on the part of the French Government to enforce by its authority the introduction of acid fumigations into the military hospitals, afforded new motives to M. Morveau for resuming his enquiries on this subject, and gave rise to the present important publication, in which this distinguished author takes a brief review of the circumstances which suggested the trials of fumigation with the
muriatic

muriatic acid; the results obtained; the conclusions deduced from them; the experiments made to prove that they may be performed without removing the sick; and the instructions circulated for carrying them into execution. He next presents the reader with some extracts from the Reports of the experiments made on this subject, in foreign countries, and principally from those undertaken by order of the Admiralty of England, and describes the particular method of Dr. Smith, comparing it with those adopted by Mr. Cruickshank, and the physicians of Madrid: after which, he examines the opinions delivered as the results of the different observations, and the principles on which a preference may be given to one or other of these processes: and concludes by pointing out such as considered in every respect seem to promise the most advantage, and ought to inspire the greatest confidence.

On the whole, whatever theory we may form of the nature of febrile contagion, it must be allowed, that if future experience shall confirm,

firm, what may, we think, with the highest degree of probability be inferred, from these and other experiments, as well as from the testimonies of many respectable practitioners, the discovery respecting the efficacy of the mineral acids, in a state of vapour, for the destruction or neutralization of contagious virus, will prove of the greatest benefit to mankind.

It is here only necessary to remark that the few notes which have been added by the Translator, are distinguished from those of the author by having the letters T. or Tr. subjoined; and that the Translation has been executed with that strict attention to accuracy which is so essentially necessary to be observed in all works of science,

London, June 12, 1802.

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PRELIMINARY DISCOURSE.

THE study of nature, whilst it gratifies the inquisitive propensity of the mind, affords a still more pleasing recompence from the hope of applying the result of its researches to the advantage of society; and this object, chemistry daily presents fresh means of attaining, since it has been raised to the rank of the demonstrative sciences.

It must, however, be admitted, that its application to useful purposes, does not keep pace with its discoveries. We might almost be led to think, that, when a ray of light suddenly extends the horizon of our knowledge, we, at first, avert our eyes from the lustre which overpowers them, and that, in order to enjoy its benefits, it is necessary to mould our education anew, or to leave it to time to operate a gradual change in our habits.

In how many instances is practice at variance with the truths revealed to us by modern chemistry ! How many theories are there which still subsist, merely because they have not yet been submitted to the test of the new instruments which it employs ! How many objects which require to be re-examined by observers accustomed to their use !

There is one which the most mournful events incessantly recall to our attention—the effect of contagion. The bare mention of this word presents the image of the most dreadful of all the evils which afflict humanity. The sword blunts its edge on the body which it pierces ; poison remains inactive in the organ which it has deprived of sensation ; fire, removed from its aliment, dies of itself ; but contagion derives additional force from the number of its victims.

What then is the nature of those invisible corpuscles which, like organic beings, possess the power of reproduction, and of assimilating to their own essence, every thing with which they come into contact, and which seem to assume *life* but for the purpose of propagating *death* ? Is their composition sufficiently powerful to resist the force of the chemical agents,

agents, which destroy almost instantaneously the equilibrium of the elements in animate as well as inanimate matter?

The period at which these questions first engaged my attention, was well calculated to increase their interest. It was at the moment when an epidemic fever in Genoa, daily carried off about 500 of its inhabitants. I flattered myself, for some time, with the hope, that the treatise, in which I intended to investigate them, might appear soon enough to rouse the attention of that city to efficacious preservatives that seemed to be there totally unknown. But I felt, on the other hand, the necessity of giving in this work all the proofs and illustrations suited to the importance of the subject, and which were necessary to raise it to a level with the progress of science, and to induce the public confidence. The few moments my ordinary occupations permitted me to devote to this undertaking rendered it impossible to complete the design in so short a period*.

B 2

I did

* When I was appointed to the magistracy, about 40 years ago, and during all the time that I discharged the laborious duties of that situation, I still had some intervals of leisure which I could employ in physical researches. This purpose I cannot
at

I did not however forget to do what might have partially accomplished these intentions. The *Citoyen Francais* of the 16th Thermidor, in the year 8, (4th of August, 1800) had published the most lamentable details of the progress made by the contagious malady at Genoa. Four days after, I procured the insertion in the same journal, of a letter, in which I concisely stated, the use I had made in 1773 of fumigation with the mineral acids, in purifying air infected by putrid emanations, as well as the favourable judgment passed by several learned societies respecting this method of arresting contagion; and the success obtained from it, particularly in the case of the *Hospital Fever*, which was then generally admitted to constitute the character of the epidemic in question. I felt satisfaction in thinking, that this communication, when conveyed to a place where the mortality had left but a melancholy impression of the inutility of the usual preservatives, would excite a desire of at least giving it a trial. I have every reason to believe that it never reached its destination;

at present accomplish, but by prolonging my evenings, in order to gain a few hours, which I am, in some measure, obliged to steal, by anticipation, from the last years of my life.

and

and it is remarkable, that the Editors of the other periodical publications of the time, did not conceive that article to be of so much importance as to contribute to its publicity.

Had I been capable of relinquishing my design of treating this subject anew, in order to demonstrate in the clearest manner the advantages of these fumigations, this circumstance would have furnished a fresh motive for resuming it with increased ardour. I had besides, received very flattering encouragement from Citizen Carnot, then Minister at War. He had requested that I would present to him a sketch of my views with respect to the means of correcting the insalubrity of the hospitals; and, in consequence of the report made to him upon that sketch, he wrote me on the 14th Thermidor of the same year, in the following terms: " I instantly transmitted it to the Board of Health, appointed for the war department. The zeal which animates you for the preservation of mankind requires that I should communicate the observations made to me upon this subject, which has always appeared to me to be of the highest importance." The Board of Health admits the

solidity of the principles on which your doctrine is established, and reports them to be perfectly similar to those which in the year 2 (1793—4) formed the basis of the *instruction* published by order of the Committee of Public Safety. The zeal with which you assisted on that occasion has not been forgotten. That instruction was profusely distributed at the time, and the means pointed out were carried into effect in the course of the epidemic disease which then prevailed in the army of the Western Pyrenees; and since, upon all occasions where circumstances required it, fresh copies of the instruction have been sent off, with orders to use the means therein prescribed. The processes which you have suggested shall be put in practice. You have facilitated your purpose by simplifying them. The Board of Health has proposed to me to have them subjoined to the Formulary, of which it is preparing a new edition.—The simplicity and œconomy by which they are characterized will leave no pretext for dispensing with their use, and I shall give the most precise orders that they be carried into execution.”

This

This disposition on the part of government, to support by its authority the introduction of this method into the military hospitals, imposed it as a duty upon me to neglect nothing that might produce a conviction of its efficacy, and justify the opinion which had been formed of it.

By reading some fragments of this treatise to the class of physical and mathematical sciences of the Institute*, I gave an opportunity to several of my colleagues to furnish me with observations, which prove how much they were interested in this undertaking, and of which, it will be seen, I have eagerly taken advantage.

Two remarks, communicated to me since this work has been at press, require some explanation upon my part.

1. It has excited surprise, that I should give a superiority to the *acetic* acid over the *acetous*, in regard to its anti-contagious powers†. I am aware that chemists are still divided upon the question, whether there be

* In the months of last Brumaire, Frimaire, Nivose and Pluviose. The description of my plan was read at the public meeting on the 15th of Nivose.

† See No. 77, 101, and 174.

any essential difference between these two acids, or at least as to the cause of that difference*. But a discussion upon this point would here be misplaced, because it is of little consequence to my purpose, whether the former derives its intensity of action from a greater proportion of oxygen, or a smaller proportion of hydro-carbon as an acidifiable basis, or even from a more complete separation of extraneous mucus. I had only to direct my attention to facts; and those which I have related on the authority of experiments made by myself, manifest a much more energetic principle in the vinegar termed *radical*. Doctor Bonvoisin had before me, observed that, on being applied to the skin, it separated the epidermis with scarcely any disagreeable sensation, on which account he employed it as a mild caustic; and he further discovered that it acted as a preservative in putrid, malignant, and pestilential maladies, when its fumes are inhaled by the organs of smell†.

* Observations respecting the differences which exist between the *acetous* and the *acetic* acid, by J. A. Chaptal.—*Annales de Chimie*, tom. xxviii. p. 113.

† Memoirs of the Academy of Turin, for the years 1788—89, p. 380.

2. Since pneumatic chemistry has demonstrated the existence of certain principles unknown in former times, attempts have been made to employ them in the explanation of all the phænomena of which the causes yet remained to be discovered; and the imagination, eagerly catching at some analogical appearances, conceived that it might anticipate the result of experiment and observation. The nature of contagious miasmata, so difficult of comprehension, could not fail in its turn to experience the effects of this spirit of system. M. Wentrop Saltonstall, in a medical history of azot, which he denominates *Septon*, has endeavoured to show that those miasmata, as as well as the purulent matter of ulcers, pestilential buboes, &c. derive their morbid properties from a certain chemical combination of azot with oxygen*. Those who may have wished that I had examined the foundations of this hypothesis, have not considered, that it would be rather favourable than contrary to the inference I have drawn from the medicinal and preservative virtues of *oxygenants*; for the

* This dissertation was printed at New York, in 1796. See *Annales de Chimie*, t. xxii. p. 97.

surest means of destroying the oxyd of azot, is to reduce it to an acid state by an additional quantity of oxygen. But I was not disposed to employ an argument which rests on so insufficient a basis. The theory of M. Wentrop is in opposition to the greatest part of the facts which I have detailed, on the authority of observers equally skilled in the sciences of medicine and pneumatic chemistry. It could not have been regarded as probable, even for a moment, had it not been that the idea of an extraordinary energy was exclusively attached to the oxygen, and unless it were imagined that such powerful effects could not be produced without the co-operation of that agent. I have shewn that it is in the nature of things, that *super-azotation* should produce an increased activity, in the same manner as *super-oxygenation**.

It will, of course, be supposed that, whilst I was employed in collecting the materials of this treatise, I was not inattentive to any of the events which seemed to proceed from a principle of contagion, and the circumstances of which might direct my enquiries, or correct

* See No. 154, and those which follow it.

my views. Unfortunately those events have been but too well known. At the time when the epidemic disease of Genoa raged in its utmost violence, a malady, different in character, but not less dreadful, broke out at Cadiz, and spread with such rapidity as to threaten the whole of Andalusia. It will be **seen** in the sequel, what use I have made of the description given of this disease, on the 28th of October, 1800, by the physicians of Cadiz, and also of the ingenious remarks which Citizen Blin, lately chief physician to the army, has annexed to his translation of their report. I shall take no farther notice of them in this place, than to mention the success obtained at Seville, from employing the means which were neglected at Cadiz. But, proceeding in chronological order, I ought previously to give some details relative to the epidemic disease of Genoa, for which I am entirely indebted to the account lately published by Doctor Rastori at Milan*; and which seem to me to furnish important conclusions in favour of anti-contagious fumigations.

* *Storia della Febre Epidemica di Genova negli, anni 1799 e 1800.*—Milan 9th year, in 8vo. 222 pages.

Doctor

Doctor Rasori, who, for eleven months observed the progress of the malady at Genoa, and attended a great number of the sick, does not hesitate to declare this epidemic distemper, as well as that which preceded it at Nizza, to have been the *true hospital fever**. He positively assigns as its cause, some foreign matter introduced into the system in an unknown manner, and of which we yet scarcely begin to observe the action upon the living fibre. It is his opinion that it originated in the hospitals, and from the exhalations from a number of dead bodies improperly interred. He remarks that the deleterious miasmata affected more suddenly persons not inured to the climate; that their action was not always immediate; and that a predisposition in the patient was necessary to the production of the disease. In support of these positions, he cites the striking instance of his friend Doctor Deho, who received the morbid taint at Genoa, but did not feel its first symptoms until after his return to Milan, where he died.

* *La nostra Febre Epidemica e della stessa indole della vera nosocomiale.* Storia, &c. p. 91.

Thus

Thus it appears, that in this description, traced by the hand of a master, I have the satisfaction of recognizing the facts and principles upon which I established the advantage of the processes for destroying contagion; and that the disease of Genoa, produced and propagated by an accumulation of putrid effluvia, was precisely of the nature of those in which the most effectual relief was to be expected from the means of destroying such exhalations.

What use has been made of them? Of that Doctor Rasori has not thought fit to inform us. It is not to my present purpose to examine the doctrine upon which he has founded an antiphlogistic mode of treatment; a method which five other physicians have adopted, and which has been justified by numerous instances of success: neither shall I permit myself to deliver an opinion upon his observations respecting Sthenic diathesis, the passive irritability of Brown, counter-stimulants, &c. I shall stop at the only passage in which he speaks of the employment of preservative means.

Having stated what took place at the consultation to which he was summoned, in concert

cert with the physicians of Genoa, by the Board of Health, in order to draw up a joint advice, he adds "instead of applying ourselves to indicate the ordinary, and commonly ineffectual, preservatives, it was necessary to think at first of deciding upon a general method of cure*." We have already seen, that the advice of those who proposed these means, was but little attended to, since the writer mentions neither their nature, nor their effects. I shall farther observe that he may have passed a very just judgment, if it be understood to apply to the *ordinary* processes: but I will conclude, at the same time, that it could not have been his intention, by so slight an observation, to invalidate the various proofs of the happy effects of acid fumigations; in short, I will suppose that he was unacquainted with the true anti-contagious processes. If any other proof of this be necessary, it will be found in the frequent recurrence of the terms *phlogistic* and *anti-phlogistic*, in the course of his work, while that of oxygen is not *once* named.

* *Storia*, p. 218.

Let us now see what was done in Andalusia, to stop the progress of the malady known under the name of the *yellow fever*.

“In the commencement of the epidemic disorder,” say the physicians of Cadiz, “orders were given to have the common sewers cleansed, and the dead interred without the precincts of the city; and it was recommended to the inhabitants to water the vicinity of their houses, and to ventilate their apartments. In the squares and streets were lighted large fires of green fir; the insides of the houses were sprinkled and perfumed with vinegar and aromatic plants; and in different places explosions were made of small quantities of gunpowder. This is what they term having employed all the proper means for purifying the atmosphere, and having tried every thing that was capable of contributing to divest the air of its noxious particles *.”

One of the principal objects of the following treatise was to appreciate the means so gratuitously assumed, and which, with the

* An account of the epidemic disease of Cadiz, translated into French from the Spanish, by F. P. Blin, &c. p. 10.

exception of carrying off the filth and removing the cemeteries, could not be of the smallest utility. But the reader will certainly find it difficult to comprehend how they could be so completely ignorant, at Cadiz, of the method of destroying contagion by acid fumigations, which was recommended and practised nearly three years before at Madrid *.

This was not the case at Seville, to which place this malady had extended, and where it made the most alarming progress. Acid fumigations were there employed with success. This intelligence I owe to the friendship of M. Ch. Gimbernât, who, being apprized of the plan I had in view, had previously procured for me in the course of last year, Dr. Smith's Report to the Admiralty of England, and which he has himself translated into Spanish. I cannot better conclude this discourse than by giving the terms of the letter which he addressed to me upon this subject on the 28th of last Nivose, (18th January, 1801.)

“ The instructions which I communicated respecting the manner of performing fumigations with the muriatic and nitric acids, have

* See No. 33.

produced the happiest effects in stopping the progress of the contagion in Andalusia.

“ Unfortunately, prejudices, for some time, retarded the application of this powerful remedy: But at length the zeal and information of two medical men, Queralto and Sarrais, sent by the government to Seville with the necessary orders and authority to practise the acid fumigations as profusely and generally as the extent of the contagion required, produced the most prompt and fortunate success.

“ Commissary Sarrais, one of the ablest physicians in Spain, was seized with the contagion, on the very day of his arrival at Seville, and died on the following.

“ The reports made by Queralto to the government attest, that it is to the acid fumigations we owe the extinction of a malady which threatened to throw the whole nation into mourning. These reports are to be printed, and I shall send you copies of them.”

*Addition to the Account of the Trials of Acid
Fumigations made in foreign Countries.*

THE last page of the preceding Discourse was at press when I received the number of the "*Bibliotheca Britannica*," for March 1801, which contains an extract from a work published at London in 1795, intituled, "A Description of the Jail Distemper, &c. as it appeared amongst the Spanish prisoners at Winchester, in the year 1780; with an account of the means employed for curing that fever, and for destroying the contagion which gave rise to it, by James Carmichael Smith, &c."

I have stated, at pretty considerable length, the anti-contagious process of Dr. Smith, and the happy effects obtained from it towards the end of the year 1795, on board *the Union* hospital ship, where I have reason to believe, from the Report presented to the Admiralty, the experiment was made for the first time. But to fix the dates, and to give at the same time, an additional well-authenticated testimony

mony of the efficacy of acid fumigations, I shall copy from the learned authors of the *Bibliotheca Britannica* the resolution adopted by the House of Commons, on the report of the Committee appointed to enquire into the health of the prisoners at Winchester.

“ RESOLVED,

“ That it is the opinion of this Committee, that by the skill and ability of, and the measures pursued by, Dr. James Carmichael Smith, physician of the Middlesex hospital, (whom the Commissioners of Sick and Wounded procured to go to Winchester upon this occasion), the violence of the distemper reigning among the prisoners there was first checked, and has been in a state of decrease ever since; the number of the sick in the hospital being reduced upwards of one hundred, and the burials, in the two last weeks, having amounted only to five in each,”

“ RESOLVED, *nemine contradicente*,

“ That an humble Address be presented to his Majesty, that he will be graciously pleased

to take the merits of the said Dr. James Carmichael Smith into his royal consideration, and to confer upon him such mark of his Majesty's favour, as his Majesty in his royal goodness may think fit."

A

TREATISE

ON THE

MEANS OF PURIFYING INFECTED AIR.

1. **U**PWARDS of twenty-five years have elapsed since I published a process for purifying air impregnated with putrid and contagious exhalations. Two well-authenticated and decisive experiments attested its efficacy. It was adjudged by the Academy of Sciences to be the most effectual of any that could be employed. I have not neglected in cases evidently contagious, which have unfortunately been but too frequent, to recommend it to the attention of government. In a word, foreigners have published accounts of the beneficial effects which have resulted from its employment; yet in France it still remains almost unknown to the majority of those who ought to practise it for their own security. The periodical journals daily inform

us of the mortality in our hospitals, which carries off both the patients and their medical attendants; nevertheless, among the means employed to check the progress of this scourge, fumigation by the mineral acids is not so much as named; and, notwithstanding the *instruction* published by the Board of Health, we have not yet had a single report of the measures taken to carry it into execution, nor of the effects obtained from them *.

If there exist any hope of removing that careless indifference, which still abandons to the ordinary routine of practice an object so

* All our journals concurred in informing us of the dreadful progress of the epidemic malady which raged, last year, at Genoa, and which in the first *decade* of Thermidor still proved fatal to 494 out of 1400 patients. All stated, upon the authority of Dr. Batt and the most intelligent physicians, that this destructive fever was, in every respect, the same as the *hospital fever*; and that the Board of Health had dismissed the female attendants employed in the hospitals, and caused the sick to be removed to the lazarettos, &c. &c. But they did not take the slightest notice of fumigation with the mineral acids, though already practised with so much success in similar circumstances. We might be almost inclined to believe, that this process, though described in works of the most extensive circulation, had never been so much as heard of in that unfortunate country. I shall have occasion to show what is still the ordinary process employed in most of the lazarettos for the destruction of contagion. It will then appear less surprizing that, according to the statements in some journals, several physicians should have refused their attendance upon the sick in such situations.

important

important as the preservation of human life, it, doubtless, is to be found in offering a more profound discussion of the subject, to those who are capable of forming a decision from principles ; and in fixing, by an aggregate of the most respectable testimonies, the opinion of those who are to be persuaded only by example, and who cannot proceed but in the trammels of imitation.—Such is the proposed object of this undertaking.

2. I shall, in the first place, take a slight review of the circumstances which gave birth to the trials of fumigation, with the muriatic acid : the results obtained ; the conclusions deduced from them ; the experiments made to prove that they might be executed without removing the sick ; and the instructions circulated for carrying them into practice.

In the next place, I shall give extracts from the reports of the experiments made upon this subject in foreign countries, and principally those undertaken by order of the Admiralty of England : I shall describe the particular method of Dr. Smith, and compare it with those adopted by Mr. Cruickshank, and the physicians of Madrid.

I shall, thirdly, examine the opinions delivered as the results of the different observations, and the principles on which a preference may be founded, in favour of the one or the other of these processes.

In the last place, I shall point out such as, considered in every respect, seem to promise the most advantage, and ought to inspire the greatest confidence. I shall describe them, pretty much in detail, that they may, under all circumstances, be directed and executed by men the least conversant with medicine.

(25)

FIRST PART.

A CONCISE NARRATIVE

OF THE

FIRST TRIALS OF FUMIGATION

WITH THE

MURIATIC ACID.

3. **T**HE sepulchral vaults of the principal church of Dijon having been entirely filled, in consequence of the winter of 1773, which froze the ground of the common cemetery to such a depth that it could not be opened, orders were given to remove the bodies from these subterraneous repositories. It was conceived that sufficient precaution had been taken by throwing in some quick lime, without even furnishing a vent for the putrid effluvia, or suspecting, what ought to have been anticipated from the experiments of Macbride, that lime, though it prevents the process

cess of putrefaction, tends only, when employed at a certain stage of that process, to accelerate the evolution of its products. The infection* of the air soon became so insupportable, that it was found necessary to shut up the church.

Unsuccessful attempts had been made to purify the air by the detonation of nitre; by fumigations of vinegar; by burning a variety of perfumes and odoriferous herbs, storax, benzoin, &c. &c. and by sprinkling the pavement with a large quantity of *anti-pestilential vinegar*, known under the name of “the vinegar of the four thieves.” The odour of the putrid effluvia was merely masked for a moment by these operations, and soon reappeared with its former activity, spreading to the neighbourhood, where the symptoms of a contagious fever began to appear. At this period, I was consulted on the means of destroying the source of the distemper.

* The idea conveyed by this term (which frequently occurs in the course of the present work) is obviously different from that which we affix to it, in our language. The author employs it to express merely an impure, or contaminated state of the air by putrid effluvia; whereas with us, it is understood in a sense nearly similar with contagion. Tr.

4. I, at once, turned my attention to the muriatic acid, the very diffusible vapours of which might seize the ammoniac, which I regarded as the vehicle of the fetid miasmata, and thus leave the latter to subside by their own gravity.

This theory had for its basis two well-known facts; the 1st, that all putrid decompositions produce a great quantity of ammoniac; the 2d, that the muriatic acid and ammoniac when they meet each other in a state of vapour or gas, form almost instantaneously a neutral salt. I had several times rendered this phænomenon visible, by placing under a very large bell-glass, filled with common air and immersed in water, two small gallipots, one of them containing concentrated muriatic acid, or common salt sprinkled with sulphuric acid; the other ammoniac in a liquid state, or even a solution of the carbonat of ammoniac. White fumes were instantly seen to ascend, fill the capacity of the vessel so as to render it opaque, and then become condensed so far as to permit the inclosed air to resume its transparency. But it is a fact particularly worthy of attention, that on removing the bell, and replacing it, after renewing the
air,

air, the fumes will recommence, and the same phænomena may be produced repeatedly, or more accurately speaking, until one of the liquids be exhausted by the formation of all the quantity of muriat of ammoniac which it is capable of furnishing. It might be supposed, that the elastic fluids should at last produce upon the liquids a degree of pressure which would put a final stop to the volatilization. But I completely ascertained that, on opening a cock above the bell, the suspended evaporation still recommenced in fresh air; a circumstance which indicated a reciprocal saturation.

5. I proposed, therefore, to make trial of fumigation with the muriatic acid, as a means of purification. It was accordingly executed in the evening of the 6th of March, 1773, with six pounds of common salt (about three *kylogrammes*) and two pounds of concentrated sulphuric acid. The whole was put into a capacious bell-glass inverted and placed on a bath of cold ashes, which were gradually heated by means of a large chafing-dish. I shall, here, pass over the details of the process, which is described with considerable accuracy in the "*Journal de Physique*" of that year,

year, under the title of "A new method of purifying, completely, and in a very short space of time, a mass of contaminated air*." But it is a circumstance which deserves to be recorded in this place, that a person who, about two hours afterwards, had gone up to the gate the farthest distant from where the chafing-dish stood, found himself affected by the acid vapour that escaped through the key-hole.

The next day, the church being thrown wholly open for the admission of fresh air, not the slightest vestige of any offensive odour remained, and all who were present went away convinced that the infection was completely exterminated. Four days after, service was performed in it as usual, without any danger, or even the least apprehension.

Thus did a single trial of fumigation, in the proportions which I prescribed, prove sufficient for the entire purification of a mass of air, which cannot be estimated at less than 5000 cubic metres†.

6. Another event furnished occasion for a second trial of this process.

* Vol. i. p. 436.

† A metre is 3 feet 11 lines of the old French measure. Tr.

Towards the end of the same year, 1773, the Jail Fever, which is known to be of the same nature with the Hospital Fever, had been carried into the Jails of Dijon by some prisoners removed from another part of the country. Thirty-one persons had already sunk under it, and the contagion continued to make the most alarming progress. The effect of the fumigation practised, a few months before, in the church of St. Stephen, was recollected, and I was requested to superintend the execution of a similar process, which was accordingly performed with the greatest success. M. Maret, Secretary of the late Academy of Sciences at Dijon, inserted an account of it in the "*Journal de Physique*" of Jan. 1774*. A singular circumstance occurred in this instance, which I ought not to omit, because it may serve to undeceive those who regard fire as the most effectual purifier†.

Such

* Page 73,

† It has been unfortunately but too prevalent an opinion, that fire purifies foul air by destroying the noxious particles incorporated with it. That fire, when kept in an apartment, wherein the air is vitiated, may in some cases prove beneficial, cannot be questioned. Closeness and dampness, it is well known, are extremely favourable to the production and dissemination of contagion; so far, therefore, as fire tends to promote a free ventilation, to rarify contaminated air, and dispel moisture, it will certainly

Such was the virulence of the infection in a particular cell, that no person could approach the entrance without suspecting that one of the dead bodies had been left behind. This was the unanimous opinion of all who were present, when I first visited it; and it was generally known that even subsequently to that time, three bundles of straw had been burnt in it, the traces of which were visible on the walls, the archway and the gate, which was of iron. The day after the fumigation, in which I had employed about fifteen *deca-grammes** only of common salt, and five of sulphuric acid, the putrid odour was so completely removed, that a student of surgery offered to sleep in it for the night.

7. In 1774, an almost general epizootic distemper ravaged the south of France. M. Vicq d' Azyr circulated some directions with respect to the manner of purifying the villages and stables: among these he takes notice of

certainly prove useful. But that fire and combustion, in general, must, instead of purifying, contribute still more to vitiate the air, particularly in close apartments, to which the external air has not free access, will be evident to any person, in the least acquainted with the theory of combustion, or the principles of modern chemistry. Tr.

* A decagramme is $1\frac{1}{2}$ gr. Tr.

fumigation

fumigation with the muriatic acid. In the following year, two productions by M. de Montigny, which had the approbation of the Academy of Sciences, were published together in the same volume by order of Government. The one of them was intituled, "Instructions and Advice to the Inhabitants of the Southern Provinces respecting the putrid and pestilential malady which proves so destructive to cattle;" the other "Advice to the people of the provinces into which the contagion has penetrated." Both of them equally recommend this method of destroying infection. It will not be superfluous to quote in this place, the terms in which it is spoken of by those learned men.

"The object to be proposed," says M. Vicq. d' Azyr, "is to destroy the miasmata with which the atmosphere and the walls are impregnated, and to admit a free circulation of air into the stables. Those who wish to effect these purposes must begin with putting a quantity of ashes, or sand, into an earthen pan. In the midst of this bath should be placed a glass vessel filled with culinary salt; and the whole must then be heated. A quantity of vitriolic (sulphuric) acid must be gradually

dually poured upon the salt. The same process should be performed at both ends of the stable, if it be somewhat large. The white fumes which ascend will then become very active. The same success will be obtained by pouring the acid upon salt, which has been previously heated in a common shovel*.

The following passage from M. de Montigny is no less precise. It is extracted from the article respecting the means of purifying wearing apparel.

“ The fumes most effectual against infection, seem to be those of marine salt decomposed by oil of vitriol (sulphuric acid). For the first application of them we are indebted to M. de Morveau, a corresponding member of the Royal Academy of Sciences, who employed it with the greatest success in Burgundy, in purifying the air of several churches which had been infected by the opening of sepulchral vaults and graves. The air surcharged with exhalations of a very putrid nature occasioned the sudden death of several persons, and in others brought on putrid disorders of which they died in a very few

* Instructions and Advice, &c. p. 23.

days. The fumigation with marine acid dissipated the noxious odour almost instantaneously, and restored the salubrity of the air*."

8. I shall not conceal that these learned academicians direct at the same time, the use of perfumes, resinous substances, juniper berries, ivy, and aromatic flowers, &c. either with the intention of obtaining a more ready compliance, by leaving a more ample choice in the means prescribed, or from an acquiescence with a prejudice, which unfortunately is not yet destroyed. I feel the less hesitation in making this remark, as they themselves have stated how little confidence they placed in those boasted recipes. "These aromatic substances," says M. d' Azyr, "in burning, substitute only an agreeable for a fetid odour. They merely deceive the organ of smell, but do not destroy the putrid miasmata. The saline vapours possess the latter advantage, and, on that account, ought to be preferred†."

The opinion of M. de Montigny is not less strongly expressed. "For purifying air," says

* Instructions and Advice, &c. p. 28.

† Instructions and Advice, &c. p. 24.

he, "acid vapours are preferable to aromatic fumigations. The latter only serve to dissipate the disagreeable smell, without correcting the nature of the air." In connection with this remark he mentions the process of fumigation with the muriatic acid, and then relates the success which it had in Burgundy*.

9. In 1780, the Academy of Sciences was consulted by the government on the means of correcting the insalubrity of prisons, and appointed a committee to investigate the matter, composed of M. M. Duhamel, De Montigny, Leroi, Tenon, Tillet, and Lavoisier. One of the objects of their research was to compare and appreciate the different known methods of purifying infected air. I subjoin the opinion which they delivered respecting my process of fumigation, in their report of the 17th March, 1780, printed in the volume of memoirs for that year.

"Another precaution which we think it our duty to recommend, and which will contribute more than any thing to the salubrity of prisons, is, once a year, to destroy contagion by the method successfully employed by M.

* Instructions and Advice, &c. p. 125.

de Morveau. It consists in disengaging, in those places which it is proposed to purify, *a considerable quantity of marine acid in the state of vapour, &c.* The vitriolic acid disengages that of the sea salt, which last rising in the form of a white vapour diffuses itself over the chamber, *and neutralizes the putrid miasmata*.*"

10. It might have been supposed, that, supported by such respectable authorities, this method would have been practised wherever the first symptoms of contagion rendered it necessary; but so much was it neglected, notwithstanding the instructions and repeated recommendation given in many works, and in periodical publications, which were officially distributed in great numbers, that it might be supposed that, for the twelve subsequent years, there has fortunately occurred no occasion for employing it. In the mean time the lazarettos were abandoned to the usual routine of aromatic fumigations, and the hospitals and prisons to the most deplorable neglect, at the time when the croud of patients augmented the ordinary contagion, which began to prove

* Memoir of the Royal Academy of Sciences for 1780, p. 421.

fatal,

fatal, in many instances, even to the attendants of the sick.

11. In the second year of the Republic, 1794, in consequence of the multitude of persons infected with fever, and of the wounded, which it was necessary to receive into the military hospitals of the interior, this evil had reached its height. The mortality was long erroneously attributed to diseases which the patients had introduced with them, or to the effects of their wounds. But the contagion attacked even the officers of health and the attendants; the bulletins were filled with notices of their deaths; and many physicians, whose reputation made their loss more sensibly felt, fell victims to the hospital fever. I therefore proposed to the Convention, on the 14th Pluviose, that instructions should be drawn up and published respecting the means of arresting the progress of the contagion. They accordingly passed the following decree: "The Executive Council shall cause to be drawn up, without delay, by the Board of Health, detailed instructions respecting the mechanical and chemical means of preventing the progress of infection in the hospitals, and of purifying the air from the mephitic vapours, or putrid miasmata, with

which it may be charged. These instructions shall be printed, and sent by the minister at war to all the military hospitals; by the minister of marine to the naval, and by the minister of the interior to the civil hospitals. Guyton is charged with the superintendence of this matter."

12. The Board of Health was then composed of Citizens Daignan, Bayen, Parmentier, Hego, Heurteloup, Lassis, Pelletier, Theny, Chevalier, Ant. Dubois, and Biron. Their names will sufficiently indicate what was to be expected from their zeal and their intelligence. They comprehended within the plan of their labours every thing that could preserve or restore the salubrity of hospitals, barracks, houses of detention, &c. such as attention to cleanliness, currents of air receiving their direction from fire, and fumigations of every kind. I shall have occasion, in the sequel, to mention their opinion respecting the efficacy of some of these means: it is here only necessary to notice the opinion which they entertained of fumigation with the muriatic acid. They thus speak of it in the plan which they communicated to me, at the first conference which I had with them, as commissioned by the

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the Convention to superintend the execution of their decree.

“ Among the means which chemistry has employed with wonderful success to produce this purification, we shall mention the process used by Guyton, in 1773, in the cathedral of Dijon, infected to such a degree, by exhalations from the vaults, that it became necessary to shut it up. This method consists in diffusing through the atmosphere, the muriatic acid in the state of gas, disengaged by the application of the sulphuric acid *.” They then described the process of destroying contagion in a ward containing 40 or 50 beds, by employing nine ounces of sea salt and four ounces of sulphuric acid; but they commenced this description by prescribing, that *the sick should be previously removed into another ward.*

13. It was easy to foresee, that the recommendation of this method, under such circumstances, was not only to excite fears with regard to its effects, but to render it almost

* Instructions respecting the means of preserving the salubrity and purifying the air of the wards in the military hospitals, drawn up by the Board of Health in conformity to the decree of the 14th Pluviose, second year, p. 18.

Instructions D 4 impracticable,
 respecting the purification

impracticable, in any case, and particularly where, instead of having supernumerary wards, there was scarcely sufficient room to place the beds at a proper distance from each other. On making this observation to the Board of Health, they resolved to suspend the publication of their instructions till they had ascertained, from repeated experiments, that this species of fumigation might be practised without injury to the patients, and, at the same time, to form a decisive opinion from the experiments made in the presence of their committee with respect to the efficacy of the process itself. It will be proper here to extract, at length, the passage in which an account is given of these measures, and of the decisive conclusions to which they led.

“The Board of Health, unwilling to recommend to their associates a process that may be new to many of them, without being satisfied of its efficacy in those establishments which are under its immediate inspection, appointed a committee of its own members to make the proper experiments at the hospitals of Saint Cyr, Frânciade, and Gros-Caillou.

“The result of these experiments incontestably proves, (these are the precise words of the

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the report), that the proposed method of purifying hospitals by the muriatic acid gas, may be practised *without inconvenience, and with the greatest advantages, in full, as well as in empty wards*; observing always to disengage in the former a smaller proportion of gas."

Such was the conclusion which the Board of Health delivered in the instructions approved by the provisional executive council, on the 7th Ventose, year 2, and which were sent by the minister of war to the military commissaries, to the officers of health, and those employed in the military hospitals, with injunctions to carry into execution the processes prescribed.

14. What was the result of opinions so decisive, and orders so precise? It is with regret I observe, that occasions on which the process might have been employed, have repeatedly occurred of a nature to rouse the attention of the officers of health to their own safety; yet most of them remain ignorant both of the process of fumigation, and of its salutary effects. Citizen Chaussier, indeed, Professor of Anatomy in the Medical School, practised it with success in one of the military hospitals at
Dijon,

Dijon, of which he had the direction *. It was also employed, when I was with the army of the Sambre and Meuse, in purifying some hospitals in Belgium, which the Austrians had left in a very foul state. But these were the only instances of the execution of the instructions which had come to my knowledge, when I very recently learned from the report made by the Board of Health to the minister at war, that the process prescribed in the instructions was practised in the course of the epidemic disease, with which the army of the Western Pyrenees had been attacked, in the year 3. It is also in consequence of the solicitude which the minister has felt on this subject, that I have learned that the process was recommended and followed in the destructive disorder, which last year (year 7) made such ravages in the army of Italy, and the southern departments.

15. Thus we have received not one attestation, not one relation, no official publication, and not even a simple notice respecting the

* Citizen Chaussier has reduced this to the most simple manipulation. He places upon a small chafing-dish a Hessian crucible, containing a quantity of sea salt; an assistant carries it through the wards, and even close to the beds of the patients, pouring in, from time to time, a little sulphuric acid.

practice of acid fumigation, and its results in different circumstances! Shall we be astonished that some have not yet the slightest knowledge of it, and that others place it in the number of those prescriptions that are only supported by uncertain theory? Shall we be astonished that the want of materials so common, the loss of a few pipkins so easy to be replaced, have served so often as a pretext to dispense with the process, even with those who have finally become the victims of their own neglect? The means of procuring a remedy are always in proportion to the opinion which is entertained of its efficacy; and this confidence cannot be established but by repeated observations, and the publicity of its good effects.

This reflection, which will not have escaped those who have followed with attention the detail which I have given, is the melancholy conclusion of the first part of this memoir. It will acquire new force, when it is seen, in the second, how different has been the progress of neighbouring nations in rapidly establishing the practice of these fumigations, the advantage attending which had been verified by testimonies worthy of their confidence.

PART

PART SECOND.

An Account of the Experiments made by Foreigners respecting the Purification of Air by Fumigations with the Mineral Acids.

16. THE oldest publication which has reached me, on this subject, is intitled—"An Account of the Experiment made at the desire of the Lords Commissioners of the Admiralty, on board the Union Hospital Ship, to determine the effect of the Nitrous Acid in destroying Contagion, and the safety with which it may be employed, &c." London, 1796, in 8vo, 73 pages.

It appears from the dedication, that the Lords of the Admiralty being desirous that Dr. Smith should send some person on board the hospital ship, Union, to make trial of fumigation with the nitric acid*, the doctor intrusted

* This term in the original is *nitrous acid*, which it might be at first supposed, ought to be translated into French *acide nitreux*. But it will be easily seen from the sequel, that this expression would imply a directly opposite meaning to that of the author; and

trusted the direction of the experiment to Mr. Menzies, a surgeon in the royal navy; so that the report which he presented is an exact copy of the journal of the means employed by him to arrest the progress of the contagion.

17. Mr. Menzies set out from London, November 24, 1795, and arrived the same day at Sheerness. He speaks highly of the reception he met with from the officers, and from the surgeon in ordinary; and of the zeal with which they seconded his undertaking, with the success of which they perceived that their own safety was intimately connected.

On his first visit to this hospital, he judged that it would be difficult to obtain conclusive results from his experiments, because new contagion was every day conveyed from the Russian vessels. Their lower and middle gun decks were divided into wards by cross partitions, with a free communication between each. The sick were much crowded, and placed without order, to the number of nearly 200, of whom about 150 were in different

and that he employs it merely because the English chemists have not yet two separate terms to express substances so very different, of which the present instance will be sufficient to shew the advantage; or, more properly speaking, the necessity.

stages

stages of a malignant fever extremely contagious, as appeared evident from its rapid progress and fatal effects. From the month of September, when the Russian sick were first admitted, eight nurses and two washerwomen had been attacked with this fever, and of these three had died. About twenty-four of the ship's company had likewise been ill of the same disorder, and of these a surgeon's mate and two marines had died. In short, there could be no doubt, from the evident malignity of the fever, that, without the incessant attention and activity of Mr. Bassan, to whose care they were intrusted, it would have proved still more fatal.

Mr. Menzies caused to be brought on board the necessary apparatus and materials for fumigation; these consisted of a sufficient quantity of fine sand, two dozen quart earthen pipkins, as many common tea-cups, together with some slips of glass to be used as spatulas, and a quantity of concentrated sulphuric acid, and pure pulverised nitre.

18. On the 26th November he began his operations, by causing the ports and scuttles to be shut. The sand, which had been previously heated in iron pots, was then scooped out

into the pipkins by means of an iron ladle, and in this heated sand, in each pipkin, a small tea-cup was immersed, containing about half an ounce of concentrated sulphuric acid. To this, after it had acquired a proper degree of heat, an equal quantity of pure nitre in powder was gradually added, and the mixture stirred with a glass spatula, till the vapour was disengaged in considerable quantity. The pipkins were then carried through the wards by the nurses and convalescents, who kept walking about with them in their hands, and occasionally putting them under the cradles of the sick, and in every corner where foul air was suspected to lodge. In this manner the fumigation was continued, till the whole space between decks was filled with the vapour, which appeared like a thick haze.

“I, however, proceeded,” says Mr. Menzies, “in this first trial slowly and cautiously, following with my eyes the pipkins in every direction, to watch the effect of the vapour on the sick, and observed that it at first excited a good deal of coughing, but which gradually ceased in proportion as it became more generally diffused through the wards. This effect appeared indeed to be chiefly occasioned by the
ignorance

ignorance of those who carried the pipkins, in putting them sometimes too near to the faces of the sick, by which means they suddenly inhaled the strong vapour as it immediately issued from the cups.

“In compliance with Dr. Smith’s request, the body clothes and bed clothes of the sick were, as much as possible, exposed to the nitrous vapour during the fumigation; and all the dirty linen removed from them was immediately immersed in a tub of cold water, afterwards carried on deck, rinsed out, and hung up till nearly dry, and then fumigated before it was taken to the wash-house; a precaution extremely necessary in every infectious disorder. Due attention was also paid to cleanliness and ventilation. As the people were, at first, very awkward and slow, it took us about three hours to fumigate the ship. In about an hour after, the vapour having entirely subsided, the ports and scuttles were thrown open for the admission of fresh air. I then walked through the wards, and plainly perceived that the air of the hospital was greatly sweetened even by this first fumigation.”

19. Next morning the ship was again fumigated, and the operation was performed in the
course

course of an hour. The sand being more heated, the vapour disengaged itself more speedily, while the patients suffered no other inconvenience but a slight coughing, which was less general than on the preceding day.

Twelve pipkins were found sufficient for fumigating the lower deck, ten for the middle gun deck, two for the ship's company's bed room, two for the marine's bed room, and one for the washing-place, in all twenty-seven pipkins; consequently about fourteen ounces of the sulphuric acid, and as much nitre, was expended in the forenoon*.

In the evening, as every place was so close, and the fresh air could not afterwards be so freely admitted, it was not thought necessary to employ so many pipkins; so that little more than half the quantity of the fumigating materials used in the morning was generally found sufficient for the evening's fumigation.

The immediate effect of this process in destroying the offensive smell arising from so

* If it be considered that the hospital here alluded to contained 200 sick persons, in whom the contagion appeared in the highest state of virulence, and that the evening fumigation required only half the quantity used in the morning, and was soon left off as unnecessary, we shall be able to estimate the trifling expence necessary to prevent or stop the progress of contagion.

nitric acid in the state of fumes
nitric acid in the state of fumes

many sick crowded together, was now very perceptible even to the nurses and attendants, who were no longer afraid of approaching the cradles of the infected; so that the latter were better attended, while a pleasing gleam of hope cast its cheering influence over that general despondence which was before evidently pictured in every countenance, from the constant dread each individual naturally entertained of being, perhaps, the next victim to the contagion.

Mr. Menzies caused these fumigations to be repeated for eight days, with equal success: not only was there no inconvenience felt, but he observed, that while the danger of infection was removed, the malignity of the disorder was diminished. He also proposed an useful alteration in the position of the necessaries, of which it was not possible to banish the putrid effluvia without perpetual washings, which endangered the life of those who were charged with the troublesome office. He took care that the beds of those who were discharged from the hospital should be washed with the diluted muriatic acid, in pursuance of the instructions of Dr. Smith.

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On the 7th December, Mr. Menzies resigned to Mr. Bassan the care of continuing these experiments. Since their commencement none of the *attendants* or *ship's company* had been seized with this fever, with the exception of one nurse, who suffered a slight relapse from some imprudence; and none of the patients had died. It was therefore manifest, that the process had produced the happiest effects, and that it might be employed with particular advantage, and without any inconvenience or danger of fire in ships where many people were crowded within a narrow compass. Mr. Menzies visited this hospital, for the last time, on the 16th December, and he found the air in such a state of purity, and the sick and their attendants so free from the dread of contagion, that he judged it unnecessary to continue the two fumigations, and gave orders that there should be but one every day.

21. Annexed to this journal of Mr. Menzies, are extracts from the correspondence of Mr. Bassan with Dr. Smith and Mr. Menzies, concerning the effects of the operations which the Doctor had intrusted to his care. In these it is noticed that only one sick Russian had died

since the commencement of the fumigations up to December 11.

That before this period few days passed without some one or other of the attendants or ship's company being seized with the fever, but since that not one had been taken ill.

That the symptoms of the disorder were become much milder.

That of eighteen patients, recently introduced into the hospital, not one had died, though many of them had been in the most alarming state.

That the fumigation caused not the slightest inconvenience, even to those who were frequently surrounded with a thick cloud of the acid vapour.

That the patients not only bore it very well, but that they voluntarily gave their assistance in the process.

That the convalescents themselves carried about the pipkins; and that those who had escaped from the disorder were so convinced of the good effects of the operation, that it would be a matter of difficulty to discontinue it.

That, in the latter end of December, one nurse and one marine having been taken ill of
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the fever, although the symptoms were much milder than formerly, Mr. Bassan determined to recommence the practice of fumigating twice a day; and exclusive of the general fumigation, he placed a pot or two in the wards near the worst of the fever patients.

On the 3d of February, Mr. Bassan writes that the contagious fever had entirely ceased, and that no person had been seized with it since the 26th of December, though, during the intermediate space, they had been daily receiving patients labouring under the same putrid petechial fever, from the Russian ships. In short, he regarded the experiment as decisive, and proposed continuing to employ the same acid fumigation for the purpose of destroying the alkaline miasmata, and of purifying the air. He also informed Dr. Smith, that Captain Senevin, of the *Pamet Eustaphia*, of 74 guns, had assured him, that having continued the fumigation every day since the departure of Mr. Menzies, he had no longer any sick on board.

22. Next follows a *second journal* of Mr. Menzies relating some new trials of this fumigating process, made on board some ships of the Russian squadron, at the request of Ad-

putrid miasmata

miral Hannicoff. It will be sufficient to extract the most important particulars.

The *Pamet Eustaphia* was first pitched upon for this fumigation, because that ship had sent more sick, with malignant fever, to the hospital, than all the rest of the squadron. This the captain in part ascribed to the nature of her ballast, which being chiefly composed of sand intermixed with a large proportion of wet earth, kept up a constant moisture and dampness below, in spite of every means.

Another circumstance which appeared to Mr. Menzies as contributing to nourish and augment contagion in the ships of the squadron, was the kind of clothing which the Russian sailors commonly wore, which consisted of a sheep-skin great coat, with the woolly side inwards; this, in such a narrow and crowded space, could not fail to occasion a putrid smell. Notwithstanding his representations of the unsuitableness of this mode of clothing, in a climate of which the temperature was so different from their own, the commanders did not think themselves at liberty to alter it immediately without the orders of their superiors. Mr. Menzies besides experienced many other difficulties, sometimes
from

from meeting with priests who sprinkled the decks with holy water, frequently from not obtaining the fire necessary for heating the sand of the pipkins, at other times from being obliged to carry on the process in ships of which the ports and hatchways were not shut close enough to retain the acid vapour, and most commonly from the want of an interpreter to make himself understood: notwithstanding these disadvantages, the effect of the first fumigations was so perceptible, that the Russian surgeons were inclined of themselves to continue them.

The fumigations were begun on the 16th of December, on board the *Pimen*, of 66 guns, Captain Colokolsoff, where the infection had reached such a height that communication with the other ships was forbidden. Five days after Mr. Menzies wrote that the fumigating process having been regularly practised, the disagreeable and pernicious smell had totally ceased.

The ship the *Ratvezan*, and the frigate the *Revel*, where a malignant fever had discovered itself were also put in possession of the means of destroying infection.

23. In addressing these reports to the Admiralty, Dr. Smith has thought it his duty to accompany them with some reflections, the following abstract of which, with several documents relative to the experiments given at the conclusion of the pamphlet, must afford considerable gratification to my readers.

“That the vapour of the nitrous acid,” says he, “should be found to destroy an offensive smell, the effect of animal exhalations, I was not surprised at, having myself had repeated experience of the fact; but that it would also render the air pure, and more proper for respiration, I was by no means certain, until I found the repeated observations of those gentlemen, Messrs. Menzies and Bassan, confirmed by the evidence of Mr. Keir, of Birmingham, one of the first chemists in Europe.”

24. In the sequel I shall communicate the two letters of Mr. Keir on this subject, and I shall then examine to what extent this opinion is just: but I ought first to present the most important part of this recapitulation of Dr. Smith's, which consists in a review of the facts establishing the contagious nature of the disorder, and a comparison of the periods that preceded

preceded and followed the practice of acid fumigation; a comparison formed from the list of all those of the ship's company and attendants of the sick on board the ship *Union*, attacked by the contagious fever since the 3d of September, 1795, the period from which the sick began to be transported thither from the Russian fleet, to the 10th of February following.

From the 3d of September to the 1st of October, nine persons were seized with the distemper, one of them belonging to the ship's company, and the others attendants on the sick.

In the course of October, eight others were attacked with the disease, five of whom were attendants, and three belonged to the ship's company.

From the 1st to the 26th of November there were twelve, in this instance, consisting of eight of the ship's company and four attendants. This circumstance clearly showed that the contagion, at first confined to the hospital, had gradually spread over the whole ship.

Of 35 persons, officers included, 30 had been attacked by the disorder, and of these
eight

eight died; such was the state of things prior to the employment of the acid fumigations. The following is a representation of that which ensued:

From the 26th of November, when the ship was fumigated for the first time, to the 25th of December, not a person on board was attacked with the fever.

On that day one of the nurses suffered a slight relapse; and on the 26th a marine, who for a week preceding had been in a state of intoxication, was seized with a fever, of which he died on the 6th of January. Dr. Smith, while he thinks it very probable, that the latter was the victim of his own intemperance, partly attributes that event to the discontinuance, for the ten preceding days, of the fumigation in the evening. Contagion, he observes, being constantly generated, it requires to be as constantly destroyed. The practice of fumigating twice a day was therefore resumed, and from that period the contagion made no farther progress.

But the advantage of the fumigation was not felt by the ship's company and attendants alone; the sick and convalescents also experienced its good effects, and the malignant symptoms

symptoms of the disorder gradually disappeared.

25. It was equally successful on board the Russian vessels in which it was continued, after the departure of Mr. Menzies, by the attention of the Russian officers, who were convinced of its good effects. These were particularly conspicuous in the *Pamet Eustaphia*, which, though the most sickly of the Russian squadron, had no longer any appearance of contagion on board, nor even a man ill of the fever; and so great was the opinion entertained in consequence, by Admiral Hannicoff, of the efficacy of the fumigation, that he applied for a fresh quantity of materials, in order to have it performed on board some other ships.

26. "Such," concludes Dr. Smith, "has been the result of an experiment, by which some lives have been already saved, and from which two important facts are clearly established, viz. the power of the nitrous (nitric) acid to destroy contagion; and the safety with which it may be employed, in any situation, without inconvenience, or risk of fire. This is a discovery equally applicable to every species of putrid contagion, even to the plague itself; a discovery, therefore, in which all nations
are

are more or less interested, but whose utility must be most sensibly felt by our own; where a commerce, extended to every quarter of the globe, covers the sea with our ships."

27. Of the documents which I have mentioned as annexed to this report, I shall here introduce only the certificate sent to Mr. Menzies, by the commanding officer of the Russian fleet, and the extracts of two letters from Mr. Keir, which require some observations on my part.

Certificate of Captain Chechagoff, commanding Officer of the Russian Fleet, in the Absence of His Excellency Admiral Hannicoff, dated Chatham, March 9, 1796.

"It has been observed, that the fumigation with the nitrous (nitric) acid, introduced by M. Menzies on board the ship *Pamet Eustaphia*, has produced, in a short time, the best effect in stopping the progress of the fever and other evils, which were then evidently increasing; for which reason it was not only regularly continued on board of that ship, even after M. Menzies's departure, but adopted on board of others, and always found useful. It is, therefore,

therefore, my duty to certify by this, not only the good consequences that have been observed from that useful contrivance, but even the advantage that arises from its easy and sure execution, in comparison with other means of fumigating the ships, which requires greater attention from the fire that must be made use of, and therefore cannot be effectuated in all parts of the ship."

Extract of a Letter from Mr. Keir, of Birmingham, to a Friend in London.

January 25, 1796.

"I consider Dr. Carmichael Smith's discovery to be very valuable. The fumes, in his process, are quite different from the ordinary nitrous vapour in the distillation of aqua fortis, or from that which exhales in the solution of metals by nitrous acid; the latter is highly suffocating and noxious, and may be called the phlogisticated nitrous acid vapour. The fumes made in Dr. Smith's manner, if there is no metal employed in the vessel, &c. is highly dephlogisticated or oxygenated nitrous vapour, and is also mixed with a large quantity of pure dephlogisticated air, which is extricated from the materials; and these fumes are not only not

imagine

*means to unmask it. The fumes of which
ver 2 by apt to imagine
the might be means to unmask it some*

suffocating, but have a very pleasant smell. If the distinction is not made between these two kinds of vapour, it is to be feared that some person, by accident, or in expectation of getting the nitrous vapour more expeditiously, may use metal vessels, or dissolve metals in nitrous acid."

*Extract of another Letter from Mr. Keir,
dated near Birmingham.*

March 3, 1796.

"The difference between the white nitrous acid, called by Dr. Priestley dephlogisticated acid, and by the French chemists *acide nitrique*, and the red acid, called phlogisticated or *acide nitreux*, is well known, and was first particularly noticed by Scheele, who shews how the one may be separated from the other by distillation. There is the same difference in the colour of the vapours from these two acids; and Dr. Smith has himself observed, that the vapours, in the distillation of nitrous acid, were not noxious, which observation he has very happily and usefully applied. In distilling the nitrous acid from very small quantities of nitre and oil of vitriol, in glass vessels, and when the materials are very pure, I have
seen

seen nothing but the white vapours, such as arise in Dr. C. Smith's process; but Scheele says, that at the end of this operation some red vapours rise, and it may be the case when a very strong heat is applied. But the very noxious red fumes which appear in the usual process of distilling aqua fortis, are occasioned, as you mention, by the iron vessels; and the manufacturers even put old nails and small pieces of iron into their pots, in order to give a high degree of red smoking quality to the acid. When you acquainted me of Dr. Smith's discovery, it occurred to me, that as the common notion of nitrous acid vapours is confined to those that are red, some people might, in the first place, be prejudiced against it, from the idea of the vapours being noxious, as the red vapours are undoubtedly; and others might think that they made the process more effectual, by adding, to Dr. C. Smith's mixture, metals, or inflammable substances, in order to produce those red vapours. I, therefore, thought it would be proper for Dr. C. Smith, to point out the difference between the vapours produced in his method, and the red nitrous fumes which are so well known; and also to caution the operators to avoid metal vessels,

vessels, or the addition of metals or inflammable substances.

“There is a good deal of vital air extricated from the mixture; but I cannot agree with those who attribute the medicinal effect to it. We know little of this subject; but the analogy of the destruction of all animal and vegetable fermentation by mineral acids, which is well ascertained, inclines me to believe the agency of the acid, in the destruction of the contagion; the matter of which is, I presume, animal, in some vicious kind of fermentation.”

30. The reflections which occurred to me, upon perusing the Report of Dr. Smith, and particularly the two letters which I have just copied, will find a place in the subsequent section. To complete the present, it remains that I should describe the method of destroying contagion, introduced by Mr. Cruickshank into some other hospitals in England, and likewise that which has been adopted in Spain.

*Acid Fumigations according to the Process of
Mr. Cruickshank.*

THIS process is described in a work by Dr. Rollo, on the Diabetes Mellitus, published at London in 1797, and of which I have given several extracts in the *Annales de Chimie* *. I promised, indeed, to resume the subject of acid fumigations as instrumental in purifying the air; but my attention was called away from it by a multiplicity of other occupations. This author expresses himself upon the subject in the following terms:

“ It is observed, that the oxygenated muriatic gas was found to destroy the offensive smell of sores, that it destroyed specific contagion, and could be easily obtained, and very safely used; we had, therefore, given it a preference to other things; and in order that it may be more generally tried, we must insert Mr. Cruickshank’s manner of procuring and using it in the wards of this hospital.

* Tom xxiv. p. 175. tom xxix. p. 209, 221.

“ This consists in intimately mixing two parts of common salt, and one of crystalized manganese previously reduced to powder. Two ounces of this compound are introduced into a small bason; about an ounce of water is then added, and afterwards an ounce and a half of the concentrated vitriolic or sulphuric acid at different times, so as to preserve a gradual discharge of the oxygenated muriatic gas. One of these basons is sufficient for a ward or room containing five or six beds, and more must be employed according to the size of the apartment.”

32. In comparing these quantities with our new and old denominations of weight, the following will be found to be the proportion for what Mr. Cruickshank calls a pipkin:—

	English Weight.			French Weight.			
	oz.	dra.	scr.	Decimal gra.	old oz.	dra.	gr.
Common salt	1	2	2	34	1	0	64
Oxyd of manganese	0	5	1	16	0	4	13
Water	1	0	0	25	0	6	39
Sulphuric acid	1	4	0	36	1	1	30

Though the proportions are not of very great importance in this case, provided there be a progressive extrication of the acid gas saturated

saturated with oxygen, I shall shew in the concluding part of this Treatise, that those prescribed by Mr. Cruickshank should be changed, for the purpose of avoiding an unnecessary expence.

Method of Fumigation adopted in Spain.

33. I Shall not dwell long upon the mode of fumigation practised in Spain, for correcting the insalubrity of the air, as it consists only in disengaging the muriatic acid gas by means of sulphuric acid, in the manner directed by me in 1773. The Journal of Agriculture and the Arts, for 1797*, gives a description of it, under the article "Domestic Medicine." It informs us that it continued to be used with success at Madrid; and farther, that experience had proved, that it might be employed in wards, where persons were present, even without any inconvenience or danger to the sick, performing it with small quantities at a time, and frequently repeating the process. It

* This journal, which is printed at Madrid, and compiled by the learned D. Virio and D. Juan Melan, is entitled—"Semanario de Agricultura y Artes dirigido a los Parrocos." I have given an account of it in the 22d volume of the "*Annales de Chimie*," p. 317.

recommends this method as very beneficial, in all cases of pestilential fevers, epidemic and epizootic distempers. The process even appears to have become so common, that it was considered of importance to derive some advantage from the salt remaining in the vessels. The authors of the Spanish journal recommend that it should be given to cattle, being of a cooling and diuretic nature, in the *decoctum album* of the shops, which is prepared with calcined harts-horn reduced to powder. This supposes that the common salt was in sufficient quantity to admit of all the sulphuric acid passing into the state of a neutral salt, otherwise the residue could not, without danger, be administered even to cattle; it would therefore be more eligible, to separate from it the sulphat of soda, by the customary processes of lixiviation and crystallization. This remark, however, is but remotely connected with the object of the present work. I proceed to examine the principles by which we may estimate the comparative advantages of the different methods of fumigation*.

THIRD

* M. Manthey, Professor of Chemistry at Copenhagen, having been at Paris when I read some fragments of the present treatise to

THIRD PART.

Reflections on the Effects of Acid Fumigations, and the Opinions delivered on that Subject.

34. IT is far from my intention to endeavour to diminish the confidence which must be produced by experiments so well authenticated, made upon a grand scale, in the most decisive circumstances, and under the immediate direction of professional men, whose reports breathe nothing but the purest zeal for

to the first class of the Institute, transmitted to me, upon that occasion, a note of some experiments made by himself on board a Danish ship of the line, the *Wilhelmine Caroline*, for purifying the air by fumigations with the different mineral acids; in the course of which he had observed, that the oxygenated muriatic acid destroyed the noxious smell, in a much shorter space of time than any of the rest. He adds, in the same note, that in consequence of thus fumigating every part of this vessel, there were much fewer sick on board her than in any other of the Danish ships.

At the conclusion of one of the readings, some members of the class assured me, that fumigations with muriatic acid were practised on board the vessels of the Republic in the port of Rochfort. This circumstance was, indeed, mentioned to me in the course of last year, but I was not quite certain of the truth of it.

the alleviation of human calamity. But it is precisely at the period, when we possess an aggregate of facts established on testimony so respectable, that we can most advantageously proceed to examine the consequences that flow from them, and fix, according to such data, some theoretical points, which, like the curve of geometricians, may serve to regulate a series of observations.

35. The mineral acids possess the power of destroying contagious miasmata, and the putrid smell which indicates their presence: these acids may be converted into a state of vapour, so as to purify a mass of infected air: in short, with a few simple precautions, these vapours may be diffused in places shut up, and where people are present, without producing the slightest inconvenience. This conclusion must, undoubtedly, be drawn from what I have stated in the two first parts of this work. Still, however, it may be asked whether these acids all act in the same manner? whether they exercise the same affinities? whether their effects be equally prompt and complete? whether their action be increased by oxygen? whether this principle be really extricated in Dr. Smith's process? whether all kinds of conta-
gious

gious miasmata equally yield to the power of these agents? whether putrid effluvia, of every description, necessarily possess this property? whether ammoniac forms an essential part of their composition? whether they are, in every case, accompanied with carbonic acid gas? in a word, whether they are likewise subject to decomposition by the vegetable acids?

36. The solution of these questions cannot fail to throw very great light upon the causes and immediate effects of contagion, and to determine the particular object we should have in view, in applying the means of destroying it. But in this discussion we are not to be exclusively regulated by the writings of those who have acquired a just reputation from their enquiries and observations upon this subject; such as Messrs. Macbride, Pringle, de Haen, the translator of Shaw, Gaber, Gardane, &c, who knew neither the properties of the component parts of water, those of *hydro-sulphures**, nor the formation of ammoniac. The facts, indeed, collected by those laborious observers still subsist, and I have not omitted to give

* To compounds resulting from the union of hepatic air with various bases, the French chemists give the above denomination: by the English they are termed *hydro-sulphurets*: by Kirwan *hepatules*. T.

an account of them. But I felt, at the same time, the necessity of examining them in a new point of view, in order to correct the inferences drawn from them, by the data necessary to their explanation; and to effect this purpose, I have, in some cases, been compelled to ascertain them a second time, with the instruments, and according to the accurate method of modern chemistry. I, therefore, had recourse to direct experiments, and proceeded in the following manner:

37. I placed, under a very large receiver, a pipkin, containing three *hectogrammes** of raw beef, immersing the lower part of the receiver in water, in order to intercept the communication with the external air. In this state it was left till it became perfectly putrid; which it did in six days, in consequence of the temperature, which was constantly between 23 and 29 degrees of the Swedish thermometer.

At the top of the receiver were a cock and a bent glass tube, by means of which, after withdrawing the pipkin, I could, by sinking the receiver in the pneumatic tub, introduce

* A hectogramme is 3 oz. 2 dr. of the old French weight. Tr.

the gas into any liquid or vessel I pleased, without its sustaining, in passing through the water, any considerable change, or even any diminution of its activity.

Such was the simple apparatus which I used in making my first experiments. But I was not long in perceiving that the water of the pneumatic tub, into which I plunged the receiver, very soon contracted a disagreeable smell. I, besides, discovered, that in order to obtain more decisive effects, it would be necessary to let the putrid gas remain, for some time, upon the different re-agents which I intended to submit to its operation, and, in some cases, even to shake them together. At length the infected air, which issued undecomposed from the liquids through which I had made it pass, diffused through the laboratory an offensive smell, to which it would have been imprudent to remain long exposed, and which already blackened several pieces of silver coin that I had about me.

38. I resolved, in the first instance, to substitute for the tubulated receiver, large double-necked jars; the one neck containing a syphon by which the gas might escape, and the other a funnel with a spigot, by introducing water
through

through which I could displace the gas at pleasure, in the same manner as in the instrument called an Inflammable Air Lamp.

39. I then thought of uniting the two jars by means of a crystal cock, so adapted, that the two extremities of the communicating tube might serve as stopples to them. Having filled one of these jars, which contained about thrice the quantity of the other, with air mephitized by putrid flesh, I shut it with one end of the tube, the moment I took out its stopple. I then put into the smaller jar the substances on which I wished to make experiments. This second jar being, in like manner, shut with the other end of the tube, I turned the key of the cock in order to open a communication between both, and I thus transferred instantaneously, or in succession, a part of the gaseous fluid, and the inclosed substances, from the one to the other.

40. These instruments, it will be seen, accomplished all my purposes, while they considerably diminished the danger of the processes; during which, however, I did not neglect to make constant use of the powerful anti-contagious agent which I shall have occasion to mention in the sequel.

I now

I now proceed to give a succinct account of the results of my experiments, beginning with those which were particularly directed to the discovery of the principles communicated to the air by the effluvia from substances in a state of putrefaction.

EXPERIMENT I.

41. I introduced a quantity of air impregnated with these effluvia, into *lime water*, which it instantly rendered turbid in a very considerable degree. The precipitate collected upon the filter produced a strong effervescence with the acetous acid. The smell of the gas, after this operation, was still very fetid, though the lime-water had not been entirely saturated with the quantity introduced. It still became turbid upon pouring into it water strongly impregnated with carbonic acid.

This operation was repeated at three different stages of the putrid decomposition, and constantly presented the same phænomena. The lime-water assumed a milky appearance, and the gas preserved its smell, even after being strongly shaken with the lime-water; the last time only, the surface of the lime-water seemed
to

to be covered with a thin pellicle, reflecting the various colours of the rainbow.

EXPERIMENT II.

42. Another portion of the same gas was conveyed into a vessel filled with a solution of *nitrat of silver*: the latter turned immediately black, and a brownish pellicle formed upon it, a part of which fell to the bottom of the liquid.

EXPERIMENT III.

43. The solution of *nitrat of mercury*, agitated with the same gas, instantly assumed a deep black colour, and the liquor presented a pellicle reflecting all the colours of the Iris. After a free exposure, for a few days to the atmosphere, there remained only a white precipitate.

EXPERIMENT IV.

44. In the solution of *acetite of lead*, the effect was still more sudden, and, particularly, more considerable. In a few moments there was deposited, at the bottom of the vessel, a powder which remained of a deep black colour.

EXPERIMENT

EXPERIMENT V.

45. By passing the gas through the solution of *nitrat of copper*, the liquid acquired a yellow tinge. There was produced a light precipitate, which at first assumed a flaky appearance, and then settled in the form of a brown powder; and there remained upon the surface a very thin pellicle which reflected the colours of the Iris, and possessed a kind of metallic lustre. This phænomenon even took place in a solution in which there was a small excess of acid.

EXPERIMENT VI.

46. The putrid gas introduced into a jar, containing a solution of *sulphuret of lime**, rendered it instantaneously turbid; and a deposit was formed of *carbonat of lime*, but without any appearance of a black or brown precipitate, or any extrication of ammoniac.

* The term *sulphuret* is employed, according to the new nomenclature, to denote the combination of sulphur singly with different bases. Such compounds, when the bases are of an earthy or alkaline nature were formerly known by the name of *hepars*. Tr.

EXPERIMENT VII.

47. Slips of paper coloured with *fernam-bucca*, the petals of *marshmallows*, *turmeric*, and the solution of *nitrat of copper*, were suspended for twenty-four hours in vessels filled with air impregnated with putrid effluvia, without undergoing any change which could indicate the presence of the smallest quantity of ammoniac. The colours merely lost somewhat of their vivid tint, and appeared as if they had been diluted; but they still retained the property of manifesting, by a very perceptible alteration, the presence of free alkalis.

EXPERIMENT VIII.

48. I endeavoured to incorporate this air with *syrup of violets*, *the weak solution of copper*, *the infusion of turnsol*, reddened by the acetous acid, without being able to discover the slightest trace of ammoniac in them.

EXPERIMENT IX.

49. But the case was different when I submitted these re-agents to the fumes disengaged by
by

by the lime, from the water which I had used in displacing the infected air, and which coming into immediate contact with the putrid flesh, had acquired a slightly reddish tinge. At the end of two hours, the slips of paper coloured with the *fernambucca*, the *mallows*, and even the *turmeric*, gave unequivocal signs of the action of ammoniacal gas.

EXPERIMENT X.

50. The important observations by which Citizen Berthollet ascertained the rapid and very perceptible action of various substances upon sulphurated hydrogen*, and the hydro-sulphurets, suggested to me fresh instruments for prosecuting my enquiries, which were the more appropriate, as the decomposition of several metallic solutions, by infected air, sufficiently discovered in them the presence of some analogous reductive. Though these trials did not answer my expectation, it is, nevertheless, proper to give a detail of them. In chemistry

* The combination of sulphur with hydrogen, takes place in the state of gas, and constitutes what was formerly termed *hepatic air*; but which, in conformity to the new nomenclature, is denominated *sulphurated hydrogen*. T.

negative results frequently lead to the most important conclusions.

The solution of *sulphat of zinc* was kept closely confined, for twenty-four hours, in the apparatus having two jars, with air impregnated with putrid effluvia, and the mixture was several times violently agitated; no trace, however, appeared of the white precipitate which the sulphurated hydrogen, and the hydro-sulphurets produce in that solution; the liquid merely seemed more disposed to crystallize in the form of feathers upon the sides of the jars. The smell was but very little diminished.

EXPERIMENT XI.

51. I inclosed, in like manner, with a quantity of infected air, the oxyds which act most powerfully upon the *hydro-sulphurets*, such as oxyd of zinc, black oxyd of manganese, and brown oxyd of lead, all reduced to a very fine powder, and slightly moistened with distilled water. At the end of twenty-four hours, during which these mixtures were frequently agitated, I did not observe any change in the colour of the oxyds, no indication of the

the disengagement of ammoniac, nor any appearance which marked the presence of sulphur. The fetid smell merely seemed to have somewhat abated, in the jar containing the oxyd of manganese, and the water had acquired the property of precipitating the solutions of nitrat of mercury and acetite of lead, of a dirty grey colour *.

The

* At the sitting of the Institute, on the 7th of November last, Citizen Berthollet, after hearing the above experiments read, verbally communicated the following observations, which he was requested to prepare for insertion in the minutes. Though all of them are not directly connected with the object of this treatise, my readers will feel some satisfaction in knowing the result of the labours and reflections of this profound chemist upon a subject of so much importance.

1. " Gas produced by means of putrefaction, contains a considerable quantity of carbon, but no hydrogen.

2. " Urine exposed to the light, in close vessels, continues acid; in the shade, it forms ammoniac.

3. " Meat kept fifteen years in close jars, with a very small quantity of water, rendered the water acid, and produced a small portion of ammoniac.

4. " This meat was still capable of being converted into jelly, by boiling.

5. " The gas twice gave him a fit of the cholick; experiments of this kind, therefore, require much caution.

6. " The putrid principle, in the air, is not absorbed by lime-water; unless it be previously dissolved in water.

7. " A substance which is not putrid, may absorb a good deal of this gas without becoming so; but at a certain point of the absorption, it acquires a strong tendency to putrefaction.

8. " Water is formed in most cases of putrefaction; but there is no extrication of hydrogen.

9. " The

*The Corollaries which may be deduced from
the preceding Experiments.*

52. These experiments, it may be seen, do not embrace so extensive a plan, as those described in several works upon the subject of putrefaction. But they were circumscribed by the nature of my object; and in this point of view, they are wholly new, even in respect to phænomena, of which they seem only to afford a confirmation. Preceding writers performed their experiments upon substances in a state of putrefaction, such as flesh, blood, lymph, bile, urine, &c. whilst it was the air itself infected by the putrid effluvia that I proposed to examine.

53. It is at present acknowledged that eudiometers, constructed on the best principles, are insufficient for affording a test of the salubrity of the air; which induced the celebrated Gren to observe, that a *cacometer* would be better adapted to this purpose. Not that we

9. "The most antiseptic substances are Peruvian bark, and gall nuts."

ought to reject an instrument which, restored to its proper use, would enable us to determine, with sufficient precision, the proportion which an aëriform fluid contains, of what we call vital air, and which is really the principle of life; but it is necessary to distinguish:

1. The air which destroys, or rather which ceases to support life, because it is either altogether deprived, or too much impoverished, of this elementary principle.

2. Air that is noxious, because surcharged with carbonic acid, or carbonated hydrogen.

3. Air rendered odorous or fetid by emanations.

Of these the two first are sufficiently known; they have no sensible smell, yet are highly pernicious, since, when at a certain degree of intensity, they produce sudden death. Before the reformation of chemistry, and the discovery of the constituent principles of atmospheric air, these effects were ascribed to phlogiston; which was regarded by Pringle, Whyte, and others as pestilential in itself, and when uncombined, though it then made no impression on the olfactory nerves. We feel no disposition, at the present day, to recur to any pretended properties of this imaginary principle,

principle, to explain either the alteration of the air observed by Dr. Whyte, on having kept fresh meat shut up in it for twenty-four hours, or the terrible effects of the *black hole* at Calcutta, where, out of 146 Englishmen who had entered it in health, 123 perished in the course of eleven hours. Granting that animal effluvia had some share in producing this catastrophe, the principal cause it will be easy to discover, when it is known, from calculation, that the space into which the unfortunate sufferers were crowded, gave to each a surface of only 23 square decimeters, or 312 square inches. What affords a convincing proof that the putrefactive process had not yet produced miasmata actually contagious, is, that nothing further was necessary to the recovery of the survivors than the benefit of fresh air*.

54. With

* The fever with which those, who survived their confinement in the black hole at Calcutta, were afterwards seized, although not noticed by our author, far from militating against his reasoning tends rather to confirm it; since it evidently appears to have been produced by the too great exciting power of the fresh air, and the emotions of joy experienced on their escape. What may serve to illustrate this opinion, is a well known law of the animal economy; that when the usual exciting powers have, for a certain space of time, been withdrawn from the system, they act with much greater effect; in like manner, as the application of heat to the hands or feet, after being exposed to severe cold, occasions considerable

54. With regard to the third kind of air, that which is rendered odorous or fetid by emanations, there are still greater difficulties, since of the nature of these emanations we have only vague ideas. Odour, in common language, means the agreeable or disagreeable, strong or weak sensation, that the odorous body produces; by the chemist it must be regarded as indicating the presence of some particular substance, which has the power of thus affecting our senses. Modern chemistry does not permit us to separate, in bodies, their mode of action from that of their existence.

I am far from thinking, that the different odorous corpuscles respectively consist of particles essentially different; but there seems to me still less reason for supposing that all odours have one common principle; and I do not hesitate to apply, to animal odours, what M. Fourcroy has established in his Memoir on the *spiritus rector* of Boerhaave, or the aroma of vegetables*, that there is no particular principle to which we can exclusively attri-

considerable pain. Hence an important caution may be deduced, that those, who have been obliged to breathe lowered air, should not make too sudden a transition into an atmosphere of a higher standard. Tr.

* Journal Polytechnique, tom. ii. p. 82.

bute this property; that it belongs to every substance that is diffused or dissolved in the atmosphere, and that the odorous particles act immediately on our organs*. In fact, they are sometimes immediate particles of bodies, from which they are separated by their volatility; sometimes they are certain elements in their composition, set at liberty by the action of affinities; sometimes, in short, they are the results of different combinations produced by the presence of a new agent.

55. It was easily discovered that, with the exception of morbid particles, which act merely by immediate contact, corpuscles at once odorous and contagious, could not be regarded as floating in the atmosphere in a state of unequal, and, as it were, mechanical

* There is no more reason, Mr. Nicholson well observes, for admitting a common principle of smell than a common principle of taste. He makes this reflection in reference to a very curious fact observed by Mr. Howard, which may suggest the possibility of rendering palpable the most subtile emanations. He had exposed some animal oil perfectly rectified, to the action of very strong oxygenated muriatic gas; he perceived a thick vapour immediately rise about 4 inches above the small phial containing the oil, and again insensibly descend. He thought the phenomenon might be explained by supposing, that the vapour was formed by the union of the hydrogen of the emanations with the superabundant oxygen of the acid.—*Annales de Chimie*, tom. xxvii. p. 218.

diffusion; hence it has been inferred, that there is a principle which is their common menstruum; but it is easy to perceive, that this does not advance us a step farther, since, in order to rank it among the phænomena which nature, in no instance, produces but by the process of solution, recourse must be had to a series of other suppositions; for example, it must be supposed, that this principle has an affinity with as many different substances as there are different odours, and that all these compounds are soluble in the atmosphere.

It is, therefore, more conformable to sound theory, to recognise in the atmospheric fluid itself the true solvent of these emanations, and the cause of that expansibility, which conveys them to our olfactory nerves, in a state weaker or more concentrated, as the solvent power of this fluid is itself affected by heat or humidity. Nothing but affinity can produce an equilibrium independent of differences in specific gravity. Hence Bergmann has observed, that air, even when stagnant, displaced at last the carbonic acid gas*; and that, on the other

* Dissertation I^r. §. 25.

hand, the carbonated hydrogen gas settles in the depths of mines; which could only happen, as Berthollet remarks, in so far as it is there in a state of combination*.

56. There can be little doubt but that it is the whole body of the air, in its habitual state of composition, which is charged with these corpuscles; for if this capacity resided exclusively in oxygen or azot, the proportions of these elements would undergo a change, in the same manner as happens when air is in contact with substances disposed for acidification or oxydation; while eudiometric experiments indicate no sensible alteration in air shut up in close vessels with musk, assafœtida, opium, and other substances, equally odorous; provided the latter, as Dr. Whyte remarks, be kept apart from every matter susceptible of fermentation, and *a fortiori* of oxygenation. He submitted a quantity of air taken from the sink of a privy to the nitrous gas, and found the absorption the same as in an equal volume of common air†.

* Ecoles Normales, tom. v. p. 84.

† *Journal de Physique*, tom. xxvii, p. 145. This observation must not be considered as extending to sinks constructed of materials containing sulphur, or sulphuric salts; and still less to those into which the remains of animal matters have been thrown.

57. Even putrid emanations do not vitiate the air to that degree, which the tainted odour might lead us to suspect. I have submitted successively to the action of nitrous gas, sulphuret of pot-ash, and phosphorus, what I call putrid gas, or air charged with exhalations from the sanious decomposition of flesh, comparing their results with those from common pure air submitted to similar agents. The greatest difference in the results of these eudiometric experiments did not exceed 3.4 in 100; so that the loss of bulk, in the putrid gas, still manifested the presence of at least 0.18 parts of oxygen.

58. But there is an observation, which ought not to be overlooked, in our investigation of the true solvent of the different kinds of emanations. That species of air termed azot, which forms almost four-fifths of the atmosphere, and of which, as Citizen Berthollet justly remarks, little more than the negative properties have yet been examined*, is, without doubt, the agent of many unknown combinations. It is, therefore, possible, that it may exercise, at least on some odorous cor-

* Journal Polytechnique, tom. i. p. 277.

puscles, especially on those given out by animal matters, the same solvent affinity which it has been recently found to exert on phosphorus, and without which this combustible ceases to be acted on by oxygen.

59. Some have supposed that odours had no boundaries, that they could not be defined, and that they possessed only vague characters: others have maintained that similar odours indicated analogous powers, of which the effects differed only in proportion to the degree of concentration, or of the sensibility of the organ of smell. A discussion of the facts, on which it has been sought to establish these opinions, would lead me from my subject. What at present should occupy our attention, are odours at once fetid and pernicious, or which indicate the presence of contagious miasmata. Their constituent principles may doubtless exist in the atmosphere, without producing any distinct impression on the olfactory nerves; but it then remains unchanged, except in the proportion which it bears to its solvent. Can we entertain a different opinion, when we see every day in these menstrua which produce the strongest sensations, taste and odour become weaker, or rather disappear

appear altogether, when the particles reach a certain point of diffusion? The water of sulphurated hydrogen, when not distinguishable by its odour, still manifests the presence of a portion of that principle long after, by producing a black precipitation with the nitrat of mercury.

60. In directing my attention particularly to air sensibly infected by putrid exhalations, I gained a double advantage. The first was that of being always guided in my opinion respecting the results, by an unequivocal indication of the intensity or weakness of the malignant action of the effluvia; for nobody will deny that a body only remains the same while it preserves all its properties, that it cannot lose one of them without becoming a new body either by analysis or some new combination, and thus to destroy the odour is to destroy the danger: I say to *destroy* not to *mask* the odour, two things which it is unhappily customary to confound. But they are very different in the estimation of the chemist, who only sees in odour disguised a confused mixture, of which the parts have a constant tendency to separation; whereas the destruction of the odour is the result of a combination by which

which the odorous body is decomposed, or combined with a base which changes its properties: thus in neutral salts, the most corrosive agent remains inert, until it be disengaged by new affinities. To illustrate this by an example;—the odorous principle in the benzoic acid exists entire in the benzoat of lime; but in order to restore all its activity, it is necessary to disengage it from this earth by more powerful acids*.

61. The second advantage which I derived from choosing air infected by putrescent animal matter, was that of making my experiments on effluvia which may be regarded as the most abundant, especially in hospitals, and consequently the most common source of that contagion which there so frequently manifests itself. “We know by fatal experience,” says Dr. Whyte, “that both animal and vegetable matters, when in a state of putrefaction, are the fatal sources of the most formidable maladies, from the mildest malignant fever to the plague itself.” Sir J. Pringle has furnished us with an instance of a prison or hospital fever caused by the infection of a

* *Memoires de Chimie de Scheele*, tom. i. p. 126.

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gangrened member. Venice experienced a terrible fever occasioned by a quantity of putrid fish; and the town of Delft in Holland suffered a similar evil from putrescent cabbage and other vegetables. Other examples might be quoted of countries almost depopulated by similar causes*. †These observations, which appeared to me necessary to establish the consequences

* Journal de Physique, tom. xviii. p. 147.

† While, it is now very generally admitted, that the effluvia of living persons, crowded together, for a certain space of time, in confined situations, is capable of generating febrile contagion; it seems a question, as yet, far from being fully ascertained, whether pestilential diseases be ever produced by the putrid exhalations arising from dead bodies.

Several facts, recorded both by ancient and modern writers, tend evidently to support the negative of this question. “*Cadavera, sive hominum,*” observes Diemerbroeck, “*sive aliorum animalium putrescentia pestem non generare, docent multæ magnæ strages, in quibus talis cadaverum inhumatorum putrefactio nullas pestes induxit. Anno 1642, in agro Juliacensi, maxima strages facta est, et ad minimum 8000 militum, occisa fuerunt, præter majorem adhuc famulorum, rusticorum, aurigarum, puerorum et mulierum numerum, atque equorum copiam innumerabilem; corpora inhumata sub diu computruerunt, nulla tamen pestis insecuta est. Hic in Germania, durantibus his nostri ævi crudelissimis bellis, etiam plurimæ maximæ strages factæ sunt, post multas tamen illarum nulla peste subsequente,” Even, when the plague has appeared in the immediate vicinity of places, where heaps of slain have remained unburied, other causes, it has been justly observed, may be pointed out as more likely to have produced that disease.*

Many

sequences of the facts which I have related will be found equally applicable in the examination of those which remain to be described. Let us see then what conclusion we can draw from the former.

62. It must have been remarked that in every degree of putrefaction, there was such a disengagement of the carbonic acid gas, that the proportion of this gas was considerably augmented, independently of that produced

Many other facts and arguments, did our limits permit, might be adduced in confirmation of this opinion; but, whilst, we contend that these and other circumstances render it highly probable, that the concurrence of some other cause, than that of putrid effluvia from dead bodies, is necessary to the production of pestilential fever, we must not be understood as affirming that they do not, in certain circumstances, produce deleterious effects on the living system. Some examples of this nature are related by Mr. St. John, and other writers, but it does not appear, that the symptoms of these patients had the least resemblance to those of pestilential fever; but were, on the contrary, of an inflammatory nature. We shall only farther observe, what may be well recollected, that, at one period, the *Typhus-Icteroides* of Philadelphia was attributed to the exhalations from a quantity of damaged coffee, although from a comparison of all the evidence, it now clearly appears, that the disease in question proceeded from a very different source, and was afterwards propagated like other pestilential maladies. In like manner, it seems improbable, that the epidemic which prevailed in the town of Delft should derive its origin from the exhalations of putrid vegetables:—a cause evidently much less powerful than many others, to which every commercial city must be, frequently, more or less exposed. Tr.

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by respiration, particularly when a great number of people are assembled.

This preliminary fact being fully established, it is necessary that we should deduce our conclusions with greater accuracy than has been hitherto employed.

It would appear, that in the greater part of eudiometrical experiments no allowance has been made for the absorption of this gas by water, which must nevertheless affect the general result, by producing a diminution of bulk sufficient to lead us into an error as to the real proportion of oxygen gas*.

On the other hand, this accumulation of a deleterious gas shews us the necessity of resorting to the means of diminishing it, stated in the Instruction of the Council of Health, dated the 7 Ventose, 2d year, which consists in placing in the corners of the wards several buckets filled with water wherein lime is mixed, and which must be carefully renewed from time to time.

* Dr. White observed, that air which remained for some time upon plumbs in a state of putrefaction, lost about 75 per cent of its bulk in passing through water.

Journ. de Physique, vol. xviii. p. 166.

63. But the first experiment furnishes us with a result much more important, and which cannot be too much dwelt upon, in order to undeceive those who imprudently confide in the opinion which unfortunately has met with too general a reception, that lime water decomposes the contagious miasmata. It proves that corrupted air preserves its smell, even after being agitated with lime water, and before the latter is deprived of its active qualities. From this fact we may learn how to estimate the practice, recommended in the most recent works, even in cases of plague, of new white-washing with lime the walls of infected places*.

It does not hence follow, that we should call in question the powerful operation either of this solvent, or of the caustic alkalies, upon animal substances, but it is very easy to conceive that the same action ceases to produce the same effects, when the body submitted to their action, has undergone a change so considerable as that which occurs in a state of putrid decomposition. Instead of supposing the existence of the same affinities in such cir-

* De la Peste, &c. by J. F. Papon, vol. ii. p. 128.

cumstances,

Cumstances, we ought very justly to be surprised at finding the recurrence of the same products. It is the more difficult to account for the prevalence of an opinion so erroneous, as the observations made almost daily upon the employment of lime in both of these cases, seem sufficient to point out the true principles of its operation. Every one knows that lime prevents the corruption of bodies, or, vulgarly speaking, consumes them before putrefaction can take place, when applied immediately after the extinction of animal life ; whilst its only tendency is to accelerate and increase the disengagement of the putrid effluvia, when applied to bodies already putrescent ; that is after the azot, carbon, hydrogen and sulphur, have already entered into new combinations. Experiment ix. is, in this respect, a confirmation of a fact generally known.

64. The ammoniacal gas extricated by lime from putrid animal substances, is undoubtedly a new compound, as well as that obtained by distillation from the same substances before putrefaction. It might hence be presumed, that if it be not the volatile principle which carries up with it into the atmosphere the contagious miasmata, it is at least one of the ingredients

gredients in their composition. We have seen that, in the Experiments VII. and VIII. I tried, without success, every possible means of discovering the slightest vestige of ammoniac; and this fact more particularly required to be ascertained, from the consideration of its appearing at first view, to be in opposition to the almost general opinion of chemists*; but it would be going too far to conclude that it does not exist in any degree, since it still may be present in a saponaceous form, upon which the re-agents that produce an alteration of colour, have no influence. As nothing more, however, is necessary than the evidence of our senses to enable us to pronounce that the putrid odour is essentially different from that of pure ammoniac, and carbonat of ammoniac, we are necessarily led to suppose from a view

* It is on the supposition that the air is infected by ammoniac, that Citizen Van Mons opposes the employment of lime-water to absorb the carbonic acid gas, which should serve, in his opinion to saturate the ammoniac (*Annales de Chimie*, tom. xxix. p. 101): but we find that he himself discovered in the atmosphere, of the chambers of sick persons, a considerable quantity of carbonic acid gas, and occasionally a portion of ammoniacal gas. He is, besides, very far from regarding the ammoniac as the contagious miasma; since he adds that that particular emanation appears to him to be carbonated hydrogenous gas, holding in solution some animal fluids hitherto but very little known.

of all the phænomena, that it is carried into the air in a state of combination anterior to its solution in that fluid, which sufficiently indicates the necessity of turning our attention towards such agents as may be capable of destroying the affinities of this composition.

65. The phænomena presented in the Experiments II. III. IV. V. evidently discover in air corrupted by putrefaction, a reductive or disoxydifying principle, since it is only by losing their oxygen that silver, mercury, lead and copper, could have been separated from their acid solvents, and resume their concrete form accompanied by the colours which attest the alteration. But what is the nature of this reductive? Does it exist in a simple or compound form? We are acquainted with several reductives capable of producing these effects, and which may be obtained from the putrid substance itself, such as hydrogen, azot, carbon, sulphur and phosphorus, which analysis discovers in the composition of animal substances. We also know, however, that these reductives, seperately employed, act in certain circumstances only, It is necessary that some of them should previously lose the gaseous form, and that others should be carried to a higher

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temperature, or that in some other mode, they should undergo an incipient separation of their parts. The hydrogenous and azotic gases pass through the metallic solutions without occasioning the smallest cloud; the carbon and sulphur do not take up the oxygen of the metals most easily reducible, without the assistance of heat. I even completely ascertained that phosphorus itself, a combustible which so readily inflames other bodies; which is instantaneously covered with a black pellicle in a very dilute solution of nitrat of silver, and deposits, after the lapse of a few days, a metallic chrystallization; neither produces, nor sustains any change in the solutions of nitrat of mercury and acetite of lead, which we have seen partially decomposed by putrid air.

66. We know, on the other hand, that the action of these reductives is more rapid and efficacious, in proportion as they meet in a composition less tenacious, and more disposed to part with them, in order to form a new combination before resuming the gaseous or concrete form. Upon this law principally depends the remarkable activity of the sulphurets, of ammoniac, and particularly the combina-
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tions of hydrogen with carbon, sulphur, and phosphorus.

Independently of this law, which of itself forms a very prominent characteristic, there is another which we have seen (No. 54) equally conclusive in favour of the identity of the cause from the identity of the effect; I allude to the impression received from it by the organ of smell. Every one must have been struck with the resemblance of the odour of sulphurated hydrogen gas to that of rotten eggs. "The smell of phosphorated hydrogen gas is exactly the same as that of putrid fish;" these are the expressions of the illustrious Lavoisier*.

From these circumstances we cannot hesitate to regard putrid air, or rather the noxious miasmata which it holds in solution, as compositions of several substances of the same nature. In order to attain a more complete knowledge of them, it would be requisite to determine the respective proportions of these ingredients; and it would be equally necessary, but still more difficult, to distinguish in this composition the remote and the proximate elements; that is, those which have entered

* Elementary Treatise, &c. chap. xiv. upon Putrid Fermentation.

into it in the form of simple substances, and those which have been subsequently taken up, and still maintain themselves in the equilibrium of a primary combination, such as soaps, oils, hydro-sulphurets, &c. We might then distinguish the differential principle of these miasmata, and assign the cause of that sort of assimilating power which operates to render them the *fomites* of disease.

67. The instruments of chemistry are not yet sufficiently perfect to enable us to undertake such an analysis; but we have proofs abundant of the infinitely varied effects which nature can produce by a change of proportion, and by quantities too diminutive to admit of calculation, that there is no inducement to seek for their causes in unknown principles or imaginary suppositions; particularly as the phænomena which are obvious to our senses, have already removed a part of the veil, by enabling us to ascertain the presence of these elements from their affinities.

Here experience and analogy perfectly concur in determining the nature of, at least, the principal constituent parts of contagious emanations; and that is sufficient to put us in the way of discovering the remedy. Having to
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combat the action of a composition of reductives, let us call in the aid of the most powerful oxygenants ; assured of destroying the composition and its properties, if we succeed in effecting the combustion of only some of its elements.

In order to corroborate this conclusion by proofs of another kind, I instituted the experiments which I have now to detail, and which may at the same time serve to fix our opinion as to the choice of the means to be employed in purifying infected air.

EXPERIMENT XII.

68. I filled a receiver containing sixteen *decilitres*, with air impregnated by the effluvia of flesh in the last stage of putrefaction. I burnt in it at different times, a quantity of benzoin until it became almost opake, and, upon cooling, its internal sides were partly covered with flowers; the odour of the benzoin, though predominant, did not prevent me from still distinguishing the putrid character by a very disagreeable fœtor.

This air was poured, a few hours after, into a stopped jar ; at the end of eight days it was found to have still preserved its fetid odour.

EXPERIMENT XIII.

69. I transfused the infected air into the apparatus of the two jars already described (No. 39). I then introduced a solution of benzoin in alcohol, which I had rendered milky by the addition of a little water, in order to heighten the odour. The communication being established by opening the cock, I repeatedly agitated the air with the liquor. Next day the odour still imparted a mixed sensation, though somewhat less disagreeable than in the preceding experiment.

EXPERIMENT XIV.

70. I treated the infected air in the same manner with balsam of Peru, storax and myrrh, dissolved in alcohol. The fœtor was still more perceptible, or at least more unpleasant, notwithstanding its being mixed with the odour peculiar to these substances.

EXPERIMENT XV.

71. The anti-pestilential preparation known by the name of the *vinegar of the four thieves*, did not escape my attention, while examining the effects of aromatic compositions. It was strongly

strongly agitated with the putrid air ; and after remaining twenty-four hours in the apparatus of the two jars, it was still very easy to distinguish the faint and disgusting odour which characterizes those mixtures in which the putrid smell is modified, but not destroyed.

EXPERIMENT XVI.

72. The *pyroligneous acid* seemed to me deserving of being submitted to the same trial, more particularly because, if fires, which are regarded as so efficacious in purifying the air, act in any other way than that of accelerating the motion of this fluid, the principle of their action is discoverable only in this product of the combustion of vegetables. This acid, being inclosed and agitated with the putrid gas, actually produced so great a change in the odour, that, at the end of two hours, it was difficult to distinguish the impression of a remaining faint odour amidst that of the empyreuma of which this acid can never be entirely deprived by rectification.

EXPERIMENT XVII

73. The explosion of *gunpowder* has been regarded as one of the best means of purifying
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the air *. It is evident that the repetition of this operation, within a narrow compass, expels a certain quantity of æriform fluid, which being mixed with the external air, when it rushes back to restore the equilibrium, produces a partial renovation. It might also be imagined that, as sulphur and nitre enter into the composition of gunpowder, the gaseous products of their combustion would act upon the air with so much greater force, as they instantaneously expand through a larger space by the deflagration. But these opinions being in opposition to the experiments in which modern chemistry confines these gases, determines their nature and respective quantities, and shews the great proportion it contains of carbonic acid and azot, compared to the small quantity of sulphureous vapours; I conceived that it would be sufficient to make a direct trial of them, with respect to the action of the latter product. I filled, with putrid air, a recipient of the capacity of twenty-four decilitres, and stirred into it, at three different times, twenty-five centigrammes of gunpowder; at first the odour was very little changed,

* De la Peste, par J. F. Papon, tom ii. p. 47.

it was sensibly diminished at the second, and at the third entirely disappeared. From the quantity of gaseous fluids, however, which had successively filled the recipient, even so as to render it opaque, and the volume of water which had been raised up during the condensation, there remained not a doubt that the putrid air had been replaced, not corrected.

EXPERIMENT XVIII.

74. We have observed (Exper. xv.) the small effect produced by vinegar impregnated with aromatic substances: the lotions and fumigations of pure vinegar merit particular attention, since they continue to be regarded as the best preservatives against every kind of contagion.

I filled the small jar of the apparatus already described (No 39) with common vinegar, the other being full of infected air. I then established the communication, and at once mixed the vinegar with the aeriform fluid; the large jar being immediately opened, the odour was found sensibly diminished. After again agitating it thrice in the course of an hour, although the odour of the vinegar was still

still perceivable in a small degree, yet that of the putrid air was altogether destroyed.

We know that in several circumstances, for example, when vinegar is poured on excrementitious substances, an unrespirable air, or even hepatic gas, is disengaged *. To reconcile the result of my experiments with these observations, it is not necessary to suppose the hydrogen, the carbon, and the sulphur, in a different state of composition, which, although extremely probable, is not yet fully ascertained; it is sufficient that, in one of these cases, the acid meets with some fixed matter on which it may exercise a preferable action; this, however, cannot occur when the odorous particles are only combined with the air in which they are dissolved.

EXPERIMENT XIX.

75. I poured a decilitre of the same vinegar into a matrass with a syphon placed under a glass bell filled with putrid gas, and raised above the surface of the water, which closed

* Collection of Essays concerning the Exhumations at Dunkirk in 1783, p. 67. Enquiry into the Nature and Effects of Mephitisme, &c. by M. Hallé 1785, p. 67.

the communication between the bell and the external air. I then distilled one-third of the vinegar by means of a small lamp: in half an hour the air appeared to have lost its fetid odour, and when washed in a solution of nitrat of mercury no precipitation was produced, nor any alteration whatever in the colour of the solution.

This experiment was repeated by substituting in place of the bell a glass tube three times higher, the capacity of which, however, scarcely exceeded one-tenth of that of the bell. In this case, the distillation was pushed much farther; nevertheless, on raising the stopple, which shut the superior opening of the tube, the fetid odour continued to be felt, which convinced me the acetous vapour had not ascended to that height, although the heat of the season was not favourable to a speedy condensation.

EXPERIMENT XX.

76. To appreciate the method of fumigations with vinegar sprinkled on hot iron, I poured nearly five centilitres into a tubulated recipient filled with putrid air, and under which

which I had introduced a small iron vessel made red hot: on turning up the recipient, after being cooled, a faint disagreeable odour was exhaled from it, in which the smell of the vinegar was no longer distinguishable.

EXPERIMENT XXI.

77. I repeated the experiments (Nos. 74 and 75), employing an apparatus of the same dimensions, and substituting for the common vinegar an equal portion of the *acetic* acid or radical vinegar; the effect immediately took place: the fetid odour had entirely disappeared, whilst the agreeable smell of the acid was very little diminished.

EXPERIMENT XXII.

78. It appeared extremely probable, that common vinegar simply digested upon the black oxyd of manganese, might acquire a similar property; a circumstance that must have proved extremely important from the readiness with which this preparation could be obtained: the result, however, did not answer my expectation, the putrid air preserved a
small

small degree of taint after being repeatedly agitated in a solution of acetite of manganese.

I distilled a portion of this solution after it had been concentrated; the product agitated with putrid air completely destroyed its odour. This fluid neither precipitated silver nor mercury, but it rendered turbid a solution of acetite of lead.

EXPERIMENT XXIII.

79. I had now to proceed to the most important part of my labour, viz. the examination of the power of the mineral acids to purify contaminated air. To this purpose I began with the fumigation of sulphur, and found that on burning about two decagrammes of it beneath a glass bell, containing thirty-two decilitres of that air, the fetid odour immediately disappeared. It is true, the penetrating nature of the sulphureous vapour did not allow me to form a very accurate judgment; but the water, which closed the opening of the bell, had acquired the property of producing a slight precipitate of a dirty grey colour, in a solution of nitrat of mercury.

EXPERIMENT

EXPERIMENT XXIV.

80. In order to obtain a more decisive result, I employed the apparatus with two jars already described. I put into one of them very strong sulphureous acid, prepared the preceding evening by the distillation of sulphuric acid upon mercury; the other contained the contaminated air. After the communication had been established twenty-four hours, I was much surprised still to discover a small degree of putrid odour, which was sensibly evident, notwithstanding the pungency of the sulphuric vapour.

EXPERIMENT XXV.

81. I enclosed in the same apparatus, very pure, and highly concentrated, sulphuric acid, with the contaminated air; a single agitation was sufficient completely to destroy its odour, and the colour of the acid did not experience the slightest change.

When I employed the acid diluted with an equal portion, and afterwards with three parts of water, the results were precisely the same.

EXPERIMENT XXVI.

82. I have described, in the second part of this treatise, the method of destroying contagion by the nitric acid, according to the directions of Dr. Smith; the authentic testimonies produced in its favour, instead of preventing me from submitting it to a new examination, presented additional motives for investigating, with precision, its peculiar manner of action, and particularly on the same substances, and by the same process, which would enable me to compare its efficacy with that of other agents. In order, as much as possible, to conform to the mode employed by Dr. Smith, I filled, with contaminated air, a large balloon, or recipient, with a double neck, into which had been introduced the beak of a small glass tubulated retort or cucurbit, placed on a sand bath, into which I had put six grammes of concentrated sulphuric acid. When the sand had been heated, I introduced by degrees through the opening of the cucurbit, an equal quantity of very pure nitrat of pot-ash reduced to powder: there had been some vapours disengaged each time, and as I was careful immediately to replace the stopple, they were forced

to enter the cavity of the balloon, which having a syphon adapted to the other neck to discharge it when too full, the expansibility of the vapours was not checked. After this operation the air in the balloon did not preserve the least trace of putrid odour, and produced no alteration whatever in the colour of a solution of acetite of lead, or nitrat of mercury.

83. It is almost unnecessary to mention, that I was extremely careful to avoid the use of all metallic substances whatever, and employed only air-tight glass vessels, notwithstanding which I always observed red vapours at the beginning of the operation, which, indeed, very quickly disappeared. As neither Dr. Smith nor Mr. Keir had mentioned, in a precise manner, the specific weight of the acid, or the degree of heat in the sand, I conceived at first that by diluting the acid and diminishing the heat, I might obtain the pure nitric vapour; I only, however, succeeded by proceeding gradually to that point at which the disengagement of the acid vapour was almost imperceptible. It cannot be doubted, that the smallest portion of reddish gas is rendered far more evident in close vessels than
in

in the open air, where it is immediately diffused and saturated with oxygen. But it appears to me almost incredible, as affirmed by Mr. Keir, that the process of Dr. Smith actually produced only white fumes, and that it was not till towards the end of the operation, when the degree of heat was augmented, that any red vapours were extricated; besides, this opinion cannot be reconciled with the report given by Mr. Menzies, that *the vapour occasioned much coughing* when the pipkins were carried too near the faces of the sick, and that it ceased, in a great measure, when the fumes became diffused.

EXPERIMENT XXVII.

84. The direction of, as much as possible, disengaging only white vapours, required, in my opinion, to be considered under another point of view. Chemists know how much they differ from red vapours in relation to their expansibility; the latter continue in a permanently elastic state, until they enter into new combinations; the first are condensed, like all other liquid products of distillation, as soon as the heat has ceased. It was then of import-

ance to ascertain, at least by approximation, how far these acid fumes could be carried, as we have already seen in the case of the acetous vapour (Exper. xix). With this intention I proceeded as in the foregoing experiment, interposing only between the retort and the recipient containing the same quantity of contaminated air, another recipient of twenty-two centimetres in diameter, filled with atmospheric air; these recipients communicated with each other by two large necks, as in the apparatus formerly known by the name of enfiladed balloons. The thermometer stood in the laboratory at 19°: I employed the highest concentrated acid, and augmented the heat of the sand bath, yet no cloud appeared in the last balloon; and on opening it after the vapour was entirely condensed, I could scarcely distinguish the smell of the nitric acid, but the putrid odour was still evident.

EXPERIMENT XXVIII.

85. I could not terminate these experiments on the nitric acid without first endeavouring to ascertain if, as Mr. Keir assures us, the vaporous fluid, disengaged from nitrat of potash

ash by the process of Dr. Smith, really meliorates the air by giving out oxygen gas.

The most familiar observations are so far from giving any degree of probability to this opinion, that they compel us to believe the English chemist has founded it on a mere analogy; but it is to be regretted, that he has not described the experiments which led to its adoption, and of which the examination would have furnished an explanation of the facts, and enabled us to determine the results with accuracy. Being obliged to supply this defect, I have endeavoured to render the experiments as direct, and as little dependent on extraneous circumstances, as possible.

86. I filled a large bell-glass with atmospheric air, of which I previously ascertained the proportions of vital air and azotic gas. Having placed in the sand bath a small tubulated retort, I adapted to the beak a glass tube, sixteen millimetres in diameter, which was intended to carry the vapour to the height of about one-third of the bell, or seven centimetres of the water, in which the bell had been placed to interrupt any communication with the external air. In short, I several times disengaged the nitric acid, either by pouring

the sulphuric acid upon the nitre through the tube, or by throwing the nitre into the acid.

I repeated this operation a great number of times, varying the capacity of the bell, or the quantity of the air, as well as the mode of introducing the vapour; rejecting all those results which could be affected by any accidental circumstance, and particularly by the smallest perceptible quantity of red vapour.

87. I should have been astonished, if a distillation, the essential property of which is not to decompose a single particle of acid, had furnished a sensible quantity of oxygen gas. But I still less expected to find, in opposition to the assertion of Mr. Keir, that instead of being meliorated by an additional portion of oxygen, the air was actually deprived of a part of that principle it possessed before the commencement of this process, which was, however, uniformly the case.

Having allowed a sufficient time for the cooling and condensation of the vapours, the air in the bell was submitted to several eudiometrical experiments, by nitrous gas, sulphuret of pot-ash, and phosphorus; the mean difference, between the air introduced into the apparatus, and that which remained after distillation,

tillation, was 2.6 in 100 less in the latter. I found it once 0.164 only, or about 16.5 in 100 of vital air, after it had remained during twenty-four hours in the eudiometer with phosphorus.

EXPERIMENT XXIX.

88. In order to satisfy myself by a comparison of the results under directly similar circumstances, the muriatic acid was submitted to the same direct tests in the different states in which it could be employed to purify the air. I first filled, with this concentrated acid, the small jar of the crystal apparatus already described; and the large one being full of highly putrid air, I established the communication in such a manner, that only a few drops of the acid fell into it. At the end of a few minutes, all trace of the putrid odour had disappeared, and the air, which before turned a solution of acetite very black, now only produced in it a slight white precipitate.

EXPERIMENT XXX.

I repeated the foregoing process in such a manner, that the putrid air could only be acted

upon by the odour of the acid gas; in less than a quarter of an hour, by this means, the air was also completely purified.

EXPERIMENT XXXI.

When the acid was diluted so as to reduce its specific weight to 1.087, there remained, after the same time, some degree of fetid odour, which however was quickly destroyed, when I agitated the two communicating jars.

EXPERIMENT XXXII.

The expansibility of the muriatic acid gas, immediately on being disengaged from its alkaline base, is so well known to those who conduct similar operations, that any attempt to measure the space it filled before becoming condensed, would be useless, since we have not yet discovered the means of reducing it to a liquid state by cold alone. But it appeared to me proper, at least to ascertain by observation, and under circumstances the most unfavourable to gaseous expansion, what effects might be expected from the employment of a given quantity.

With

With this intention, I filled a small tubulated cucurbit with putrid air; having closely shut it, I introduced and luted the extremity of its neck into the opening of the recipient of a pneumatic machine, twenty-two centimetres in diameter and thirty-four in height, which remained full of common air. On the other side, I put into a small saucer twenty-five decigrammes of common salt not dried, and an equal quantity of sulphuric acid. Every thing being thus disposed, I raised up the stopple of the beak of the cucurbit, and afterwards replaced the whole recipient in a vessel, which contained enough of water to cover its edges, and in the midst of which the saucer had been previously placed. It is evident that the gas, carrying along with it the water of crystallization of the salt, and passing through moist air, should be disposed very readily to assume the form of aqueous vapour, and even to become entirely condensed, considering the small quantity of the mixture, and the impossibility of a complete decomposition, without the application of heat: having, however, opened the tube of the cucurbit about ten minutes afterwards, I perceived the odour of the muriatic acid

acid gas, but was not able to distinguish the least vestige of the putrid air.

EXPERIMENT XXXIII.

92. In order to procure the oxygenated muriatic acid, according to the process of Mr. Cruickshank, already mentioned (No. 31), I employed the same apparatus as in the foregoing experiment, only adding to the mixture of common salt, and sulphuric acid, thirteen decigrammes of powdered black oxyd of manganese, and sixteen of water: the putrid odour not only disappeared immediately, but in about three hours, during which the tube of the cucurbit had been several times opened, the oxygenated acid gas gave out such a smell as to leave no room to doubt, that this quantity would have been sufficient to impregnate a far more considerable volume of air.

93. I might here terminate the series of these experiments on all the means hitherto known of purifying air, if I had not to mention a process by which this powerful gas may at all times be readily obtained. It will form the subject of the last experiment.

EXPERIMENT XXXIV.

Into a flask, the capacity of which was three centilitres, I introduced four grammes of the black oxyd of manganese, grossly powdered; I then filled the flask about two-thirds full with the nitro-muriatic acid. After a few minutes, on being agitated, the oxygenated acid gas was disengaged with such intensity, that vegetable colours applied to the mouth of the flask, were in a very short time radically destroyed. The ease, and particularly the promptitude, with which, without the intervention of a distilling apparatus, this powerful re-agent may thus be procured, induced me to name it the *extemporaneous oxygenated muriatic acid*, and I have since discovered another property of this preparation which will render it still more generally useful. The difficulty of preserving the oxygenated muriatic acid, procured by the common processes, unchanged even in the closest vessels is well known; whatever may have been the degree of its concentration when put up, we always find it after a short time reduced to a liquid which only changes into red paper tinged with turnsol, without destroying the colouring principle. A
jar

jar prepared in the manner here pointed out, after being forgotten eight years in my laboratory, diffused, on being opened, an odour capable of painfully affecting the organs when breathed without precaution*.

94. It is here unnecessary to detail how often I have experienced the efficacy of this agent, which I always employed whenever the abundance of the putrid exhalations, which it was impossible wholly to restrain, rendered it unsafe to remain exposed to their influence, so that it became the subject of daily experiment during the continuance of my labours, and which it was therefore useless to repeat under a recipient, when it had acted in so sensible a manner in the whole laboratory. The jar which I employed six months ago, preserves even to-day the same activity which it possessed at the moment of its preparation.

95. Such are the observations I have collected in the course of these experiments,

* This occurred during the visit I made to Dijon, in Brumaire, year 7, after an absence of eight years. The label of the flask being entirely defaced, I poured the liquor into a glass, in order to discover what it was from the smell: I was so affected with the pungency of the vapour, that it occasioned a continual sneezing for several hours.

which

which were undertaken to determine in a more precise manner than has been hitherto done, aided by the discoveries and instruments of modern chemistry, the power of the different substances which can be employed to purify air charged with putrid exhalations. I shall next endeavour, from a general view of the results, to solve the different questions I propose to myself.

On the comparative efficacy of the different means employed to correct the insalubrity of the air, and stop the progress of contagion.

96. What confidence should be placed in aromatic fumigations for purifying the air and stopping the progress of contagion? What has been already said in the first part of this Treatise from Vicq. d' Azyr, and Montigny, seems to show that the opinion of these intelligent men has been long fixed respecting their inefficacy*. Had I conceived it necessary to support this opinion by new authorities, I would have cited the learned authors of the *Instructions* published in the year 2, by order of the Government. “ Perfumes (say

* Macbride has observed, that the fœtor of putrid bodies is not diminished, even by their immersion in a strong decoction of tormentil, pomegranate-flowers, &c. Exper. XI. and XIII.

they)

they) are far from possessing the wonderful properties attributed to them ; they only afford a deceitful security—this vapour does not furnish any new air different from that with which it is intermingled, it in fact only covers the fetid odour without destroying it. Let us hasten then to banish the use of perfumes*.’

The Board of Agriculture published in the year 5, Instructions drawn up by the Citizens Huzard and Desplas, on the epizootic malady of the departments of the east, and a part of Germany : these learned veterinary professors equally interdict the use of perfumes for correcting the infection of stables. It would be useless (say they) to burn in them juniper berries, aromatic plants, or old leather as has been recommended.”

It would be endless to adduce the numerous testimonies against this ancient routine ; I shall confine myself to those of men whose opinions must command respect, hence I ought not to forget that of Citizen Chaptal. “ The aromatic fumigations usually employed

* Instructions on the Means of preserving the Salubrity of Hospitals, &c. p. 15. In order to entitle this work to our utmost confidence, it is only necessary to observe, that it was digested by Citizen Parmentier.

only mask the fetid odour.' It is thus he expresses himself in a note which he communicated to A. Poulle, which the latter has inserted in a *Chemico-medical Dissertation* on the application of vital air to the animal economy, printed at Montpellier in 1784.

97. But when on the contrary we observe fumigations with aromatic and resinous substances recommended in the most recent works, published with the laudable intention of pointing out the best preservatives against the most destructive of contagious disorders, when we know that the employment of perfumes still form the principal part of the regimen in the greatest number of lazarettoes*, it would be deserting

* A proof of this may be found in the work published last year by Citizen Papon, entitled "*On the Plague, or the remarkable Periods of its Appearance, and the Preservatives to be employed against it.*" In this work we have an accurate relation of the means hitherto employed as well as those still in use for purifying the patients, the clothes, furniture, apartments, and the air. He gives the composition of the different perfumes employed during the plague in 1720. Some of them contained sulphur, gunpowder, cinnabar, antimony, and even arsenic; but always a great quantity of resin, ivy, and juniper-berries, anise, fennel, incense, laurel-leaves, thyme, lavender, &c. &c. (vol. ii. p. 96, 99, 202, &c.) Howard, the enlightened friend of humanity, has recorded in his *History of Lazarettoes*, the answers to the questions which he addressed to several physicians, established in those places where the plague is almost constantly present, on the means

deserting the cause of humanity merely to deplore the lukewarmness with which the most useful truths are received, and the difficulty of overturning the established routine by which error is transmitted from age to age. The importance of the subject demanded new efforts, in order to carry conviction to the mind; and this I have undertaken in Experiments XII. XIII. XIV. and XV. We ought to remark in the first place, that the fumes of benzoin, which I thought deserved to be placed in the first order, on account of the volatile acid which is disengaged from this resin, only diffused its own odour without destroying that of the infected air, even after having been confined with it several days, which would seem to demonstrate that these odorous particles have no reciprocal action on each other, or, at least, no affinity capable of disuniting their constituent parts.

means of stopping the contagion; he has likewise inserted the instruction drawn up by Dr. Paitoni, by order of the Venetian government, at the request of the Court of Russia. In what consists the preservative method? In following up the precaution of separation, cleanliness, and aspersions with vinegar, by lighting fires of odoriferous woods, throwing into them flowers and aromatics, and fumigating with resinous and balsamic substances.

98. We might presume, however, that the resinous and aromatic substances dissolved in alcohol, and brought into immediate contact with the infected air, would act with greater energy, more particularly when violently agitated; the Experiments XIII. and XIV. produced, in the most favourable circumstances, decisive results in opposition to this opinion.

99. After these new experiments there was little necessity for examining the effects of the vinegar, to which is given the name of *antipestilential vinegar*, or the *vinegar of the four thieves*, since it is from aromatics alone it derives its boasted virtues, and that we are not able to conclude any thing respecting the purification of the air, from the effects it would produce by its direct application either as an acid, or by the combination of any of the fixed principles which enter into its composition. But it was necessary to appreciate this pompous character, repeated even in our best modern pharmacopœias, that it possesses the property of expelling bad air, by means of evaporation, and thus acts as a preservative against contagion.

Although far from being imposed on by these old traditions, I confess it was not with-

out some surprise that I observed the small effect of this liquor in Experiment xv; but my astonishment ceased on considering, that the different materials with which it was impregnated by a long digestion, could not fail to weaken the action of the vegetable acid. It is likewise customary in some laboratories, in order to give it a somewhat pungent smell, to add a few drops of the acetic acid.

100. The results obtained from the employment of common vinegar, or the acetous acid, are certainly very different (Nos. 74, 75, and 76). My experiments perfectly accord with those of Dr. Crawford, who assures us, that the peculiar smell of animal hepatic gas is destroyed by agitation with vinegar, and also with the concentrated sulphuric acid*. Thus there no longer remains any doubt as to the efficacy of vinegar in purifying putrid air when diffused through it by evaporation, or, what is still better, when employed in the liquid form, and the air is, as it were, washed by it at different times. I feel considerable satisfaction in bearing this testimony in favour of the precaution, in almost universal use, of passing

* Philos. Transact. vol. 80. p. 423.

through vinegar, letters and other articles brought from countries where any contagious malady is supposed to exist*. But we must not thence infer, that the evaporation of vinegar is sufficient to purify a mass of air, even in a small and confined space; since we have seen that it expands but to a very short distance in a state of vapour, and that the odorous particles, which are spontaneously disengaged from it, produce no effect even after the lapse of several hours†. It would be in vain to expect

* I am sorry to read in Citizen Papon's Treatise on the Plague, that "Perfumes are much more efficacious than vinegar in purifying papers," vol. ii. p. 205. Though perfumes should be employed in a constant and uniform manner with all the precautions which he points out (that is, putting the papers into a tin box, placing them upon the fire, and there leaving them until they turn yellowish), still it cannot be supposed, that they would act more forcibly upon the condensed poison adhering to these substances, than in the circumstances in which I tried their action upon infected air, without being able to destroy even the smell.

† I have before me two hand bills printed and distributed at London in 1796, respecting a *fumigatory lamp*, invented by Messrs. Jackson and Moser, for purifying the air in ships' hospitals, and the chambers of the sick, in consequence of neutralizing the alkaline emanations by the acid fumes of nitre, vinegar, and acetite of pot-ash (foliated tartar). It is easy to perceive, that this process is a simple distillation by the flame of a lamp, in order to diffuse the acid through the atmosphere. We can conceive how little benefit is to be expected from vinegar alone; and the acetite of pot-ash would yield much less, without employing a stronger acid to retain its basis. No mention is made of the mode of using this apparatus.

a more extensive dispersion by the aid of a stronger heat, as in pouring the liquor upon burning coals or red-hot iron. In such cases the vinegar is, in a great measure, destroyed, and the air retains only the impression of the gases resulting from its combustion.

It will not appear surprising, that I have not here taken any notice of the anti-mephitic qualities of the vinegar, so pompously advertised a few years ago, for neutralizing the gas formed in privies. Besides that these vapours seem to be of a different nature from putrid contagious emanations*, this pretended specific, as I have observed in the article, "Acetous Acid," of the "Chemical Dictionary of the Methodical Encyclopædia," has been reduced to its true value, by the report drawn up in

* From the properties and modes of action of these and other mephitic vapours, it seems fairly presumable that they are of a different nature from putrid contagious exhalations. The affections to which persons are subjected from exposure to such effluvia are termed, by Nosologists, *asphyxia foricariorum*, *a carbone*, &c. according to the substances from which such exhalations proceed. As, however, several of these affections, although considered by Sauvages as constituting different species of the same genus, appear, nevertheless, to vary only in degree, and not to be essentially different, it should seem more consonant to nosological rules to consider them only as varieties of one and the same species. T.

1782, by the joint committees of the Academy of Sciences, and the Society of Medicine*.

101. The acetic acid has, in this respect, a decided superiority over the common vinegar, which would be sufficient to prove, had we no other evidence, that it is upon a difference of composition, and not merely upon a higher degree of concentration, that its properties depend. The circumstances which principally characterize this difference are the powerful action of the odour of radical vinegar, and the promptitude with which it purifies putrid air, without the necessity of employing it in a liquid form, or of promoting its evaporation by means of heat. I cannot, therefore, but recommend the use of so simple a preservative, to all who may be exposed to breathe an atmosphere charged with putrid emanations. I have known several medical men who constantly had a phial of it about them; and I have myself employed it in situations in which I was liable to be affected by noxious effluvia†.

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I shall

* The details may be seen in the learned enquiries of Citizen Hallé, into the nature and effects of this mephitism, printed in 1785, by order of the government.

† The following fact may give an idea of the action, which is but too little known, of this acid upon animal substances. Being called

I shall shortly have occasion to consider this acid under another point of view, which will serve to induce still greater confidence in its beneficial effects. Still, however, it cannot be denied that its sphere of action is too confined to admit of its being used with effect in a large space, and that this operation would become expensive from the labour requisite to the preparation of the acid. It was to abridge that labour, that I endeavoured to superoxygenate the common vinegar by simple digestion with oxyd of manganese. In this, however, I was unsuccessful; and it appears to me that my failure ought to be attributed to the

called to examine some vaults which emitted cadaverous effluvia, I provided myself with a phial of this liquid, of which I poured a quantity upon a handkerchief that I held in my hand upwards of an hour, in order to breathe the odour more freely. The epidermis of the thumb which, during the whole time, pressed the wettest part, was so much affected, that it came away; and it was not until a fortnight after that the skin, which grew under it, ceased to experience the same desiccation. Had I not been assured of the purity of the acid, I should have been inclined to suspect that it was mixed with some mineral acid. I ought, indeed, to observe, that the intense cold which I felt at the same time may have contributed to this accident.

A preparation was sold a few years ago, under the name of volatile salt of vinegar, consisting of small crystals of sulphat of pot-ash, sprinkled with a little of the acetic acid. This may answer the same purpose, with the inconvenience only of paying for a few drops a much greater price than a phial filled with the same liquid would cost.

oxygen

oxygen separating itself from the metal in solution, and combining with the superabundant carbonaceous matter abandoned by the acetous acid.

102. The pyroligneous acid has the power of making some impression upon putrid air (Exper. xvi.), and this is the less surprizing, particularly since Citizens Fourcroy and Vauquelin have shewn, that this product of the distillation of wood is nothing else than the acetous acid modified by the quantity of empyreumatic oil which it contains*; but it may be easily seen that its action as an acid must be diminished in proportion to this alteration; and that it is so much the more considerable in this case, as it is not the rectified product of distillation, but the pure product of the combustion of ligneous substances, which can be employed in purifying the air.

* The pyro-mucous, and pyro-tartareous acids, as well as the pyro-ligneous, were formerly considered, by the best chemists, as essentially different from each other; and belonging to a genus well characterized. But the experiments of Citizens Fourcroy and Vauquelin have fully established their identity with the acetous acid, impregnated with the empyreumatic oils peculiar to each of them. Hence, it obviously follows, that the acetous acid is not the sole and necessary effect of fermentation, but is a much more frequent production than has been hitherto supposed. T.

Is it probable that this operation ought to be considered in another point of view? This is a question which likewise deserves examination.

103. The practice of kindling fires for the purpose of destroying contagion, may be traced up to the time of Hippocrates, who conceived that, in air vitiated by pestilential miasmata, he discovered the principle of the disease which desolated Attica, 330 years before the christian æra. Though the presence of an acid is very perceptibly manifest in fuliginous vapours and the smoke of wood, if we had no other proof than the pungent sensation which they excite in the eyes, it is probable, that in recommending large fires to be lighted in the streets, and before the houses, the father of medicine, as well as those who have followed this example, depended, in fact, entirely upon the disorganizing action of heat at a high temperature, such as that which in our analyses by fire, resolves into their elements animal and vegetable substances, and produces affinities which effect a total alteration of their properties. But this degree of heat is unattainable, when the space is not extremely confined; for, unless it be supposed that the contagious miasmata will spontaneously rush from a distance to pass through

through those scattered fires, the whole effect will be reduced to the displacing of a certain mass of air by successive rarefaction and condensation; without taking into account, that this momentary elevation of temperature, near inhabited houses, may be more injurious than useful. A writer upon the plague of Marseilles, states, that, large fires having been kept burning there for three days together, the atmosphere was obscured with a thick smoke which increased the natural heat of the season and climate, and “appeared to give additional activity to the contagion*.” I shall lastly mention in support of these reflections, the decisive fact, already cited in the historical part of this work (No. 6), relative to one of the cells of a prison, that is, a narrow space, containing at most about 10 cubic metres of air, in which, though three trusses of straw had been burnt in the evening, the putrid smell was not in the smallest degree abated on the following morning.

104. What I have said respecting the explosion of gunpowder as a means of purifying the air, requires no elucidation. It displaces, but

* Papon de la Peste, &c. tom. i. 234.

does

does not destroy, the odorous particles, by putting in motion the air which dissolves them. It may, indeed, to a certain degree, expel them from a confined space; but in the open air, it can only weaken their impression by diluting them in a greater quantity of the aerial fluid. In employing gunpowder in 1773, in the church of St. Medard of Dijon, my only object was to clear it of the aromatic scents with which it was filled, that I might more exactly ascertain the state and progress of the putrid emanations, and in this I completely succeeded; for in thirty-six hours after, the putrid smell was very plainly distinguishable, and soon became intolerably foetid*.

As it but too commonly happens, that those who have only a superficial degree of information, apply it improperly, it is right to observe in this place, that though the distillation of nitre actually yields a large quantity of vital air, there is no similarity of effect to be inferred from the detonation of the powder, because the presence of carbonaceous matter completely changes the products of its decomposition.

* Journal de Physique, tom i. p. 431.

105. It might at first view be imagined, that the same effects should be obtained from fumigations of sulphur, and exposure to the fumes of the sulphuric acid ; since, in both cases, it is the sulphur in a state of oxyd, which is brought into contact with the infected air. We have seen, however (Experiment xxiii. and xxiv.) that there was a very sensible difference. The fumigation of sulphur acted much sooner and with more effect ; of which I can see no other cause than that the heat produced by the actual combustion of the sulphur promotes that action, and perhaps urges it to a state of dry concentration which disposes it more readily to combination. In both cases, however, the conclusion to be drawn is, that this method ought to be employed only in purifying such articles as admit of immediate exposure to the sulphureous vapour. With this limitation, I willingly adopt the practice of Dr. Russel, in his description of Aleppo*, of fumigating wearing apparel with sulphur. Besides, this operation is so simple, and attended with so little expence, that it ought to

* Papon de la Peste, tom. ii. p. 119.

be recurred to without hesitation, when more powerful means are not accessible, and in places where it can be executed without any inconvenience. Vicq. d' Ayzr recommends it in his Instructions respecting the manner of purifying stables*; the Board of Health included it in the number of purifying processes for the cloathing and bedding in hospitals†; and I myself practised it with success in the little yards in the prisons of Dijon in 1774, in order to correct the insalubrity of the air.

106. What I have above stated on the subject of fumigation by the combustion of sulphur, might, without some farther explanation, induce several persons to place greater confidence in the use of perfumes than they deserve. It is certain that sulphur enters into several receipts for perfumes. That which obtains the preference in the latest work upon the plague, by Citizen Papon‡, admits it in the proportion of a seventeenth part of the whole composition. But it is merely sufficient to consider

* Instructions et Avis aux Habitans, &c. 1775. p. 24.

† Instruction sur le Moyens d' Entretienir la Salubrite, &c. 7 ventose, an. 2, p. 3.

‡ Tom. ii. p. 207.

the nature of the other fifteen ingredients, all of which are susceptible of forming more or less readily a carbonaceous residue, and among which we find neither nitre, nor any other substance capable of furnishing oxygen, to be convinced, that a part of this sulphur serves only as a match to determine the more instantaneous inflammation of the combustibles which form this composition; whilst another part produces an hydro-sulphuret, with the hydrogen disengaged from the resins decomposed by combustion; which products are undoubtedly very different from the fumes of the sulphureous acid.

107. We have seen that the three mineral acids, have in the course of this enquiry, confirmed the opinion which daily observation affords of their superior activity, and by which they are in general regarded as the most powerful instruments of destruction of every organic composition. They might be placed nearly in the same rank, were we to judge of their effects only at a certain degree of concentration, and in all cases where they can be immediately applied to the substances to be decomposed; hence the sulphuric acid, diffused in three parts of water, instantly destroyed all odour
in

in the mass of air with which it came into contact (Experiment xxv.); and there can be no doubt that the sulphureous acid itself, employed in a liquid state, would have produced the same effect.

It must not, however, be concluded that these acids all act in a similar manner: their modification is also very different relatively to the extent of the sphere in which they exercise their power; that is, according as they are more or less susceptible of assuming and preserving the gaseous state, which is as we have already seen, essentially necessary to their direct action on the air, in order to destroy the miasmata with which it is charged. Let us relinquish then immediately the sulphuric acid, which on account of its fixity is wholly unsuitable to our purpose, as well as the sulphureous acid, of which the spontaneous evaporation, although very troublesome from its odour, acts only in a very slow and inefficient manner upon those bodies exposed to its influence (Experiment xxiv.)

108. The nitrous acid indicates by its odour a very considerable expansive power; but its first effect on the air is to absorb a portion of its oxygen, or to take from it the principle which

which renders it fit for respiration ; and the precautions recommended by Dr. Smith to prevent, in his process, the formation of nitrous vapours, sufficiently show in what manner the sick were affected, and the danger which must inevitably have resulted to them had these fumes been more abundant.

109. The nitric acid was submitted to the greatest number of experiments, and gave rise to questions of the greatest importance. It was not employed merely with a view to ascertain whether it possessed the power of destroying putrid miasmata ; the general opinion of chemists accustomed to employ it for the purpose of decomposing the remains of animal bodies, had in this respect anticipated the researches of Smith, Menzies, and Keir. In order to institute a comparison between it and other agents, long ago employed to destroy infection, it was necessary to examine, First, To what degree we could render its preparation easy, and free from danger. Secondly, What would be the sphere of its activity, in the most favourable circumstances. Thirdly, Whether as asserted by Mr. Keir, it carried into the atmosphere a very great quantity of respirable air.

110. Ex-

110. Experiment xxvi. has solved the first question ; the care with which I operated authorises me to believe that it is almost impossible to disengage the nitric acid, by means of concentrated sulphuric acid, and heat, without the appearance of some red fumes from the very commencement of the operation. I have already observed that a proof of this is furnished in the report of Mr. Menzies.

I shall without hesitation acknowledge that we may, according to his method, prevent these vapours from incommoding the by-standers, by employing only vessels perfectly clean, the acid and nitre of the utmost degree of purity, by preserving an uniform heat in the sand bath, and carefully avoiding to carry the apparatus too near the faces of the sick ; but it is evident that these precautions are difficult to be fulfilled, even under the direction of an intelligent man, in the most common cases, and unless every thing necessary for carrying on the process be provided with particular care.

111. We are already acquainted with the difference of expansibility in the vapours of the nitric and those of the muriatic acid ; these last exist wholly in a state of gas, the volatility of which is augmented in proportion to

to the quantity of oxygen united with it, whilst on the contrary the former loses its smell and becomes more fixed, even in a high temperature, in proportion as its acidifiable base approaches towards a state of complete saturation. It was not after that difficult to foresee the result of Experiment xxvii, instituted in order to estimate its expansion from the heat employed in the distillation. In operating upon a quantity of materials equal to a fourth part of those employed by Mr. Menzies for the officers' ward, (Nos. 19 and 84,) the interposition of a volume of air about six cubic decimeters was sufficient to condense the vapours, which scarcely diffused beyond it a faint and inert odour. This does not invalidate the evidence in favour of the happy effects of these fumigations: but we are less surprised to see that notwithstanding the small height between the decks, it was found necessary to employ so great a number of pipkins, to repeat the process morning and evening, and that Dr. Smith should insist on its being performed twice every day. In fact, the contiguous air which these vapours had not reached, would quickly re-contaminate that portion which had been charged with them.

What then must occur in hospitals, the wards of which are very large, and the ceilings extremely lofty?

112. The question, whether the air, in which the vapour of the nitric acid was diffused, had really acquired an additional quantity of oxygen, is not so unconnected, as may at first appear, with the examination into the means of its purification, or the methods of preserving us from contagion, as will be seen in the sequel; but it is not difficult to resolve in the circumstances communicated by Mr. Keir; because the acid being supposed at the point of saturation, which equally excludes all excess of either the base or the acidifying principle, it necessarily follows, that a portion of oxygen cannot be liberated without a corresponding portion of azot assuming immediately the form of nitrous gas, or entering into some other more fixed combination. Here there is no decomposition of the acid, which is essentially requisite; and how indeed could it take place in the sense of the English chemist, so as to liberate at the same time, two fluids which should cease to exert the affinities which promote their rapid combination? And on the other hand, there is no substance assigned which

which has the property of taking from the acid a portion of its azot. Could this in fact be a super-oxygenation of the acid? This phænomenon is yet unknown; and were it possible in an operation where the excess of oxygen could only be furnished by the sulphuric acid or the water, this unexpected decomposition would be manifested by very sensible products, and the properties of which, wholly contrary to the object in view, would be either to neutralize the acid vapour, or re-absorb, in the second instant, the oxygen set free in the first.

I have thus reviewed all the suppositions, which, in my opinion, could give the smallest probability to the circumstance related by Mr. Keir. Not willing to have it said that I had combated his assertion by reasoning alone, I have adduced the evidence of facts, which will be found in perfect conformity with these principles (xxviii). Hence we are not only compelled to conclude, that the distillation of the nitric acid does not impart to the air an additional portion of oxygen, but that it is nearly impossible it should not be somewhat deteriorated, unquestionably from the accidental

meeting of some particles which are oxydated at its expence.

113. I now proceed to the consideration of the muriatic acid, which by its property of producing a permanent gas, and its great expansibility even under the form of humid vapour, indicates a very decided superiority over every other means of purification, that we have hitherto examined.

//4 It is known to every chemist of the present day, that if two flasks be placed side by side, the one filled with muriatic acid, the other with ammoniac, the moment they are opened, the conjunction of their elastic vapours will instantly produce a visible cloud. It has been already remarked (No. 4,) that it was this phenomenon, which occurs under the largest recipients, that first suggested to me the idea of employing this acid for the purification of infected air. I have related the happy effects produced by it both in France and in foreign countries; nevertheless I have not failed to compare, by direct experiments, its action on putrid air with that of other acids: I placed it in the most unfavourable circumstances by diffusing it in a great quantity of water, by bringing into contact with the putrid air only
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the small quantity of vapour disengaged from the spontaneous volatilization of a few drops of the acid, and by very much augmenting the volume of the air through which it had to pass (Experiments xxix. xxx. xxxi. xxxii); in all these experiments, it had a decided advantage, not only from its greater activity, and the rapidity of its effect, but likewise from the conveniency of the operation.

114. I have, however, the satisfaction to relate, that the progress of chemistry has bestowed on us a still more powerful means of freeing us from the scourge of contagion. The discovery of the oxygenated muriatic acid gas, which has been already so successfully applied, will become, I dare predict, the most certain and familiar preservative against this evil. We have seen, (Experiment xxxiv.) under this last point of view, how easy and advantageous its employment is rendered by the process I followed for several years, during the course of my experiments on putrid air. I likewise proceeded in the manner directed by Mr. Cruickshank, who was the first to introduce this practice into a large hospital; and the result has fully confirmed the relation he

has published, and the opinion I have already given of the superiority of this agent.

115. Had this opinion been singular, I should have been less astonished, that we had waited for the example of foreigners to instruct us in the use of this powerful preservative, in our civil and military hospitals, our prisons, and lazarettoes, and wherever contagion appeared. But the great antiseptic power of the oxygenated muriatic acid has long been a received opinion among the most enlightened men in France. To the proofs I have already given, I might here add what has been written on this subject even before the publication of the instruction of the Counsel of Health, by Citizen Hallé, in his *Researches on the Mephitism of Privies*, and by Citizen Fourcroy in the present volume of *Medicine Illustrated by the Physical Sciences*. I shall advert particularly only to a Dissertation in the form of a Thesis, maintained in the School of Medicine at Paris, the 19th of April 1791, by A. L. Guilbert, and which had for its particular object a new method of destroying infection, and perhaps even contagion*. The author does not confine himself to

* *Dissertatio Medica de Nova Infectionis, fortasse Contagionis destruendæ Methodo.* Paris, Quillau, 1791.

the consideration of the violence with which the oxygenated muriatic acid gas inflames metals in every temperature; the rapidity with which it thickens fixed oils; consumes those which are volatile, changing their emanations into sensible vapours; effaces colours; effects the complete destruction of odours; and decomposes ammoniac: he examines its action on animal matters, the constituent principles of which it quickly destroys; the constriction it produces on the skin; the manner in which it affects the pituitary membrane; its tendency to neutralize the septic miasmata diffused in the air, or adhering to infected bodies; and concludes that it ought to be regarded as the most powerful agent for the destruction of contagion.

116. This Dissertation, of which I had no knowledge when I instituted my experiments on putrid air, still furnishes an observation which altogether agrees with what I already stated (No. 94), of the good effects produced by the oxygenated muriatic acid. The author in dissecting a dead body with Citizen Vauquelin, employed this acid to destroy the hurtful odour which it exhaled. Besides, this is not a solitary fact; and if we could believe it possible, that this precaution is not become so

general as the safety of those employed in such operations demand, I am at least certain, that Citizen Chaussier, Professor of Anatomy in the School of Medicine, has for a long time been in the habit of employing it in his dissecting room. I shall have occasion to notice in the sequel, the new and very important information which he has communicated to me respecting its mode of action: but he has rightly judged that, notwithstanding the known efficacy of this preservative, it would be frequently neglected, if it required an apparatus every time it was necessary to procure it, or any particular attention to its preservation. For the trouble, however slight, and the expence, however small, being certain, will easily preponderate in comparison with a necessity which is merely presumptive. He has adopted the preparation which I have named the *extemporaneous oxy-muriatic acid*, by means of which this gas may be instantly obtained with the greatest ease.

I conceive myself even here warranted to draw the general conclusion, which is the design of this Treatise; but I shall first examine the influence possessed by oxygen itself in the processes of purification, and whether all kinds
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of contagious miasmata be equally subject to the action of the same agents. The discussion of these questions will not be foreign to our subject, and will furnish to us some observations proper to confirm the conclusions, or to direct their application.

The Influence of Oxygen in the Processes of Purification.

NO person, at the present day, can be ignorant that it is the presence of a certain quantity of oxygen which renders the air proper for respiration; but we are not thence authorised to attribute to it any medical virtues, any more than to aliments, which are likewise necessary to the preservation of animal life. The question must then be examined under a very different point of view, and in considering the action of oxygen either on the parts of animals, to which it is directly applied, or on the general habit, when it is introduced in a greater proportion than ordinary.

118. Since chemistry has made us acquainted with the particular nature of oxygen, its properties in different states of rarefaction and
condensation,

condensation, and, particularly, the qualities which it superinduces on those substances with which it enters into combination, many celebrated physicians have not hesitated to admit it into the number of those principles, the powerful action of which may produce those changes, which tend to attenuate the morbid matter, or to re-establish regularity in the animal functions, which are the effects of medicine. We have already seen, however, that Mr. Keir has refused to allow it any medicinal virtues; which may well cause some surprise, when it is recollected that he at the same time supposes, that the nitric acid, reduced to a state of vapour, augments, in the atmosphere, the quantity of vital air; and that he, in consequence, regards it as one of the most immediate causes of the happy effects resulting from fumigation with this acid.

It is surprising, that the English chemist should have lost sight of two indisputable truths, and which are irreconcilable with his opinion. The *first* is, that aliments, medicines, and poisons, are most commonly distinguished only by the proportion in which the doses are given; and shall then the quantity of oxygen, inspired or administered in any other

other form, become a matter of indifference! The *second* is, that of all the principles hitherto known, oxygen is the most simple, the most active, and that which changes most completely the sensible characters and intrinsic properties of all bodies; and shall it then be inefficient in disorders! What then is that which constitutes the curative virtue, that physical action of medicines, which physicians have with reason called occult, since they could only judge of it from experiment and observation, unless it is a change of combinations produced by affinities?

This occult action, said the celebrated Vennel*, forty years ago, *will be found to be chemical, if it shall ever be discovered*. What he predicted has already been fulfilled in part, with regard to oxygen; it is not a theory, it is the evidence of facts which has demonstrated, that oxygenated substances are medicinal in proportion to the quantity of oxygen which they contain, and the facility with which they give it out to animal matters: so that in the very extensive scale of medicinal agents, from the slightest alterative to the most powerful

* Encyclop. article *Medicine*.

corrosive,

corrosive, this circumstance alone denotes all the degrees, and explains all the differences. The proofs of this truth have been placed in the clearest light by Citizen Fourcroy*; and I could oppose to Mr. Keir the evidence of several of the most celebrated English physicians, such as Rollo, Cruickshank, Irvine, Beddoes, Jameson, Hope, Cleghorn, Currie, Trotter, &c. to whom this doctrine is by no means new, who are constantly enriching it with new observations, and some of whom have regarded it as sufficiently established to generalize its consequences, by dividing medicines into two classes, the *super-oxygenants* and *disoxygenants*.

119. An arrangement of remedies under one or other of these classes will not be here expected, and still less an indication of the circumstances in which they can be employed with advantage. Such discussions belong only to professional men. I ought not, however, to omit collecting those facts which have a more immediate relation to the process of disinfection, or of which the consequences are

* *Memoir on the Application of Pneumatic Chemistry to the Healing Art, and on the Medicinal Properties of oxygenated Substances*, read Fructidor, year 6, to the School of Medicine of Paris, tom. xxviii. of the *Annal. de Chimie*, p. 225, 281.

interesting

interesting to all who can open their eyes to the light of evidence.

It is commonly said that fire is an universal purifier: this familiar observation is true in one sense: the substances which have undergone its action preserve neither the same form, nor the same properties; but ideas either inaccurate or absolutely false are often attached to it. The first of these is, that there are substances impure of themselves, while the fact is that they only become so by combination or mixture with others; and immediately on being detached they become all equally pure. Silver combined with gold is impure, while their separation restores to each of these metals their original purity: the same is the case with all simple substances or chemical elements.

It is on the other hand supposed, that combustion is equivalent to destruction, while in effect it only changes pre-existing combinations by new ones: sometimes it forms compound substances of those that are simple, which in reality is rather to produce than to destroy.

A third error lies in considering heat as the principal, or even as the only agent in combustion; while it is ascertained only to be a particular effect, and often independent of the affinity

finity of the combustible body with the inflammable principle, or oxygen; so much so that combustion often exists without sensible heat, and that the latter is only necessary to produce that temperature at which the affinity operates.

Thus it appears, that it is oxygen alone which possesses the property of breaking asunder the bonds connecting the elements of organised matter.

120. About the year 1771, a long time before the facts were collected, which have left no doubt as to the existence of combustion without sensible heat, or in the humid way; when we possessed nothing but hypotheses for explaining the changes in metals produced by fire, the researches which I carried on into the nature of what was then called metallic lime, led me to examine, what was hitherto considered doubtful, whether mercury be calcinable. After having established, by decisive experiments, that this mineral is combustible*, I conceived that some consequences might be drawn from it respecting its mode of action

* Digressions Académiques, or Essays on some Subjects of Physics, Chemistry, &c. p. 221, &c.

in those maladies for which it is a specific. The examination of the state in which it was administered in all the different modes, and the observations which have ascertained the existence of mercurial globules in the bodies of those who have only taken it under the saline form, appear to indicate, with sufficient clearness, that it acts by undergoing the process of reduction*. This fact is no longer merely probable. Citizen Guilbert, in a dissertation already quoted, has established the principle, from a comparison of the effects of muriates of mercury on the human body, according to their degrees of oxygenation†.

121. Animal matters undergo from oxygen changes which cannot be mistaken, as the effect of a combustion more or less perfect. It is thus that the serum of the blood, the saliva, and the white of eggs, subjected to the action of the oxygenated muriatic acid gas, speedily coagulate; and, in proportion as this concretion advances, the acid resumes the state of ordinary muriatic acid‡. It is therefore to the

* Journal de Physique, tom vi. p. 351; Elemens de Chimie de l'Académie de Dijon, tom ii. p. 371.

† *De Novâ Infectionis destruendæ Methodo*, &c. § 18.

‡ Fourcroy, *Annales de Chimie*, tom xxviii. p. 258.

oxygen alone, abandoned by the acid, that this change is owing; and the acid serves only to convey it in a state which disposes it to a more intimate combination, without any necessity for increasing the temperature.

122. It was soon suspected, that the preparation known under the name of unguentum citrinum, derived its virtues from oxygen only, and that lard oxygenated by the nitric acid would produce the same effects as that oxygenated by mercurials. Citizen Alyon has often made the experiments; and his results followed up by the Commissioners of the School of Medicine, have proved that lard thus oxygenated was really anti-psoric, and anti-syphilitic*. Citizen Grille communicated to lard the same virtue, by mixing it with the oxyd of manganese; and its effects, on persons infected with the itch, were more sudden than those produced by the ointment of Pringle†. It is not then to the substance which conveys the oxygen that the cure should be attributed, it is the oxygen itself *which acts medicinally*. I here borrow the words of Citizen Parmentier,

* *Annales de Chimie*, tom xxviii. p. 273.

† *Annales de Chimie*, tom xxxiii. 76.

in a note which he published on the occasion of these experiments.

We are well entitled to entertain the same opinion respecting its anti-syphilitic virtue, when we see the nitric acid, substituted for mercurials, and administered internally in the same circumstances, produce perfect cures, and in a shorter time*. It is but little more than
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* Since the introduction of pneumatic chemistry, it has been suggested, that mercurial preparations owe their antisiphilitic power solely to the oxygen they contain: hence some physicians, led by analogy, have supposed, that other oxygenating substances would be found on trial to produce similar, or nearly similar, effects on the constitution. On these grounds, many experiments have been made with the different acids, and other substances, containing oxygen; the results of which, although not, perhaps, fully establishing an identity of action between them and mercury, at least warrant us to conclude *a fortiori*, that their operation must depend on their possessing in common the acidifying principle. Whatever difference of opinion, however, may prevail on this subject, the efficacy of the nitric acid, as well as similar remedies, in certain stages of the venereal disease, seems no longer questionable, although hitherto neither the extent, nor the permanency of their effects, has been sufficiently ascertained.

The results of several trials made under my own inspection, with the nitric and muriatic acids, in recent syphilitic affections, dispose me to think, with many others, that these acids are capable of effecting a cure in such cases.

I have exhibited them also in several cases of constitutional lues; but their use was not persevered in with sufficient regularity to warrant any positive conclusion. In one obstinate case, where the system was very much diseased, my expectations were certainly disappointed; but it ought in justice to be mentioned,

three years since practitioners placed sufficient confidence in the theory to make the experiment; and already the new mode of treatment is supported by the testimonies of Cruickshank, Irvine, Jameson, and Whittman*. The latter had recourse, in a particular instance, to the oxygenated muriat of pot-ash, which he administered thrice a day in doses of seven grains (45 centigrammes); he obtained the same success, and the symptoms evidently indicated

that mercury had been previously exhibited with an equal want of success. The pains of the bones were, however, greatly alleviated, and the patient improved in health and vigour during their use; but, although pushed to the utmost extent, they ultimately failed to extinguish the disease.

The various and contradictory statements furnished by medical practitioners on this subject, seem to render a still more enlarged and comprehensive induction of facts necessary in order to invalidate, or confirm, the anti-syphilitic power of the nitric acid, and other analogous remedies. The results reported by Dr. Beddoes, in his last communications, doubtless tend strongly to support the affirmative of this question; and which, if happily verified by future experiments, must remove every doubt respecting the efficacy of these remedies for combating this destructive disease, in all its stages; against which, the mercurial medicines usually employed, are often attended with so much inconvenience.

From a few trials I have made with the nitric acid, in icterical cases, it appears to me highly probable, that it will not be found less beneficial in such affections than in many others, to which the use of this valuable remedy has lately been extended. T.

* *Some additional facts in testimony of the efficacy of the nitrous acid in curing the Lues Venerea.* This paper is inserted in the second volume of Dr. Rollo's work on the Diabetes Mellitus.

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the progressive advancement to a happy termination.

123. Dr. Rollo, in his Treatise on the Diabetes Mellitus, relates a great number of facts which concur in establishing the medicinal virtue of oxygen. I shall here only attend to those in which this substance is observed to act directly on the contagious germs, and change materially their nature. Observations of this kind are too directly connected with the object I have in view to be passed over in silence. Having remarked that the morbid matter exsuding from ulcers was not merely an innoxious discharge, but that it acted evidently on the sores, he endeavoured to determine the nature of its action. The experiments which the celebrated Crawford had published respecting the matter of Cancers*, left him little doubt that it was the effect of chemical combinations. How else, indeed, could any probable explanation be given of phænomena which practitioners every day see going on under their eyes?

When venereal ulcers of the mouth are washed with a solution of muriat of mercury, a black crust is speedily formed.

* Philosoph. Transact. vol. lxxx. p. 391.

Plasters of the acetite of lead applied to sores, also undergo a change of colour, which indicates an incipient reduction of the mineral.

Polished metals are speedily tarnished, when exposed to the putrid effluvia of animal substances.

These effluvia communicate to fresh lard a green colour; they render the muscular fibres soft and flaccid; and very sensibly accelerate the process of putrefaction.

Silver probes introduced into sinuous ulcers, or carious bones, are frequently corroded as if plunged into sulphuret of ammoniac.

In cancerous or malignant ulcers, the purulent matter acquires as it becomes fetid the property of combining with metals, like sulphurets, and of decomposing the metallic salts by disoxygenating their base. This matter confined for a few days with mereury, renders its surface black; and instantly produces a black precipitate in a solution of nitrat of silver. Can it any longer be a matter of surprise, that the discharge from an open cancer should produce deleterious effects, and manifestly aggravate the disease? But if we can deprive it of its putrid odour, its tenuity, and all those properties which distinguish it from real pus, properties which it evidently derives from
from

the presence of some principle on which oxygen has so powerful an action, we shall have chemically destroyed, either by decomposition, a new combination, or perhaps by both in conjunction, the virus productive of animal disorganisation; and this is the effect which we may expect from oxygenating substances. It is proper to repeat here with Drs. Crawford, Rollo, &c. what I have elsewhere laid down as a principle (Nos. 54 and 60) that it is impossible to destroy entirely the odour of a substance without changing at the same time its properties. Dr. Crawford relates a very remarkable fact on this subject: the oxygenated muriatic acid poured, in sufficient quantity, on hemlock and opium, deprives these narcotics of their sensible qualities*.

124. Guided by these observations, and the consequences which they present, Dr. Rollo extended his views to the different kinds of ulcers. Independently of those which supervene on erysipelas, and of those known by the name of Hospital ulcer, because they appear in wards where there are many patients

* Philosoph. Transact. vol. lxxx. p. 423.

with

with sores, he thought he had discovered one of a peculiar nature, proceeding from a deleterious germ, which attached itself to a part of the sore, possessed in common with other poisons the property of assimilation, and thence derived an increased activity; but which nevertheless did not affect those of a specific character, such as venereal, scrophulous, and variolous ulcers: this *morbid poison* he attempted chemically to destroy, by topical treatment. Oxygenants appeared here to be particularly indicated; he therefore employed the nitrats of silver and mercury; above all he used the oxygenated muriatic acid, both in a fluid and gaseous state. The sores were soon cicatrized; and this treatment only failed where they were of such extent that they could not be compleatly reached by the nitrat of mercury, or the oxygenated muriatic acid gas*. To shew that the signs of chemical action kept pace with the curative effects, I shall add, with the author, that one of the ulcers having been sprinkled with a considerable quantity of well pulverised nitrat

* *A Short Account of a Morbid Poison acting on Sores, &c.* This Memoir may be found annexed to the work of Dr. Rollo on the Diabetes Mellitus, vol. ii. p. 255.

of mercury, twelve hours after the dressing the mercury formed a shining stratum, was solid, and seemed in part reduced†.

125. I could here add many other facts, which, when ascribed to their proper causes, equally concur in placing beyond doubt the medicinal properties of oxygen: there are some, the mention of which I reserve for the discussion of another question, and which may still farther serve to support this proposition. I shall conclude this article with some observations which were communicated to me by Citizen Hallé, in consequence of his hearing some fragments of this Treatise read before the Institute. These observations will discover at once the solicitude of a friend of humanity to extend the resources of the healing art, and the circumspection with which that intelligent physician delivers his sentiments respecting the effects it may be expected to produce.

In 1787, conjointly with Citizen Fourcroy, he had made trial of the oxygenated muriatic acid in the case of a woman attacked by a

† *Ibid.* p. 267. On this subject the reader may also consult vol. xxix. of the *Annales de Chimie*, p. 209., &c.

large cancer in the breast. They did not accomplish the cure of this ulcer; but the simple application of cloths dipt in this acid produced a remarkable change: the fœtor became less offensive, the colour improved, and the discharge became less serous*.

126. The following are the new observations of Citizen Hallé on the internal use of the oxygenated muriatic acid, prepared with the oxyd of manganese.

“ From one observation, which has been thrice made on two persons attacked by phthisis pulmonalis, it appears that the hectic fever was suspended as often as the oxygenated muriatic acid, diluted in a sufficient quantity of water, was employed; and that one of the patients, sinking under pulmonary suppuration, died without having had diarrhœa, a symptom regarded as inseparable from the last stage of this disorder†.

“ In another case, the head-achs and obstinate rheumatic pains which appeared to be

* Annales de Chimie, tom. xxvii. p. 26.

† The use of acids in Phthisis Pulmonalis is not conformable to the theory which considers hyper-oxygenation to be the cause of this disease; for as it is well known that the system may be oxygenated through the intervention of the stomach as well as pneumatically by the lungs, it must inevitably follow, if an
excess

be the effect of long continued anatomical labours on putrid subjects, and which had been in vain combated by the most efficacious means that circumstances could indicate, suddenly disappeared from the moment that this preparation was used.

“ I employed (continues Citizen Hallé) the strongest oxygenated muriatic acid, with which Citizen Pelletier could furnish me. I diluted

of oxygen be the cause of phthisis, and the effects of acids be owing to the action of this principle, that their use cannot fail to accelerate the progress of the disease. Experience, moreover, seems to confirm the truth of this reasoning, for although all the mineral acids unquestionably possess a tonic power, and tend to improve the appetite and promote digestion, as well as to restrain the colliquative discharges to which phthisical patients are so frequently subject, yet their ultimate effects appear extremely problematical.

In that variety or species termed the florid consumption, the vitriolic acid under different forms has been generally employed; but according to the observation of the late Dr. Withering, and other practitioners, its use when long persisted in seldom failed to produce an aggravation of all the symptoms. If these observations be well founded, and the operation of the different acids be nearly identical, they certainly suggest an important caution respecting the indiscriminate employment of such remedies in different cases of phthisis, whether incipient or confirmed. To the want of a due discrimination of the various states and shades of this disease, between different cases of which there, perhaps, exists a more essential difference than is usually allowed, not less than to an inefficient and injudicious employment of curative means, seems justly ascribable the discordant sentiments of practitioners, respecting the efficacy of æriform fluids, digitalis, as well as various other remedies.

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diluted it in such a manner as only to produce a slight sensation of constriction in the throat. More than a litre of water (nearly 1.06 pint) is necessary to reduce to this point 15 grammes (half an ounce) of the acid: this quantity I caused to be taken in the course of twenty-four days. I had previously made trial of it myself; when it produced no other disagreeable effect but the feeling of constriction which I have mentioned; and I seemed to experience an increase of appetite, and a more rapid digestion. The testimony of the patient has not tended to weaken this impression."

127. When speaking of the internal use of the oxygenated muriatic acid, it is proper to

As the immediate operation of oxygen is doubtless to increase the action of the sanguiferous system, the same objections will still more forcibly apply to the inhalation of vital air in diseases arising from morbid irritability of the lungs: upon the first trials with this gas, the patients, it is true, frequently appear to experience relief, and to breathe with greater ease and freedom, but these favourable appearances are soon succeeded by an aggravation of all the symptoms, which, it seems probable, may either arise from the absorption of the ichorous virus generated by the combination of the acidifying principle with the purulent matter of the ulcers, or from the great proportion of caloric communicated by the vital air to the animal system. But however hurtful the inspiration of oxygen gas has been found in pulmonary affections, facts and observations have sufficiently established its utility in all those diseases which either proceed from or are accompanied by a defect of animal heat and a languid circulation. T.

observe

observe that it ought to be prepared with much more care than when it is only to be inhaled in a state of vapour, or employed in fumigations, to prevent those accidents which Dr. Crawford relates, and which were owing to the presence of an extraneous substance. Having taken twenty drops of this acid diluted in water, he soon felt himself affected with an obtuse pain, and a sense of constriction in the stomach and bowels, which only yielded at the end of some days, to the use of laxatives, and water saturated with sulphurated hydrogen gas. He recollected that the oxyd of manganese, on which the acid had been distilled, contained some particles of lead; and he afterwards learned from Dr. Ingenhousz that the same thing had happened to a Dutchman, who had for some time taken a considerable quantity of the acid, and whose life was endangered by the violent effects which it produced; he therefore recommends the internal administration of the oxygenated muriatic acid, only where it is prepared with oxyd of manganese, which chemical tests have proved perfectly free from lead and every other metal*.

* Philosoph. Transact. vol. lxxx. p. 420.

To this I shall add that we ought equally to guard against substances, which, without being metallic, may communicate pernicious qualities to this acid in a liquid, and even in a gaseous state. Of this description is the fluat of lime (fluor spar), which is sometimes found in the native oxyds of manganese. Since the acid during distillation carries over with it a portion of these substances, we cannot be certain that it abandons them entirely when we furnish it a base, as when it is converted into oxygenated muriat of pot-ash; the same attention is then necessary in the choice of manganese.

128. It is probable that it was an accidental mixture of this kind which occasioned the accidents that have been observed in some cases. But no consequence can hence be drawn which can weaken what has been established respecting the medicinal virtue of oxygen; since this virtue is an essential property of it, and since the vehicles in which it is given serve only to condense it, and enable it to act with more or less intensity. I can here again oppose to Mr. Keir the testimony of his celebrated countryman Dr. Crawford. "The fluids (says he) which destroy fetid odours most speedily, are those

those which are acknowledged to contain the greatest portion of oxygen; it is therefore extremely probable, that this change depends on the union of the oxygen with animal hepatic gas, or some one of its constituent parts." The proofs which he has collected entitle him to speak more decidedly; a proof more direct or more decisive cannot be desired than the fact which he relates immediately before this conclusion. He had mixed a quantity of vital air with putrid gas, and having left them in contact, after a few weeks had elapsed, the fetid odour was destroyed; he only found the odour of the hydrogen gas, which is disengaged during the dissolution of iron, in diluted sulphuric acid*.

Oxygenants, and particularly the oxygenated Muriatic Gas, considered as Preservatives against Contagion.

129. THE first object ought, doubtless, to be, to investigate the most effectual remedy, and to bring it immediately in contact with

* Philos. Transact. vol. lxxx. p. 422-3.

those

those corpuscles which propagate the contagion, for the purpose of destroying in the air, and wherever it may deposit itself, the composition which exercises this destructive property. But is there no other salutary effect which we may promise ourselves from the most active oxygenants, when the necessity of precautions is not yet sufficiently felt to overcome that indolence which stifles the feeling of danger; or even when the means of attacking the source of infection through the whole extent of the sphere in which it diffuses its pernicious influence, are not at our disposal? This question seems to merit a particular examination.

130. It is an opinion universally admitted, or rather an observation repeated as often as epidemic or contagious maladies have appeared, that among those who are the most exposed to the influence of their causes, or to the communication of the virus, there are some who escape the disorders altogether. This observation would be less striking, if it only applied to diseases produced by certain states of the atmosphere, by the quality of different aliments, or even by invisible exhalations; but numerous and irrefragable testimonies furnish us

us with similar instances in all disorders, without even excepting those which suppose immediate contact or inoculation. On this subject the celebrated Mauduit thus speaks in a memoir, sent to Petersburg in 1776, on experiments to determine the nature of pestilential virus, to combat its effects, and to arrest its progress*.

“ If, among men equally exposed to the plague, a small number do not contract it at all; if, of two persons inoculated with the same variolous matter, the one take the small-pox and the other do not; if, of several people bit, even until blood flows, by the same animal in the same paroxysm, none of them having applied any remedy, some of them are seized with hydrophobia, and others escape; if it is sufficient for some to touch the clothing of a person affected with the itch to contract the disorder, while others may with impunity sleep in the same bed with him; if debauchees escape from repeated dangers which they set at defiance, while the greater number suffer for a single act of indiscretion, may we not reasonably presume, that those who escape

* Journal de Physique, tom. ii. p. 104.

dangers under which the majority sink, possess a constitution diametrically opposite to the nature of the disorders which they escape?"

131. What may be the nature of this constitution? The learned physician, whom I have quoted, has not been able to characterize it. He merely conjectures that in those subjects a particular humour circulates in the blood, which acts as the *antagonist* of the poison it destroys. It is easy to see that he was destitute of an expression derived from modern chemistry; for admitting with him this destruction, it could only be the result either of the decomposition of this pestilential matter, or of its combination with the humour which it excites into action; but in both cases it must be by the mutual affinity of these bodies that the state of their combinations is changed. No one will here suspect me of wishing to detract from the reputation of a man, whose uninterrupted labours have been constantly directed to the good of mankind: I only enter into his views when I remark, how necessary accuracy of expression is to the progress of science, and how many errors a mode of expression may produce that is opposed to fundamental doctrines. Some, even at the present day, assert, that

that affinity is a force by which similar bodies attract one another, without considering that, were this definition just, it could produce nothing but an aggregate of greater volume: others again regard chemical action as the only effect of substances of opposite natures, since acids and alkalis have very different sensible properties which disappear in the neutral compound produced by their union. But it is high time to substitute for these vulgar traditions, principles recognized by all naturalists.

132. It may be proper to remark besides, that it is rather facts, than an explanation of them, which I have sought; and it will be acknowledged I could not have derived them from a better source, since I had not proposed to myself to collect merely vague testimonies. When I have done this, I shall have little difficulty in persuading my reader that it is not a particular humour, pre-existent in a healthy subject, which destroys the poison, but that it is rather a state of debility, an incipient change of the humours, already approaching disease, which renders some individuals more susceptible than others of the impression of the contagious virus.

It is a principle adopted by the author of the article *Plague* in the *Encyclopédie*, that all bodies are not susceptible of its virus, that it only affects those of which the fluids and solids are disposed to receive the infection; and that *if a body has not this disposition, it will resist its influence.*

“ Different states of the body,” say the physicians who have given a description of the malady of Cadiz, “ have a more particular pre-disposition to receive the action of contagion. This being of a septic nature, acts after the manner of a ferment; and when it produces in the humours a tendency to putrid fermentation, it renders the individual more susceptible of epidemic contagion; it is on this account that they are more common and more fatal in hospitals, ships, and prisons*.”

133. The author of the remarks which accompany the French edition of this report, has collected several examples in support of this principle, that the effects of contagion are in some sort subordinate to the pre-disposing causes; he coincides in opinion with those who

* Rapport sur la Maladie Epidémique de Cadiz, traduit de l'Espagnol, par F. P. Blin, Médecin en chef des Armées, &c. p. 18.

apply this principle even to the plague. "It is universally acknowledged," says he, "that it does not always break out in those places into which the pestilential matter has been imported. It is well known, that a certain state of the atmosphere is necessary to favour its appearance, and that it never exercises such cruel ravages as when the constitution of the atmosphere is favourable for the developement of its posion*.

134. This doctrine has, however, found opponents; and they have drawn their principal objection from the fact, that it was among soldiers, sailors, and the most laborious class of the community, in which the most robust men are found, that contagious fevers committed the greatest ravages; which is as much as to suppose that there is no pre-disposing debility but what arises from a weak constitution. They seem to have overlooked those numerous circumstances which may induce this disposition, by secretly undermining the

* He cites on this subject J. Guintherius, *de Pestilentia*, &c. J. Taino, on the Plague of Milan; Turiano, on that of Messina; and the following passage from the Dissertation of R. Mead *De Peste: cum vero aeris inclementia sparso stimulos addit contagio, summâ ibi furere vehementiâ observatur.*

strongest constitutions; such as, habitual confinement in a crowded place, the want of wholesome food and clothing, and the excess and long continuance of fatigue. It is precisely because this disposition may proceed from numberless different causes which act together or separately, and which affect subjects differently constituted, that we have good grounds for only considering here the effect which is common to them all, and which is the diminution of the vital power. Thus we see that those who have combated this truth, have not attempted to substitute in its room any probable explanation of the very unequal risks incurred by those surrounded by the same contagious atmosphere*.

135. Amidst the number of facts which throw light on this important subject, there are some which appear, at first sight, to establish consequences opposite to the principle which I have just laid down; but on examining them with a little attention, in place of furnishing any objection, they will be found,

* Mr. H. Owen has declared himself a partisan of this system in a Dissertation on Contagion, printed in the fourth volume of the *Thesaurus Medicus* of Edinburgh p. 359, &c. He acknowledges, however, that physicians of the first eminence are of a different opinion. *Multi medici admodum spectabiles existimant homines, nisi prius fuerint debilitati, vix contagioni patere.*

on the contrary ~~but~~ strengthen and confirm the proofs already brought forward in its support.

It has been often remarked, that workmen employed in tanneries, in the preparation of skins, intestines, and animal gluten, &c. who continually breathe an air charged with putrid exhalations, enjoy a sufficiently sound state of health, while strangers cannot, with impunity, approach the places where these fetid substances are manufactured*.

There are maladies besides very formidable to those who arrive in some countries, which do not attack the inhabitants. Citizen Blin, in his Remarks on the Report of the Physicians of Cadiz, has mentioned many instances of this, from the observations of Makittrick, Bontius, Prosper Alpinus, and Dr. Lind. Of this kind is the bilious fever of the West Indies, which Europeans contract, and from which the natives and those who have been long accustomed to the climate are exempt†.

“ How did it happen that the *Sweating Disease*, a most fatal epidemic, which made

* Vanswieten, *Comment. in Boerhaavii Aphorism.*

† *Incolas vel Climati assuetos nunquam affligit.* Makittrick de *Febre Maligna Biliosa Americæ.*

its first appearance in England, attack, in the Low Countries and France, those English people who had for some time left their country to avoid its ravages, while it spared strangers who resided in England? The reason must have been, because the English, in quitting their native country, carried with them their mode of living, their habits, and their temperament." Such is the answer given to this question by Freind in his History of Medicine, when supporting it by a similar observation of Evagrius on one of the most memorable plagues of Constantinople, and by the learned translator of Hippocrates's Treatise on Air and Water*.

The yellow fever, which lately made such ravages in Andalusia, has given rise to a similar observation, and which is still more striking as it respects persons arriving from foreign parts, in whom habit seems happily to have changed the disposition to receive the disorder. The physicians of Cadiz thus express themselves on this subject: "The heat and constitution of the atmosphere, during the preceding summer, have been similar to those which annually prevail in the Antilles; hence, it is

* A new translation by Citizen Coray, vol. ii. p. 151.

obvious how those who had lately arrived from these islands were preserved: they had been habituated to a similar temperature, while the inhabitants of Cadiz fell victims to the disease, from a cause the inverse of that which takes place on the Continent of America, and the neighbouring islands*."

136. To prove how far the force of habit will extend, it is not necessary to repeat what the ancients have related of some men who were so familiarised to the most violent poisons, that they could take them with impunity in quantities sufficient to destroy a number of the most robust men. It is sufficient to substitute for these marvellous traditions, what is every day observed from the long continued use of opium, quinquina, &c. of which it is necessary, from time to time, to augment the doses to obtain the same effects. The case seems to be similar with those kinds of aliments which lose their unwholesomeness to those persons who are accustomed to them. This was a matter of such importance, in the opinion of Hippocrates, that he has placed in his Aphorisms the injunction not to change habits,

* Report on the Malady of Cadiz, p. 19.

even though hurtful, but by a gentle transition to those that are salutary*.

137. It will now be easy to answer the proposed question. Doubtless, no one will venture to assert that habit exercises, on the contagious miasmata, a chemical action which changes their properties; they remain the same, but they no longer make the same impression on our organs; and it is the disturbance in the animal economy, caused by this impression, which produces what is called pre-disposition. It is of no importance whether it originate from the natural debility of the individual, his privations or his excesses, from a regimen habitually bad, or from an unusual state of the atmosphere; the nature of the pre-disposing causes is a matter of indifference, the effect is the same; it is always some diminution of the vital force that renders the resistance unequal, and the action of the poison efficacious. This pre-disposition may take its rise from a moral affection, as well as a physical impression. At all times the sight of multitudes, a prey to death and terror, has been reckoned a pre-

* *Ex multo tempore consueta, etiamsi deteriora fuerint, incon-
suetis minus molestare solent. Oportet igitur ad inconsueta trans-
mutationem facere. Aphor. L. sect. ii.*

disposing

disposing cause from which even the strongest minds have been unable to defend themselves. Hence it is, that those who have treated of the means of preservation from the plague, and of arresting its progress, have so strongly recommended cheerfulness and amusement, and the preventing of the removal of the dead by day; and, in short, the avoiding of every thing that might augment the terror of the people*. Some have even ventured to assert, that this terror augments the activity of the contagious virus; which can only mean that the danger of being attacked is augmented by the great number of those who are disposed to receive the infection, not that the nature of the miasmata has undergone any change. A different opinion would suppose, that the action of thought had some influence on external objects.

But why have recourse to abstract reasonings of this kind, or even to researches after the possible causes of a change of properties which does not exist, when the resistance of

* J. P. Papon, *on the Plague*, &c. vol. ii. 42, 53, 68.—In the article *Plague* in the *Encyclopédie*, it is mentioned, that Thales of Crete is said to have stopped the ravages of a plague at Lacedæmon by communicating joy to the inhabitants. At Marseilles, fear destroyed more people than the contagion.

the morbid matter may receive an explication so simple, and accurately chemical, from its relation to one of those general phænomena which are daily reproduced under our eyes, in an infinity of different operations? For example: the facility with which the sulphuric acid attacks aluminous earth is well known; but the latter has a degree of aggregation which opposes all combination, without supposing any change in the acid: the vigorous state of the healthy man is a force of aggregation.

138. When we are brought to acknowledge, that in the search after means to protect from the impression of contagious miasmata, the essential, and, perhaps, the only object which we ought to keep in view, when we cannot remove from the source of infection, should be to support and augment the vital force, the choice of these means cannot be difficult: oxygenants possess the desired property in the highest degree.

Many trials of oxygen gas have been made in the cure of phthisis, they were far from answering the hopes entertained of them. Most physicians even regard this gas as dangerous in a disorder accompanied by an inflammatory disposition,

position, where the heat and action are already too powerful, and where clinical experience rather indicates the necessity for a lowered atmosphere than the too pure air of elevated situations. This is the opinion expressed by Citizen Fourcroy, in a memoir read to the Society of Medicine in 1789*. It is easy to foresee, that he would deduce from the same principles, the consequence that vital air may be useful in all affections characterized by a feeling of cold, and by sluggish action: he points out several cases in which it had been administered with success: the description which he gives of its beneficial effects is very remarkable. "These manifested themselves," says he, "by a sensible augmentation of the heat of the skin, by the return of colour to the countenance, and the acceleration of the pulse: these symptoms increased so much, that at the end of a few weeks from the use of vital air, there resulted a true febrile action, and a general increased activity of the solids†.

139. In the same year Citizen Chaptal administered oxygen gas to two phthisical pa-

* See *Annales de Chimie*, tom iv. p. 83.

† *Annales de Chimie*, tom iv. p. 21.

tients at Montpellier, and we find the same observations and views in a letter which he addressed, on the subject, to Citizen Berthollet. His patients experienced a sensation of heat, which, from the chest, diffused itself over the whole body, and appeared gradually to stimulate their languid system; but the event proved that the use of this gas is only proper when it is necessary to animate and recruit an enfeebled organ; the relief which it afforded in a case of humoural asthma justifies this opinion,

140. No one can be ignorant, that when an animal is enclosed in a receiver filled with oxygen gas, its respiration is accelerated, its breast is sensibly dilated, and its heart and arteries contract with greater force and quickness than in the natural state. Such are the effects to be desired, when we fear lest a state of debility should favour the action of the contagious germs on some of our organs. They will be salutary only when restrained within proper limits; for, as the celebrated Macquer has well observed, oxygen gas would expend the principle of vitality in as short a time as it destroys combustible bodies.

141. A method has been lately fallen upon of administering oxygen under a liquid form,
by

by forcing water, by means of compression, to take up this gas to the amount of nearly half its volume; water thus prepared has been recommended as a tonic calculated to restore the appetite and the strength*.

All compositions, into which oxygen enters, possess similar virtues; and often in a higher degree than when it is exhibited simply in a gaseous state, by caloric. Of these the oxygenated muriatic acid holds the first rank; as it absorbs the gas in greater abundance, or, at least, parts with it more easily; and as it also produces those effects in the shortest space of time. We have seen that Citizen Hallé had himself experienced that a small quantity, considerably diluted, was sufficient to accelerate digestion (No. 126). If to this observation we add what this learned physician establishes in another place, that vital air is the principal instrument of the combinations by which assimilation is effected, and that the substance of the aliment becomes animalized, whilst the animal substances loses its excess of animalization† we shall easily perceive the ad-

* Bibliothèque Britannique, tom. viii. p. 113.

† Theoretical Essay upon the Animalization and Assimilation of the Aliments; *Annales de Chimie*, tom ix. p. 158.

vantages which must result from this regular process of nature, and the means of restoring it whenever it begins to be impaired ; since this excess of animalization, if not the only immediate cause, is one of the surest causes of the putrid disposition.

The oxygenated muriatic acid attached to a base, cannot be supposed to exercise so strong and prompt an action. Citizen Van Mons, however, experienced in himself that the super-oxygenated muriat of pot-ash produced an exciting and stimulant effect over the whole of his system, to such a degree that his skin assumed a redder and more animated appearance, his pulse became more frequent, and his spirits more active*.

142. I conceive that I have collected a sufficient number of facts and testimonies to establish, beyond the possibility of doubt, that oxygen, and the substances capable of being used as vehicles for this principle in a state favourable to new combinations, really excites the action of life, augments the heat, re-invigorates the powers, awakens the sensibility of the organs, and thus imparts to all the move-

* Annales de Chimie tom. xxviii. p. 266.

ments that regularity which preserves order in the different functions of the animal economy. We have already seen in what manner these effects become anti-contagious or preservative, by obviating the dispositions which render the system accessible to the morbid matter*. As a final illustration of a point of so much importance, I cannot do better than refer to the words of Citizen Chaussier, Professor of Anatomy and Physiology in the School of Medicine, who has himself frequently practised the acid fumigations in the hospitals, (No. 14), and who constantly uses in the dissecting rooms, what I term the extemporaneous oxygenated muriatic acid (Nos. 93 and 116). In a note which he transmitted to me in consequence of a conversation between us

* Citizen Guilbert, in the Dissertation already cited, upon a new method of destroying infection, seems to have depended only upon the constriction of the pores for excluding the contagious miasmata, which shall not have been neutralized by the oxygenated muriatic acid, when he observes, §. 22: "*Et si corpus illo acido ablueretur, constricti cuticulæ poruli, contagioso effluvio transitum recusabunt.*" After perusing what is above stated, I should hope that its properties will not be confined to this object alone. It is besides easy to see that, instead of a preservative of familiar use, it would become, by the manner of administering it, one of those remedies which are resorted to only in cases of imminent danger.

upon this subject, he expresses himself as follows :

143. " The living animal possesses a principle incessantly active, existing in all the parts, and communicating to them sensibility, mobility, and the power of experiencing the impression of different bodies applied to their surface; an impression which augments or diminishes the vital action proper to each part. Let us examine, according to this consideration, what should be the effect of fumigation upon the living being.

" The oxygenated muriatic gas in a state of vapour, carried by respiration into the nasal and pulmonary cavities, dispersed in the atmosphere we breathe, or introduced by deglutition into the stomach, acting in a word upon all the surface of the body, is an unaccustomed stimulus, which augments the action of the organs and excites their sensibility.

" The effect of this stimulation being an increased action in the part, the circulation is there quickened; the secretions which are going on over the whole surface of the body, become more abundant, and by this means it is secured from the impression of the morbid miasmata which are, as it were, expelled in proportion

they correct infected air, and destroy the principle of contagion. This is the object of the fumigations with the oxygenated muriatic acid. Should some noxious particles escape its chemical action ; should the means necessary to perform this process be wanting ; or, in short, should the danger not be so alarming as to enjoin these extraordinary precautions, it may, in such cases, be used as a preservative. Such is the point of view in which I conceived it ought to be considered in this section, and which seemed to me more deserving of attention, as, this conclusion being once admitted, it is impossible to suppose, that any one will henceforth imprudently expose himself to the slightest appearance of contagion, when the means of security are attended with so little trouble and expence.

I have promised to state, in the concluding part of this Treatise, the manner of employing this powerful anti-contagious remedy, and also such others as, in its absence, may, under certain circumstances, produce equally happy effects ; but I must first call the attention of my readers to a new question of as important interest, inasmuch as the result of the

the examination will tend to enlarge or contract the sphere of its application.

Are the same Means applicable in the different species of Contagion?

145. The experiments which I have detailed, having been made upon the products only of animal putrefaction in its last stage, and particularly upon air impregnated with them, it is fair to ask whether the agents whose efficacy I have demonstrated, would act with equal power upon contagious principles of a different nature. It would, I admit, be in direct opposition to evidence, to suppose that all the disorders, capable of being communicated by those labouring under them to persons in a state of health, have their common cause in a similar matter; whilst the symptoms which attest their presence assign peculiar characters to each, and whilst they are so various in number, such as the itch, small-pox, venereal disease, plague, hydrophobia, &c. the propagation of which manifestly depends upon a specific virus. But it is not in this first view of the subject, that we are to seek for the solution of the question.

146. Admitting the distinction justly established between diseases that proceed from certain emanations dispersed through the atmosphere, and which are termed epidemic because they attack the multitude who receive their impression, and those that are contracted by immediate contact only with a matter also frequently invisible, but more fixed, and sometimes by the inoculation of the morbid virus ; it must at once be acknowledged that the first are the most habitually prevalent, the most difficult to guard against*, and those with respect to which the necessity of pre-

* The difficulty of avoiding the influence of contagion seems not so great as some authors suppose. Clinical observations have fully established that febrile contagions operate only within a very limited sphere, and that by a proper attention to ventilation and cleanliness, the danger of infection from pestilential and other malignant fevers of a typhoid type may be generally avoided. Thus it is well known that in crowded apartments where the air has become highly vitiated, infection is almost unavoidable, but in chambers tolerably ventilated it very rarely occurs, and is never propagated in the open air, unless when the contagion is extremely powerful. While, however, we consider these facts as irrefragably proved, we cannot acquiesce without limitation in the position of those who assert that clothes and other articles cannot imbibe the contagious virus to such a degree as to be capable of imparting it; for, although individuals may from the influence of habit be able to brave with impunity for a long time, an atmosphere charged with contagious miasms, their clothes will yet frequently convey them, especially if they have been kept closely shut up in chests or drawers, and not subjected to the action of the air or other purifying processes. T.

servatives

servatives and anti-contagious remedies is chiefly felt. Now in this class are ranked the hospital, jail, and ship fevers, that which is caught in the vicinity of marshes; where, to use the figurative expression of Jaucourt, *putrefaction ferments*, and in short all the malignant fevers which owe their existence to putrid exhalations.

It would therefore, of itself, be a service of very great value to mankind, to put them in possession of sure means of preventing the return of such calamities, or of stopping their progress in the very commencement. But here two considerations present themselves of a nature to give those means a more extensive application.

147. The first is the necessary consequence of the principles established in the preceding section (Nos. 137 and 143), that the action of the most decidedly contagious species of virus does not equally affect all the individuals exposed to it; but that it depends upon an infinity of predisposing causes, of which the immediate and certain effect is the diminution of the vital force. There no longer remains any exception. The most imprudent cohabitation sometimes occurs without any injurious effect;

effect; particular constitutions even resist the inoculation of the purulent matter: and amidst the most extensive ravages of the plague, a small number of those who are employed in the most assiduous attendance upon the sick, always escape the danger*.

It is therefore unnecessary to enter into an examination of the question, which has been so much agitated, whether the contagious miasmata can be conveyed by the atmosphere, whether that fluid cannot, at least, transport them to a short distance, or whether they cannot be communicated but by immediate contact†. It will doubtless be conceded that, under

* Of this we have striking instances in the dreadful plague of Marseilles, which destroyed 87,766 persons, and in that of Moscow; which carried off 133,299.

If it be true, as M. Samoilowitz assures us it is, that such as have once completely recovered from the plague, are never after subject to it, we may hence derive a new demonstration of the effect of predisposing causes, entirely analogous to what we are already furnished with by the inoculation with viriolous and vaccine virus. As the poison, though retaining its original virulence, ceases to act on the living system, it necessarily results that the latter must have acquired the power of resisting it. See *M. Samoilowitz's Letter to the Academy of Dijon*, &c. p. 53.

† According to Mauduit, the plague is propagated by miasmata, of which the atmosphere is the vehicle. Prosper Alpinus, Forestus, and Schreiber have furnished observations favourable to this doctrine. Pringle and Dr. Smith speak as if they had not

under all the hypotheses, the most urgent considerations will be to prevent the dispositions which renders their impression fatal : and this is an advantage which may still be expected from the oxygenated muriatic acid gas, though it should be found incapable of decomposing some of these poisons.

148. The *second* consideration which seems to me to indicate a more extensive application of this oxygenating gas, rests upon a fact of which as many proofs may be enumerated, as there are descriptions of the maladies which at different epochs, and in particular countries, have deeply afflicted humanity. Whatever be the character and cause at the moment of the first attack, the quantity of putrid effluvia constantly produced by the numbers of the sick and the rapid putrefaction of the dead bodies*, soon forms a fomes of infection, which sensibly heightens its malignity, aggravates its symptoms, complicates its progress,

not the smallest doubt of the possibility of communication without contact ; while Samoilowitz absolutely denies it.—See the *Works already cited*.

* In an epidemic disorder at Cadiz in 1764, it was observed that putrefaction took place so very suddenly after death, that at the end of six hours the dead bodies emitted an insupportable stench.—*Dr. Lind on the Diseases incident to Europeans in hot Climates*.

and frequently terminates in presenting the most dreadful obstacle to the cessation of the mortality.

It would be superfluous to repeat in this place what I have already remarked on the authority of those who have written upon the well known plagues of Milan, Messina, &c. (No. 133) that it is always a particular constitution of the atmosphere which determines the invasion, accelerates the communication, and renders the consequences so fatal. This fact is certainly sufficient to recommend the means destined to combat these constitutions,

149. The yellow fever of America which last year so cruelly ravaged Andalusia, will furnish us with an example of another kind. Opinions are still divided upon the question whether it be, or be not contagious. The physicians of Cadiz do not hesitate, in their report, to assign it this character, and before them Warren and Lining came to the same determination. Citizen Blin, in his Remarks upon this report, maintains the contrary opinion, which he supports by the authority of Lind, Makittrick, Moultrie, and almost all the physicians who have resided a considerable time in the West Indies. Among the observations

vations which he has collected in favour of this conclusion, the two following seem deserving of particular attention :—" It does not appear that the contagion of the Yellow Fever at any time affected the Anglo-Americans beyond the atmosphere of the cities. Those who were already attacked, escaped the dangers of the Yellow Fever by an immediate removal to the country*."

It must be obvious that it is not my intention to take a part in this controversy, nor to decide between such opponents ; but it is necessary for me to show that, notwithstanding this difference of opinion, they agree upon the facts which indicate the necessity of preventing and correcting the infection of the atmosphere, both in the diseases which proceed from general as well as from specific contagion. I shall take my proofs from their publications upon this subject.

150. " It is not surprising," say the physicians of Cadiz, " that on perceiving the symptoms we have described, and those which appeared in the progress of the epidemic disease, we should have been led to characte-

* Report relative to the Disease of Cadiz.

terize

terize it as an epidemic, malignant putrid fever: for, if in the commencement some of the cases were accompanied with symptoms of synocha, they soon degenerated into putrid and nervous fevers, which were propagated from one to another; proving contagious to some from the immediate effect of the original cause, and to others from the effect of the putrid miasmata which exhaled from the sick; and these causes operating more powerfully on habits already debilitated, or in robust but timid subjects, very soon engendered an extreme malignity, and rendered these fevers destructive in the highest degree*.”

In this account, drawn up by professional men who traced the progress of this dreadful malady, may be easily discovered all the circumstances that contributed to prolong its duration, and to multiply its victims. It must tend to impress even those who have the least information, with all the advantages that may be expected from vigorously combating the pre-disposing causes and the foulness of the atmosphere. Let us now examine whether they would be justified in forming a contrary decision, by following the doctrines of those

* Report relative to the Disease of Cadiz, &c. p. 41.

who

who do not conceive the disorder to be communicable by contagion.

151. The author of the Remarks upon the report of the physicians of Cadiz, has embraced this opinion, and supported it by an able discussion. Still, however, after comparing together the characteristic symptoms of the Yellow, Camp, and Hospital Fevers, &c. he adds, “ the greatest part of these fevers are epidemic, and frequently assume even a contagious appearance, either from the particular miasmata that accompany certain constitutions of the atmosphere, or from the peculiar exhalations which proceed from a great number of sick crowded into a narrow space, and which contaminate the atmosphere so as to render it insalubrious.” In every case, therefore, we find powerful reasons for opposing the progress of infection, and for regarding the accumulation of these miasmata as capable of producing a new disease, by rendering that contagious which was not so originally.

But, as if the author dreaded lest his opinion should be so misinterpreted as to justify an imprudent neglect of salutary precautions, he has prefixed to his work a notice, which contains the following remarkable passage: “ I
ought

ought to premise that, in refusing to the disease of Cadiz the character of being contagious, in the strict sense of this term, I did not mean to assert, that this fever when once extended to a great number of subjects, might not, like the jail, camp, and hospital fevers, communicate itself to many persons, *in consequence of the contagion which so great a number of patients must have produced in the atmosphere.*"

152. Thus it appears, that the most terrible, and at the same time the most common species of contagion, is that which is produced by a great number of persons affected with the same malady, whatever may be its character or origin. Surely it can no longer be a matter of doubt where the remedy should be applied, after being compelled to admit that the evil consists in the corruption of the atmosphere; and, since we can neither refrain from its use, nor avoid its impression, all our views and hopes should be directed to the means of purifying it, by decomposing the putrid effluvia with which it is impregnated. In such melancholy circumstances, instant recourse should be had to the acid fumigations, and particularly to fumigation with the oxygenated muriatic

muriatic acid, which has been proved to contain this valuable property in the highest degree.

Having conducted the discussion to this point, I might dispense with examining, still farther, whether there actually exists any contagious virus capable of resisting the action of this acid, and appeal to the results of the trials actually made for a complete demonstration of its efficacy in every case; as there is not one in which it cannot at least accomplish some of the most essential indications. But, if it be possible to anticipate the measure of its power, so as to destroy every doubt, to remove every ground of uneasiness, and to induce complete confidence in its application, to do so would be to accelerate the benefits which mankind may derive from it; and I ought not to stop short until I have attained this object.

153. Were we to suppose that some of these specific poisons exist in a state of composition, or aggregation, capable of impeding the operation of the affinities of the oxygenated acid gas, it would undoubtedly follow, that notwithstanding our having corrected the impurity of the air, destroyed the putrid effluvia with which it may be accidentally charged, and subjected

subjected to the process of fumigation every thing liable to receive its impression, we should still remain in a state of insecurity; since the most diminutive of these invisible particles, floating in the atmosphere, or deposited on the walls, furniture, or clothes, would become the destructive germ of disorder to him who should come in contact with it. Fortunately, theory and observation are equally repugnant to this supposition.

154. No principle or seed of contagion exists in a simple state; substances of this nature are capable neither of multiplication nor reproduction: and how can any doubt be entertained of their reproductive power when we see the pus of a variolous patient, the bubo of one affected with the plague, give birth to other germs of the same kind, capable of infecting thousands of individuals. If then it is a compound substance, the elements of which are collected by the animal organization, it must be subject to the common law of all animal products. It is impossible that it should resist combustion; and such we have seen was the result of the action of oxygen and the muriatic acid gas, which seems to direct the whole mass of the oxygen it contains upon all
the

the bodies subject to its affinities (Nos. 119, 120, and 121).

It has been hitherto found impossible to penetrate the secret of nature in the formation of these terrible compositions (No. 67); for those vague suppositions of a free phlogiston, an essential caustic, volatile arsenical salt, alkaline ferment, &c. so arbitrarily assumed in defining them, are totally unworthy of attention; and we have no cause to regret those times when an emulation of creating, instead of observing, gave rise to so many systems, which shrunk into obscurity in consequence of a strict logical examination. But when the analogy is striking, we may be permitted to employ it, so far at least as to endeavour to convey some idea of that which surpasses all that the imagination can add to our ordinary conceptions. In considering the developement of contagious poisons, it must excite astonishment, that a particle so small, as frequently to be invisible, should so rapidly derange all the functions of life in a person of the most robust constitution. Should we not experience the same feeling on perceiving those inflammations without fire, those combustions without heat, those sudden instances of disorganization,

ganization, and all the phænomena produced by the oxygenant muriatic acid, were we not acquainted with its composition before observing its effects? But chemists, being instructed by the very processes employed in preparing it, could not remain ignorant of the cause of their activity. They clearly perceived that it was to oxygen, at once condensed and feebly retained, they had to attribute this extraordinary energy.

Let us proceed in the enquiry by the faint light which it reflected upon the subject, by the comparison of cause and effect. It is no longer an unknown substance, a new element which impresses its character upon contagious poisons; it is nothing else than an increased activity of one of the simple principles which so much abound in all animal substances. It is unnecessary to enquire any farther into the origin of this increased activity. It may be naturally explained by the familiar rule, that the more free the bodies are, which have an affinity for each other, the more powerful is the affinity; and by an example no less astonishing, the measure of this power is to be found in the union of the two simultaneous conditions of condensation and weak combination.

nation. It is, therefore, extremely probable, that it is azot condensed, but at the same time slightly attached, which forms the principal character of all contagious poisons; that they become specific from the particular nature, and different proportions, of the substances which serve as their vehicle; but that their grand energy is, in every instance, the necessary result of the action of this principle in a state hitherto but little known—in one word that it depends upon a real *super-azotation*, as that of the muriatic acid does upon super-oxygenation.

Should new enquiries tend to give this solution that complete proof which we have a right to expect, from every thing that we already know of the results of the animal analysis, the products of putrefaction, the formation of ammoniac and nitrification, nothing farther will be wanting to establish a solid theory, respecting the successful action of oxygenants in every case of contagion.

155. Let us now attempt to establish the same conclusion upon direct observations: facts speak to a greater number, and the consequences drawn from them are more generally intelligible.

The variolous virus is one of those of which the specific contagion is most strongly characterized. Mr. Cruickshank tried to inoculate two subjects with a portion of this virus, after mixing it with the oxygenated muriatic acid; the insertion produced no effect, while the other portion communicated the variolous eruption*. It is impossible to obtain a more convincing proof that its morbid property was radically destroyed.

156. I have already remarked, that practical observations prove beyond the possibility of doubt, that it is the oxygen of mercurials which, in disengaging itself from the metal, destroys the composition of the syphilitic virus (No. 122). Of this fact Dr. Swediaur has collected fresh proofs in addition to those already contained in the works of Brassavola, T. Bonet, Schenckius, Fallopius, &c.† Still, however, an experiment might have been required of the same kind with that which I have stated

* Annales de Chimie, tom. xxviii. p. 271.

† "A complete Treatise on Syphilitic Diseases, &c." In some of these cases, the facts are so evident, that nothing but scepticism, proceeding from the grossest ignorance, can refuse its assent. Such is the opinion pronounced respecting it by the learned author of this Treatise, one of those who have most examined the medicinal properties of oxygen.

respecting

respecting variolous pus: this has been furnished by M. Harrison. This physician took the matter of an ulcer, evidently syphilitic, mixed it with the oxyd of mercury in mucilage, and then tried whether it would communicate the venereal disease by inoculation; *the result was that no infection took place*, though another portion, taken from the same ulcer, and inserted in its original state, produced a venereal ulcer, and several other symptoms of that disorder.

157. The hydrophobia is still regarded as incurable, when its peculiar virus has penetrated the mass of the blood. Shall we thence conclude, that there is no agent capable of destroying it? We might as well deny that water possesses the property of extinguishing flame, because it does not rebuild a house which has been consumed by fire. The author of the Dissertation, to which the prize was adjudged in 1783, by the Medical Society of Paris, has shown that this virus may be attacked with success in wounds, into which it has been introduced by the bite of mad animals, before the supervention of fever from the local nervous irritation. He attempted the treatment of them upon this principle, "*that*

*the true antidote is that remedy which attaches itself to the poisonous substance by the laws of affinity**; and what is the specific which he prescribes as founded upon decisive observations? —one of the most powerful oxygenants, the sublimated muriate of antimony (butter of antimony). It is also recommended in a work, which has been since published by two professional men who had an opportunity of observing its effects†. Citizen Fourcroy did not hesitate to assert that the oxygenated muriatic acid, “which, in consequence of the oxygen with which it is surcharged, exercises so sudden an oxydifying action upon mixt combustibles,” might destroy the hydrophobic virus in the wounds wherein it was deposited‡.

It is unnecessary to revert to the psoric virus. What I have already stated (No. 122) sufficiently proves, that it is completely destroyed by the action of oxygenants. But have we any reason to hope, that among these powerful re-agents there are some which act

* Dissertation on Canine Madness, by M. le Roux, Surgeon-major of the General Hospital of Dijon, &c. p. 19.

† Method of treating the Bite of Mad Animals, &c. by Messrs. Enaux and Chaussier. Dijon 1785, p. 39.

‡ Annales de Chimie, tom xxviii. p. 271.

in like manner upon pestilential virus strictly so called? Such is the important question, with the examination of which I shall conclude the present section.

158. If we were to form our opinion from its duration, we should be led to think that the virus which communicates the plague, must be the product of a very solid composition. From the observations reported by Sydenham and Van Swieten, it appears that it may remain a considerable period in a state of inactivity without losing its morbid properties. According to the latter, the plague of Vienna, 1713, broke out in the very same houses which had been first infected in 1677, and proceeded from the same purulent matter which had been preserved in them for thirty-six years.

Some have conceived, that in the various instances of plague which have occurred, the disease has not been of the same nature. But Dr. Mauduit did not permit himself to be imposed upon in this particular by the authority of Sydenham, who declared himself in favour of this opinion. In the history of plagues, from the time of Thucydides to the present, he perceived, with the greater part of authors, that they had all the same origin, and produced

the same effects, without any other difference than such as might have been observed in the pestiferous symptoms of the same epoch. The result of the profound reflections of this physician upon the means of combating this calamity was, that experiments must be instituted, in order to ascertain the positive nature of its virus, either by inoculating animals with it, or by mixing some of the pestilential virus with different substances*.

Unfortunately these experiments are yet wanting, and we must acknowledge that they are as difficult as dangerous. Whatever the physicians of Marseilles may have said, it is still very doubtful whether dogs, which may certainly carry about the contagion, are susceptible of receiving it even by inoculation; whether this proceeds from the figure of the absorbing pores, and the texture of the skin, as Mauduit thinks, or whether it be connected with the more general principle, supported by frequent examples, and which Dr. Samoilowitz applies particularly to the plague, that animals of the same species catch diseases by infection,

* "Experiments to be instituted in order to determine the nature of pestilential virus, &c. *Journal de Physique*, tom ii. p. 120.

which

which do not act upon animals of a different species.

159. The trial of the virus of the plague, submitted to the action of anti-contagious matters, cannot be regarded as decisive, unless an inoculation has been made without effect, as we have seen in the case of variolous pus, and syphilitic virus; and this will be impossible, until we know an animal naturally disposed to receive this malady, and which may therefore be a proper subject for such experiments: for no man would dare to propose the risk of communicating to a human being a disorder so terrible. The very circumstances in which Dr. Samoilowitz has thought that the insertion of this virus would become a preservative, could not justify such temerity; since this would be an object foreign to the preservation of the individual.

It is, besides, proper to observe, that this virus does not discover itself by any sensation of which the absence or diminution might enable us to judge of the progress of its decomposition. If it made any impression on the olfactory nerves, the supposition would be ill-founded that the contagion could not be conveyed by the air; and a great number of con-

curing testimonies seems to have settled this point*. Thus we can obtain no aid from odour, that characteristic which constantly accompanies putrid emanations, and the changes of which we have seen become the certain indications of the destruction of the odorous particles.

160. Not that I would wish to dissuade those, who may have the opportunity, from trying the experiments recommended by Dr. Mauduit; or pretend that no light can be derived from the mixture of pestilential pus with different re-agents; but when he supposes, that these trials would confirm the opinion which he had formed of its *alkaline nature*, from considering that the plague had its origin in hot countries, that its symptoms were similar to those produced by alkalies on the animal economy, and that the most successful remedies partook of an acid nature; that the bodies of those who died of it fell rapidly into

* The reader may see what I have before said, (No. 147). I am not ignorant that some still admit, that the air may convey the plague *to a very small distance*; this is the opinion of Dr. Black in his History of Medicine, &c. but he does not exclude the necessity of contact, since, in a space so circumscribed, the motion of the air may transport the particles of the matter in a fixed form, and not in a state of solution.

a state of putrefaction, disgusting even to the carnivorous animals; and when he had obtained a proof that the matter which flowed from the buboes of the patients, changed vegetable colours like ammoniac and neutralised acids, must we hence conclude with him, that acids are a specific in this disorder, conformable to the maxim *contraria contrariis curantur*? We must, doubtless, answer in the affirmative; and the physician, acquainted with modern chemistry, would still be entitled to demand whether this alkalescence were not rather the consequence than the principle of action of the contagious virus. Observations scattered through the works of Pringle, de Haen, Gaber, Gardane, &c. have long since demonstrated that, at a certain stage of the putrefactive process, all animal substances give signs of alkalescence, in what state and manner soever they may have ceased to form a part of the living body.

161. If it be true, as Dr. White asserts, and Mr. Smith supposes, that the plague may be produced by an accumulation of putrid effluvia (Nos. 26 and 61), its nature is sufficiently known; since there cannot be, at least in its origin, any specific principle which enables it
to

to resist the ordinary agents of *their* decomposition. Let us not conceal, however, that this would only be to prejudge the question, and that it may be resolved by facts better established, and on principles more solid.

When the clothes or furniture of a person dead of the plague are burned, does any one suspect that the virus, with which they were infected, can be found entire in the ashes? All agree that it is destroyed by combustion. But if this be also a combustible submitted, like the others, to the affinities of the oxygen of the atmosphere, on what ground can it be thought that it will resist the condensed oxygen of anti-contagious substances which produces so speedily the most astonishing combustions, and which is the most *inflammable* body we know in nature? It is only necessary then to apply the definitions which I have formerly established (No. 154), to pronounce, without waiting for unnecessary trials, that the virus attacked by the superabundant oxygen of the muriatic acid, will be as completely consumed as by fire supported by other combustibles, and accompanied by a heat which liberates the oxygen of the air, by destroying its gaseous force. This
luminous

luminous theory is at present generally adopted by physicians.

162. I should address those to whom this doctrine is not familiar, in other terms, and say to them: It is a fact but too well authenticated, that a letter coming from a person infected with the plague, may convey a sufficient quantity of the virus to communicate this dreadful malady; it is on this account that letters received from suspected countries are passed through vinegar. But when submitted to this operation, you handle them without fear, because you trust that the virus has been destroyed (No. 100). I need search no farther for proofs of the possibility of this destruction: your habits, formed after the example of all mankind, are founded on this principle, and manifest a conviction of its truth. Compare, however, and merely in their sensible effects, the agent which affords you this security, with that powerful antidote which the oxygenated muriatic acid presents. On the one hand, you have a liquid placed in the lowest scale of antiseptics, which only produces on our senses the effect of a slight stimulant, which seasons rather than alters sapid substances, which, applied to colours the least fixed, produces a new combination without

without separating their elements, and of which the action, always slow, is only efficacious on those bodies that are soaked in it. On the other hand, you have a subtile fluid which, once disengaged from its affinities, bursts forth by its own internal force, diffuses itself speedily over the most extensive chambers, leaves nothing untouched, and touches nothing that it does not appropriate; which radically destroys colours, tastes, and smells the most offensive; which spontaneously inflames oils, sulphur, and metals*; which, in short, destroys the texture of all organised matter, and of which no animated being can receive the slightest impression, without being informed of its presence by an unusual sensation.

163. Such is the grand instrument of disinfection which modern chemistry has brought to our knowledge, and which it has taught us to manage without danger, and with the certainty of obtaining salutary effects. I do not suppose there can remain any doubt, that the virus of the plague, wherever it may lurk, and under whatever form it may disguise itself, will be rendered inert by the energy of its ac-

* See Annales de Chimie, tom vi. p. 249.

tion;

tion; as we have seen happen to every kind of contagious virus that could be submitted to its operation. And if the reader has not lost sight of the other advantages which may be derived from it, whether for preventing those predispositions that expose us to contagion, or to dispel those collections of putrid effluvia that are the inevitable effect of great mortality, and are often the most obstinate cause of its diffusion, he will readily conclude with me, that of all the means of preserving from the plague or arresting its ravages, hitherto proposed or employed, none presents such powerful motives for confidence; and that nothing less than the most stupid indolence, the most culpable indifference to the sufferings of humanity, can any longer neglect to employ it, and to promulgate its success.

164. Thus the application of principles the most evident, the results of experiments the most decisive, the consequences of observations drawn from the most authentic sources, all concur to establish this general conclusion: If the air which supports animal heat and life, sometimes become the source of the most cruel maladies, from the miasmata with which it is charged; if, at a certain stage of putrefaction
of

of the animal fluids, there is generated contagious virus, the germ of pestilence, our progress in the study of nature has placed preservatives at our disposal, æriform fluids which restore to the air its salubrity, agents sufficiently powerful to deprive these destructive germs of all power of developement. Such are the properties of oxygen, of super-oxygenants, of acid fumigations, and, above all, of the oxygenated muriatic acid gas. It now remains for me to point out the mode of its preparation, and to direct the choice and employment of it in different circumstances.

FOURTH PART.

An Enumeration of the Preservative and Anticontagious Agents, and on the Manner in which they should be employed.

165. I have not confined myself to recommend those means of disinfection, which have appeared to me to merit the most entire confidence, I have also endeavoured to appreciate

ciate all those that have been hitherto employed; and I have carefully distinguished those from which some advantage may be obtained, in certain circumstances, from those which it is necessary to abandon, or rather irrevocably proscribe, as only occasioning the loss of valuable time and expence, as distracting the attention from the only safe precautions, and fostering a fatal security. It will not be useless here to recapitulate in a few words what I have mentioned more at large, and to assign to each the rank which it merits, before I describe the process which sound theory, direct proofs, and confirmed success should henceforth cause to be regarded as super-eminently anti-contagious.

166. Warm or cold *water*, employed in ablu-
tion, may carry off the contagious matters,
and disperse them, so as sensibly to diminish
their fœtor in the same manner as it weakens
any solution by diluting it; but what it leaves,
as well as what it carries away, is not decom-
posed, and has only changed its vehicle. Wa-
ter, in which putrid gas has been agitated,
contracts and preserves the putrid odour, (No.
37) without the air which was impregnated
with it indicating any sign of amelioration.

Dr.

Dr. Crawford, in the well devised train of experiments which he made on cancerous virus, and on the fetid gas of putrescent meat, has proved that water which was impregnated with it, and which retained part of it in a dissolved state, still preserved the same odour, and presented the same chemical phænomena, till he had produced a decomposition of this gas, by the concentrated nitric acid, or the oxygenated muriatic acid, a decomposition which was announced by the precipitation of a white gelatinous substance; whence he concluded, that it is precisely the soluble part of these effluvia that is most deleterious*. In short, *even leys have not prevented linen clothes from sometimes communicating the infection*†.

167. Lime is only useful in decomposing animal substances before putrefaction has begun, or in absorbing the carbonic acid; lime recently slacked, and profusely scattered, will, for a time, suspend cadaverous effluvia‡; air,

* Philosoph. Transact. 1790, vol. lxxx. p. 397, 403, &c.

† Papon, *de la Peste*, &c. tom ii. p. 86.

‡ This is the effect which took place on the exhumations at Dunkirk in 1783. See the *Collection of Pieces*, &c. printed the same year.

charged with putrid miasmata, was not freed from them by passing through lime-water (Nos. 41, 62, and 63). My experiments agree in this respect with those of Mr. Cruickshank, who has stated that the fœtor of the matter of ulcers was a little changed, but not destroyed by lime-water*.

168. *Resinous substances*, even those which give out a volatile acid on distillation, in whatever manner they are employed, only mask for a moment the contagious odour, without purifying the air, and without destroying the contagious corpuscles (Nos. 96, 97, 98, 99, and 106).

169. *Fires* occasion currents of air, which may carry off and disperse putrid vapours when collected and confined in a circumscribed space, but beyond this they are rather hurtful than salutary: they can only decompose the putrid effluvia within the sphere of their activity, when carried to the degree of actual combustion (No. 103). The celebrated Mead regarded this as of very ambiguous efficacy during the time of the plague.

* Annales de Chimie, tom. xxix. p. 217.

170. No advantage can be expected from throwing different substances on *live coals*. Either *pure* or *aromatic vinegar* thus employed, is rather burnt than evaporated (No. 100). *Nitre* itself gives out only unrespirable gases, after having served by its oxygen to augment the intensity of the fire. Similar effects result from the employment of *gunpowder*, the explosion of which merely exerts a mechanical action on the air. (No. 73.)

171. *Sulphur*, operates very differently, its combustion being never complete, and producing only the first stage of oxydation ; whether lighted or thrown on live coals, it emits a sulphureous acid vapour, which acts powerfully on the miasmata within its sphere; its operation, however, is limited to a small distance, and it is altogether inadmissible in places which are inhabited ; but it may be employed with advantage, in order to destroy infection in goods and merchandize that are not easily injured (No. 105), and to purify the air in confined places, such as the small courts of hospitals during the night. For this purpose we form a kind of lamp by putting powdered sulphur on an earthen plate, with a very small match in the middle, on lighting which it is necessary immediately to retire.

172. *Common*

172. *Common vinegar*, or the *acetous acid* may be ranked amongst the best purifiers for substances that admit of being immersed in it, or which may be well washed with it : but it is not sufficiently volatile, either when cold, or even with the aid of heat, to be employed with advantage in the fumigation of confined apartments (No. 100).

173. The *pyro-ligneous acid* has an action very analagous to vinegar, but still more feeble*. (No. 102): neither can we hope to derive greater advantages from that which is disengaged by the actual combustion of certain ligneous substances. It is indeed susceptible of being diffused through a much greater space when the fire is managed in such a manner as to produce more smoke than flame; but in this case it is rendered much less active from the fuliginous particles which accompany it; and the heat ceasing, it very soon subsides without leaving the air sensibly ameliorated.

174. Frequent fumigations with *acetic acid*, or *radical vinegar*, cannot be carried on in extensive apartments without incurring a very considerable expence; but although it does

* See note p. 135. Tr.

not ascend much farther during distillation than common vinegar, its action on infected substances is more rapid and intense (No. 101). The strong and penetrating odour which it emits at all temperatures, not only serves immediately to change the condition of the surrounding air, but affords at the same time a powerful stimulus to the organs of respiration, by which means the vital powers are supported in a degree of energy capable of resisting the impression of contagion (No. 101). Thus in every case where it cannot act on the original source of infection, as in lazarettoes, the wards of hospitals, and in prisons, it will be found an useful and cheap preservative, and ought not to be neglected by those who are frequently obliged to expose themselves to noxious emanations, at least it would be extremely imprudent to put the trouble of carrying a small phial of this acid in comparison with the chance of security it affords.

175. It is well known that the *mineral acids* are in general *anti-septic*, that they check both animal and vegetable fermentation, and are capable of decomposing contagious virus ; but their mode of action is so very different that we are obliged to exclude some of them as
useless,

useless, or even dangerous, and to regulate the choice of others according to circumstances.

The *sulphuric acid* cannot, on account of its fixity, serve to purify the air ; it changes very rapidly the bodies with which it comes into immediate contact ; Dr. Crawford has observed that even when it is concentrated, it does not so readily destroy the odour of animal hepatic gas, as the oxygenated muriatic and nitric acids ; and according to Mr. Cruickshank, it increases rather than diminishes the fœtor of malignant ulcers*. The *sulphureous acid* in a liquid state produces very little effect ; and it has already been mentioned what is its action in a state of vapour, as arising during the actual combustion of sulphur. The *nitrous acid* acts only on the respirable portion of the atmosphere, and the vapours exhaled from it are highly suffocating.

The *nitric acid* disengaged according to the process of Dr. Smith, most certainly destroys putrid miasmata, but it cannot be diffused to a great distance, is readily condensed, and only acts as an oxygenant by giving out nitrous gas ; a frequent repetition of the process is

* An Account of Two Cases of Diabetes Mellitus, &c. vol. 2. p. 276.

likewise

likewise necessary to insure its success, even in a small apartment ; in a word, much caution is requisite not only in the choice of the materials, but also in the performance of the process itself (Nos. 109, &c.). I mention not here the consumption of nitre, which must be perfectly pure, and consequently of a very high price, since this were to suppose such a consideration might be put in competition with the preservation of human life.

The muriatic acid presents the greatest advantages in this respect from its prodigious expansibility, as it is of essential consequence to bring it into immediate contact with the substances upon which we wish to produce a change. Since the experiments I made with it in 1773, it has been found every where to produce the most happy effects by men capable of appreciating its value, at least in the opinion of the most learned societies. It will be seen in the sequel, that the manner of using it is equally simple and cheap, and that this process has the still farther advantage of being performed with less risk of fire, than that of Dr. Smith ; since no greater heat is necessary than what is produced from the mixture of the ingredients.

By

By adding during the operation a small quantity of the oxyd of manganese, the *oxygenated muriatic acid gas* is procured, which may be regarded as the most certain preservative from contagion, and which is still farther recommended by the ease with which it may be applied in all cases.

176. Among the number of substances susceptible of a rapid evaporation, and which are capable of producing all the salutary effects of the most powerful super-oxygenants may be ranked the oxygenated muriat of tin (*liquor fumans Libavii*) which was first proposed by M. Vicq. d' Azyr, in 1780, as a preservative from the danger attendant on exhumations; what renders the sagacity of this physician more conspicuous is, that he had foreseen at the time not only the true nature of this fuming salt, but also the action of oxygenants on putrid miasmata*. After having recommended above all, the acid fumigations as employed by me, he adds, *we might* employ with the same intention the fuming liquor of Libavius. This

* Report on several questions proposed to the Royal Society of Medicine, on the precautions necessary to be taken on digging up the vaults intended for sepulchres, in a church on the Island of Malta, p. 36.

saline substance, to which the authors of the chemical nomenclature, adhering strictly to their plan of proceeding on facts alone, could only give in 1787 the name of fuming muriat of tin, is now well known. Citizen Adet, in a Memoir read to the Academy of Sciences in 1788, has demonstrated that it is a combination of tin with the oxygenated muriatic acid, in the highest degree of concentration*; and the experiments of Pelletier have furnished new proofs of this fact†.

Such is the property of this liquid salt, that it is not possible to open a flask in which it is contained, without all the attendants being very soon affected by the irritating vapours which are spontaneously diffused in the air, and of which the effects are immediately rendered evident from the coughing which they produce.

I shall not here detail the mode of its preparation, which is well known to every person acquainted with pharmacy, as it may be easily procured by those who intend to em-

* Annales de Chimie, tom. i. p. 5.

† Memoires de Chimie, de B. Pelletier, tom. ii. p. 383.

ploy it as a purifier without the trouble of preparing it themselves, which would be altogether useless, since it is sufficient for their purpose to allow a momentary disengagement of its vapours, in order to experience their stimulating impression, whilst, at the same time, they act on the contagious miasmata diffused in the air.

It ought here to be mentioned that this liquid should be kept in flasks closely stopt, and that it frequently causes the stopples to adhere so much that it is necessary to break the necks of the bottles. This inconvenience will doubtless induce us to prefer those preservatives which are more easily applied, and likewise produce less violent sensations; but it should not be forgotten that these qualities indicate a greater degree of energy; that there are cases, as in pestilential contagion, in which it cannot be carried to too high a degree, and in which we should be justly reproachable for a timid circumspection in our attempts to discover remedies against evils, for which none have yet been found.

Description

Description of the Anti-contagious and Preservative Processes.

177. THE processes for correcting the insalubrity of air charged with putrid emanations, for destroying contagious miasmata, and securing us from their impression, are founded on those principles which have been already detailed; but conceiving that these processes, as well as the quantity of the materials, should be varied according to local circumstances, and the object we propose to accomplish, it yet remains for me to treat of this practical part of the subject. Let us stop for a moment to consider the most simple process, *fumigation with the muriatic acid*.

When it is intended to purify the air in the chambers of infirmaries, the wards of hospitals, in close places after exhumations, where animal matters have been allowed to putrify, or where some individuals have died of epidemic or contagious maladies, and which are not inhabited, we place a chafing-dish in the centre, and on it an iron pot half filled with siliceous

liceous sand or ashes. On this bath must then be placed a large glass vessel*, containing muriat of soda (*common salt*), and when this begins to be heated, sulphuric acid (*oil of vitriol of commerce*), should be poured on the salt †; after which the doors and windows must be kept as closely shut up as possible for seven or eight hours.

To determine the quantity of materials necessary for the intended purpose, let us suppose, for example, a large lofty ward or apartment containing twenty beds, it would require of common salt thirty decagrammes, (about nine ounces six drachms), sulphuric acid twenty-four decagrammes, (about seven ounces seven drachms). We suppose here the salt not perfectly dry, and the concentration of the acid to be 1.7, that is weighing 17 grammes in a bottle equal in capacity to a decagramme of water.

These quantities must be augmented or diminished, in proportion to the space in which

* This may be supplied by a garden bell-glass, or a vessel of porcelain or stone-ware.

† The acid should be previously put into a glass vase with a large opening, and poured on the salt at once, otherwise we shall be much incommoded by the vapours, which never fail to be raised during the operation.

they

they are intended to act. Experiments have demonstrated that three kilogrammes of salt are sufficient completely to purify, and by a single fumigation, the air in a church, the capacity of which is about 15,000 cubic metres, or 2023 cubic toises, (No. 5). A chamber of the size of between twenty-five and thirty square metres, will require no more than ten decagrammes of salt and eight of acid.

178. Such is the method in which fumigations may be practised, when no particular consideration renders it necessary to restrain either their duration or intensity, and when it is intended they should at once produce a complete purification. They must, however, be conducted in a very different manner, in places which are inhabited, where it is often necessary to carry them near to the beds of the sick, and where they must be repeated, at certain intervals, in proportion to the more or less rapid reproduction of the contagious emanations.

In very extensive wards, instead of a large apparatus, several small ones should be employed at different points, each containing only four or five decagrammes of salt, upon which may be poured two-thirds of its weight of sulphuric

sulphuric acid; since it would be altogether useless to effect the entire decomposition of the salt, the vapours which are first disengaged being sufficient for our purpose.

179. In this case the method employed by Citizen Chaussier, in a large military hospital which we have already mentioned (No. 14), is very advantageous. He causes the apparatus, containing the salt, to be carried round the apartment, upon which * the acid is poured by degrees, so that the extrication of the vapours may be made to take place at any point, and in any quantity that is judged necessary, without the smallest inconvenience to the sick. With this view, we must be provided with a small portable chafing-dish containing live coals, whereon must be placed a pipkin of earthen or stone ware, or what is usually termed a Hessian crucible; into this vessel we put a quantity of common salt, in proportion to the space to be acted on, and after it becomes somewhat heated, a few drops

* We have already seen (No. 18), that Mr. Menzies conducted the fumigations with the nitric acid in a similar manner, except that he first heated the acid, and afterwards threw in the nitre in divided portions, doubtless fearing that otherwise it might be partly decomposed by the heat. In our method it is not carried to that degree which can produce any decrepitation in the salt.

of the acid is poured in, and repeated occasionally whenever the vapours cease to be raised.

The only part of the process which, though not difficult, requires some attention, is least the acid, the necessary quantity of which must each time be regulated by weight, should be brought into contact with animal or vegetable substances, or even metals; but this may be superseded by the employment of a flask of such a size as to contain the quantity of acid requisite for every operation, and into which it must be poured by means of a glass funnel.

180. There are circumstances wherein the employment of a chafing-dish might give just cause of apprehension, for example in ships, on board of which fumigation ought to be frequently practised for purifying the air between decks, even in the absence of all appearance of epidemic fever; on account of the great number of individuals crowded together. But we hesitate not to proscribe the use of burning materials altogether, which can occasion the smallest risk of accident, though only by the grossest negligence, since their place can be so much better supplied by filling iron pipkins with sand previously heated, and afterwards

wards placing on them the vessels containing the salt, as practised by Mr. Menzies on board the Union Hospital Ship (No. 18); a process which has been generally acknowledged to be unattended with the least danger.

In order, however, to promote the slightest evaporation from the nitric acid, the heat must be carried to a certain degree; whilst the muriatic, on the contrary, is spontaneously disengaged in the form of a very diffusible gas. Fumigation may then be carried on without the aid of heat, and rendered equally efficacious, with no other inconveniency but that of consuming a little more salt than is absolutely essential, and, perhaps, a small additional quantity of the acid in order more suddenly to produce an abundance of vapours, the action of which in this way is more salutary than when they are extricated in a gradual manner.

181. It is not only as a security against danger from fire that I here insist on the practicability of *cold fumigations*. For although it is to be hoped that these preservative means will in the end be adopted under the superintendence of administration, in hospitals, ships, and indeed wherever a number of sick are crowded

crowded together, that they will not only be carried on with regularity, but every thing provided necessary for this purpose, nevertheless it will still frequently happen, that even individuals in the most affluent circumstances will neglect these means, or persuade themselves they are unnecessary, if they be always obliged to have recourse to a professional man, or provide a complicated apparatus. It is therefore necessary to remove these obstacles. The following receipt will render every individual capable of performing the process of fumigation; for which no other apparatus is necessary except a bottle of sulphuric acid (oil of vitriol of commerce), a large glass goblet, and some common salt. The goblet being placed on the ground, or on a table in the middle of the room, a large spoonful of the salt must be put into it, and a very small *liqueur* glass full of the acid should be added at three or four different times, with an interval between each time: at every effusion of the acid there will be disengaged and diffused throughout the apartment a quantity of vapour, which will come into contact with the fetid or malignant miasmata, without

out producing any inconvenience to the persons present.

When a chamber is to be purified, in which a patient has died of a disease supposed to be contagious, or in which bodies in a state of complete putrefaction have been suffered to remain for some time, it will be necessary to double, or even triple the quantity of the fumigating materials, according to the size of the apartment, to pour in the acid at once, and having retired, not to re-enter the room for some hours.

182. I have nothing to add to what has been already observed (Nos. 101 and 174) respecting the acetic acid as an habitual preservative against infection. The mode of preparing a portable flask of the extemporaneous oxy-muriatic acid is fully pointed out (Nos. 93 and 114). I shall therefore only observe, that when we cannot easily procure either the nitro-muriatic acid, or the nitric and muriatic acid separately, that the same effects will be produced by putting into the flask along with the oxyd of manganese, double its weight of common salt, and then pouring upon them the nitric acid, or even *aqua fortis* of commerce, without being at the trouble of rectifying it.

183. After having mentioned the oxygenated muriatic acid gas as the most powerful and efficacious anti-contagious agent, I ought also to give some directions respecting the mode of employing it. This operation differs only from that with the ordinary muriatic acid already mentioned (No. 177), by the addition of a small quantity of black oxyd of manganese. The proportions employed by Mr. Cruickshank were two parts of salt, one of manganese, one and a half of water, and two of sulphuric acid (No. 32): it will be sufficient to to cast our eye over the tables of the composition of salts and metallic oxyds*, to be convinced that these quantities cannot fully combine, and that there must be a considerable waste of the materials. The following proportions I have found to approach as near as possible to the point of saturation, without any excess, except what is necessary to obtain a complete

* On this subject we may consult the Tables of M. Kirwan, in the second volume of his *Elements of Mineralogy*, or the extract I have given in the twenty-fourth volume of the *Annales de Chimie*, p. 282, from his inquiries into the constituent parts of salts.

In this process two decagrammes of black oxyd of manganese furnished eighteen decigrammes in weight, and in bulk reduced to the mean temperature 1305 cubic centimetres of oxygen, independent of that which it retained on entering into the saline combination.

and

and progressive, though not a rapid decomposition.

	Decagrammes.		oz.	dr.	gr.
Common Salt	10	about	3	2	10
Black oxyd of manganese	2	—	0	5	17
Water	4	—	1	2	33
Sulphuric acid	6	—	1	7	50

We must first reduce to powder the oxyd of manganese, which is sold by the druggists under the name of manganese simply, and which is much employed in the manufacture of glass. It is a hard stony substance of a deep black colour. That which is intermixed with shining crystals is most valued, although any advantages it may possess on that account are far more than counterbalanced by its greater price : it is sufficient that it be free from extraneous substances (No. 127). Sometimes it is kept ready powdered in the shops.

After triturating together the salt and manganese, they must be put into a glass or stoneware vessel, and the water added to them, and afterwards the sulphuric acid all at once, when the process is carried on in uninhabited chambers ; but at two or three different times in wards filled with the sick.

184. The above quantities are sufficient for the purification of a ward containing ten beds ;

and may be augmented or diminished according to the size of the apartment, but always in the same proportions. It is besides necessary to attend to what has been already said (No. 178) respecting the distribution of the apparatus at different points, the method of carrying them about the wards and pouring in the acid slowly at different times (No. 179), and the manner of regulating the quantity of acid without trouble or fear of accident.

It will not be difficult to distinguish those cases in which the quantities of the materials ought rather to be augmented than diminished, as when we propose to destroy, by a single operation, infection in a place which is not exposed to receive it anew; those cases where the fumigations must be carried on with caution, and from time to time with small quantities of the materials; those in a word where the contagion is evident, the fœtor always increasing, and the miasmata constantly reproduced in abundance, so as to require daily fumigation, and even sometimes that it be repeated morning and evening. But in this respect there can be no certain rule pointed out, we must be altogether regulated by circumstances.

When the effects of these fumigations are better known, I dare flatter myself they will
be

be solicited even by the sick themselves; that they will inform the medical attendants of the necessity for their continuance or renewal, in the same manner as is mentioned by Mr. Menzies with respect to the fumigations with the nitric acid on board the Union hospital ship, and some of the vessels belonging to the Russian squadron (Nos. 21 and 22).

It is here unnecessary to remark, how simple and easy of execution these processes are even to individuals least accustomed to such operations, how generally they are applicable in all cases whatever, requiring neither an extraordinary apparatus, nor fire, not even the heat of a sand bath; a consideration of the greatest importance when they are employed on shipboard.

185. Can these processes be neglected on account of the expence which they require? It is so moderate, that it is impossible to suppose it can ever furnish a sufficient motive to excuse a neglect of this practice, which will be readily perceived from the following prices of the materials that are employed.

The Kilogramme		Fr.	Cent.
2lb. 5 $\frac{1}{2}$ dr.	of common salt.....	0	21
	of oxyd of manganese....	0	52
	of sulphuric acid.....	1	54

When

When to these prices is added a third more on account of carriage and other extra expences, the fumigation of a ward containing ten beds will cost

	Decagr. Cent.		
Common salt	10	2	72
Oxyd of manganese	2	1	36
Sulphuric acid	6	12	31
Total	0	16	38 *

Thus the expence of each fumigation, in a ward of the above extent, will not be altogether seventeen centimes, and the same process may be repeated ten times for one franc seventy centimes.

I do not mention the original cost of the utensils, which only consist of two or three flasks, as many pipkins, and a glass funnel; as they can be only rendered unserviceable by accident, their renewal will never be an object of much moment.

I have already observed (No. 33), that it has been proposed, at Madrid, to convert the residue of the materials to some useful purpose; this is doubtless a consideration not to be neglected, particularly where fumigations are daily carried on; but as it cannot be employed

* In England, the expence of a similar process would scarcely exceed the trifling sum of *three-pence*. T.

in medicine, or even enter into veterinary pharmacy, without being subjected to new processes, it is not of so much value as greatly to diminish the original expence.

Conclusion.

186. Conceiving that I have fulfilled the task which I imposed on myself, in such a manner as to enable all classes of society, and even individuals the least intelligent, to put in practice the means of purifying infected air, of preventing every kind of contagion, and arresting its progress; I have now only to conclude, by repeating the wish I have already expressed (Nos. 15 and 163), that the time may speedily arrive when the hopes I have cherished shall be completely realized. If the attention I have bestowed to discover the best preservatives, and most powerful anti-contagious agents, to establish the theory of their action on a solid foundation, to examine their effects by direct experiment and authentic testimony, can inspire sufficient confidence, too many occasions will unfortunately present themselves for making these trials. I sincerely hope for the advancement of the healing art, that these processes will not be neglected, or what is the same thing, that they will

will not remain buried in records of correspondence, but immediately be published in official reports through the medium of the periodical papers, in order to fix the opinions, to overcome ancient prejudices, and to diffuse the knowledge of principles which observation will confirm; in a word, to enforce their application by the influence of example. How few individuals have either the leisure, or the inclination, to examine thoroughly such questions by reading and reflection! Every person turns an attentive ear to the recital of a calamity which threatens general destruction, they are painfully affected with a view of its ravages, and enquire with an interest, mingled with terror, what means have been employed to arrest its progress, what success has attended them: it is to this feeling we must entrust the care of recommending their use, of perpetuating their remembrance, and of rapidly transforming them into a common tradition; those who shall communicate the first impression of it to society in general, will prove themselves the best benefactors of mankind.

FINIS.

